Strangling Speculation:

The Effect of the 1903 Viennese Futures Trading Ban

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Abstract

How does futures trading affect the volatility of spot prices? This paper uses a unique early-twentieth century setting to test what happens when futures trading no longer exists. In 1903, futures trading in the Viennese grain market was banned. The permanency of this ban makes it ideal for studying the prohibition's effect on volatility. Prices from Budapest, a market operating under similar conditions but unaffected by the ban, are used as a control. This paper finds increased spot price volatility and lower pricing accuracy because the information-transmission and risk-allocation functions of the futures market were no longer maintained.

JEL Codes: N23, G13, G14, G18, G41, E65

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Introduction

Ever since the emergence of futures markets, the effect of futures trading on spot price volatility has been subject to debate. While the populist discourse affirms the adverse and price-disturbing consequences of futures trading, a big part of the economics literature claims that futures markets keep down spot price volatility. In this paper, I test the effects of futures trading on the cash market by looking at what happens if futures trading no longer exists. To do so, I go back to the early twentieth century, when futures trading in the Viennese grain market was, unlike in other cities at the time, banned permanently, with Vienna remaining without a futures market in grain until today. The uniqueness of this ban makes it an ideal natural experiment to test the effect of futures trading and its abolishment on spot price volatility.

In the extant literature, a variety of studies find that futures trading allows better regulation of production and consumption, and offers hedging opportunities (Keynes, 1930; Jacks, 2007; Günay and Haque, 2015). Furthermore, in the empirical work on futures markets, information flowing from futures to spot markets is believed to be essential for pricing cash transactions, increasing pricing accuracy and depressing spot price volatility (Cox, 1976; Garbade and Silber, 1986; Fama and French, 1987; Ross, 1989; Gibson and Schwartz 1990; Bessembinder et al., 1995).[1] Using daily spot and futures prices collected from the Viennese Agricultural Products Exchange's archived quotation lists and from newspapers of the time, with prices from Budapest used as a control, I test two hypotheses: (I) the ban of futures trading in the Viennese market increased the volatility of spot prices, as the risk-allocation and information transmission function of futures markets towards cash markets was no longer maintained; and (II) the ban altered information flows from futures to spot markets.

[1] Also see Butterworth (2000), Fung et al. (2003), Gorton and Rouwenhorst (2004), Jacks (2007), Balcome (2009), Hernandez and Torero (2010), and Gutierrez (2012).

The Vienna and Budapest markets provide a unique setup, because they were similarly organised, offered the same types of grain, and were the only two locations in the Austro-Hungarian Empire with a futures trade in grain. The ban only affected the Viennese market, while the Budapest Stock and Commodity Exchange (BSCE) continued to operate with an intact futures market, making it an ideal control. As information is likely to flow in from the Budapest futures market after the ban, possibly dampening the effect of the prohibition on spot price volatility in Vienna, I also test for Granger causality between the two cities.

A number of anti-futures trading movements, driven mainly by scepticism from farmers and conservative parties against speculation, developed around the globe in the 1880s and 1890s. However, unlike in Vienna, none of these resulted in a permanent prohibition. In Texas, a Hatch bill passed by the Congress in 1892 imposed a 10 percent flat-rate tax on all futures transactions in grain and cotton (Jacks, 2007, p. 344). In Ohio, anti-option bills were aimed to ban and prosecute any trade in commodity futures. In England, an 1893 anti-futures-trading movement led to an examination of the national agriculture's decline. In Berlin, an inquiry was summoned on the harmful effects of futures trading on agriculture, leading to an 1896 Law entailing a ban in trading grain futures (Kienböck 1897, pp. 1-5). These regulations were not permanent, as parties fought for the continuance of futures trading. The uncertainty of these regulations as well as their non-permanency make them unsuitable for testing for any lasting and uncontaminated effects.

The Vienna and Budapest markets were important for trade in grain. The Austro-Hungarian Empire used Vienna as its centrepiece of trade, with a 1903 trade volume of 400,000 tons at the city's Agricultural Products Exchange, and was a major location for the international trade and consumption of grain.[2] The trading volume of the BSCE amounted to around 400,000

[2] *Wiener Landwirtschaftliche Zeitung*, 5 December 1903; see also *Wiener Allgemeine Zeitung*, 8 July 1882; *Neue Freie Presse*, 16 September 1894; *Welt Blatt*, 30 August 1900; *Pester Lloyd*, 29 November 1900, etc..

tons in 1875, growing to one million tons by the end of the century (Korányi and Szeles 2005). Kostolany (2006) described the grain exchange and futures market in Budapest as the most important one at the European level prior to World War I. Substantial amounts were traded on both futures markets, with volumes ten to fifty times higher than effective spot sales (Borchardt 1999, p. 16), amounting to millions of crowns (Kostolany, 2006). Arbitrage opportunities attracted speculators. Newspapers remarked that "millions of hundredweights of grain" were traded on paper by those who "lacked the knowledge to distinguish between rye and wheat".[3] Parliamentary debates on the harmfulness of speculation led to the Viennese futures trading ban on 9 April 1903 – a day the Austrian newspaper *Neue Freie Presse* described as "historical for the Viennese grain trade".

With Budapest as a control, spot price volatility in Vienna is found to increase after the ban, with a higher intra-day variation of spot prices. This supports the existence of futures trading as making cash markets more efficient and increasing the speed and quality at which information is incorporated into spot prices, which then better reflect market information (Cox; 1976; Garbade and Silber, 1986; Fama and French, 1987; Bessembinder et al., 1995).[4] Without futures trading, the spot market lacks pricing accuracy and efficiency. In addition, information flows between the futures and spot markets of Vienna and Budapest are found to have existed prior to the ban, which links to the information transmission of futures towards cash markets and the close ties between the two cities. After futures trading is prohibited in Vienna, Budapest futures prices with three to six months maturity significantly continue to Granger-cause Viennese spot prices. The majority of related studies has examined the effect of futures trading on spot price volatility by using stock indices, focusing mainly on the U.S. market and modern-

[3] *Ostdeutsche Rundschau*, 28 November 1901. This newspaper was not politically or socially affiliated and did not position in favour of or against speculating parties.
[4] Also see Edwards (1988), Ross (1989), Gibson and Schwartz (1990), Holmes (1996), Butterworth (2000), Bologna and Cavallo (2002), Fung et al. (2003), Gorton and Rouwenhorst (2004), Baklaci and Tutek (2006), Alexakis (2007), Jacks (2007), Balcome (2009), Hernandez and Torero (2010), Srinivasan (2010), Gutierrez (2012).

day introductions of futures trading. This work, utilising the prohibition of futures trading as a natural experiment, contributes to the historical study of futures markets up to the present day pioneered by Mixon (2009), Moore and Juh (2006) and Chambers and Saleuddin (2019), as well as to understanding spot market stability and efficiency.[5]

The paper is structured as follows: in the first section, the extant literature on futures trading and its effects is discussed. The second section provides historical background on the futures trading ban. In the third section, I present the dataset, explaining the analysed window and spot and futures prices collected. In the fourth section, I elaborate on the empirical work and data analysis. I first provide an overview of the empirical strategy, volatility clustering after the ban and summary statistics. Then, futures-spot information flows are assessed through Granger causality. Finally, I present the difference-in-difference results on the ban's effects on spot price volatility, with prices from Budapest used as a control. In the last section, I discuss and conclude my findings.

Futures trading and the spot market

Futures markets complement spot markets. With a number of functions fulfilled by the practice of futures trading, possibly overshadowed by the controversies of speculation, futures markets work to contain volatility on the spot market. In their risk-transfer role, futures markets reallocate risk from producers to speculators (see Gutierrez, 2012). They are also a means to information transmission. Futures prices reflect actual and expected supply, demand and inventory news, increasing traders' information (Cox, 1976, p. 1215). While, particularly in commodity markets, radical news can provoke large price fluctuations (see Hilliard and Reis

[5] Mixon (2009), Moore and Juh (2006) and Chambers and Saleuddin (2019) found that nineteenth and early twentieth-century markets were largely efficient and did not differ much from today's markets.

1998), futures markets have the potential to lower spot price volatility (Jacks, 2007, p. 346). With futures trading, prices react more smoothly to market changes.

Assuming rational expectations, the existence of a futures market implies that at any given time, prices constitute the best estimate that can be made from currently available information on the price at the futures contract's delivery date (Jacks, 2007, p. 346). Tesler (1958) described the future price as the average of traders' expectations of the spot price at the futures contract's maturity. In a competitive futures market, information is reflected instantaneously, with prices and market participants reacting rapidly to new information. Any movement away from prices based on fundamentals is thus likely to be of a short-lived nature, as traders work to correct the price movement until a new equilibrium is attained (Etienne et al., 2013, pp. 12-20).

This information transmission function of futures markets allows for competitive and efficient markets, which not only ensure timely information flows to spot markets, but also increase the speed at which information is transmitted. With an intact futures trade, market prices show more precise signals for resource allocation (Cox 1976, p. 1235). This has been shown empirically: a number of studies on the introduction of futures trading using GARCH models found a decrease in spot price volatility favoured by enhanced pricing. Edwards (1988), Holmes (1996), and Bologna and Cavallo (2002) demonstrated that the introduction of futures trading positively affects information transmission and price discovery. With a focus on emerging markets, Baklaci and Tutek (2006) and Srinivasan (2010) found that in Turkey and India, the introduction of futures trading increased the efficiency of spot markets. Alexakis (2007) came to the result that futures trading allows for efficient market operation due to its stabilising effect on the spot market, reducing volatility asymmetries.

Fama and French (1987), Gibson and Schwartz (1990), Bessembinder et al. (1995), Hernandez and Torero (2010), and Gutierrez (2012) also emphasised the information

transmission through futures trading. Futures markets were found to be strongly intertwined with spot markets (see Garbade and Silber, 1986; Ross, 1989; Antoniou and Holmes, 1995). This especially holds true for commodity markets. In their model of simultaneous price dynamics, Garbade and Silber (1986) found that spot markets in wheat were largely satellites of futures markets, with about 75 per cent of new information incorporated first in futures prices and subsequently flowing to cash prices. They, however, also found evidence of information flowing in the reverse direction: from cash to futures markets. In his volatility study of 19 agricultural commodities from 1962 to 2008, using a panel regression, Balcombe (2009) found strong evidence of transmission of volatilities across prices.

Information does not necessarily have to flow between the futures and spot market of one trade location: it can also flow between the markets of different cities. Hill et al. (1990), and Fung and Lo (1995) studied such cross-market relationships between futures and spot prices. Fung et al. (2003) found that the U.S. futures market transmits information to the Chinese market, highlighting its important role as a leader in the global financial market. According to the authors, government policies and regulation of financial markets are prone to alter patterns of information flows.

Early economists, such as Mill (1871), Kohn (1891), and Keynes (1930), had supported the emergence of futures markets, as they allowed for hedging opportunities and standardisation (Kienböck 1897). Farmers' fear of "undue" speculation brought upon by futures trading was based on the assumption that it would destabilise spot prices and impose losses. Crump (1874, pp. 130-31) distinguished between corrective, either downward or upward price-stabilising speculation in time bargains, and illegitimate, destabilising speculation by agents who pursued short-term opportunities for profit but often acted irrationally. According to Günay and Haque (2015, p. 266), if speculation were to destabilise spot prices, high volatility would necessitate high risk premium under the risk aversion view.

This would result in misallocation and welfare loss, a line of argument often used by regulatory authorities. Countering the destabilisation argument, Günay and Haque (2015, p. 267) outlined that futures decrease risk, allowing prices to be competitive.

The testable hypotheses of this paper are: (I) The ban of futures trading in the Viennese market increased the volatility of spot prices as the risk-allocation and information transmission function of futures markets towards cash markets was no longer maintained, and (II) the ban altered information flows from futures to spot markets.

Historical Background

The Agricultural Products Exchange in Vienna was founded as an independent institution in 1869.[6] One year earlier, in Budapest, the Hungarian Stock Exchange had acquired the Grain Hall, the then centre of grain trade, to create the Budapest Stock and Commodity Exchange (BSCE) (Korányi and Szeles 2005). These two major Austro-Hungarian exchanges served as intermediaries for buyers and sellers of grain. While the Agricultural Products Exchange in Vienna was an autonomous exchange specialised in agricultural commodities, the BSCE was part of the Hungarian Stock Exchange. Despite their similarities and overlapping cultivation regions, the Viennese and Budapest grain markets were segmented, with their own trading terms and conditions, staff, and trading parties. At both exchanges, individual standardised terms served as a basis for contracts (Treibl 1903, p. 12-14).[7]

The Agricultural Products Exchange's Statutes and Law of 1875 sought to officially establish a futures trade in the Viennese grain market. For Budapest, since the very foundation

[6] The Agricultural Products Exchange was initially named "Fruit and Flour Exchange" and had operated as a loose organisation from 1842 to 1853, when it was reorganised as an urban commodity exchange (Treibl 1903, p. 71) The exchange consisted of a team of state supervision officers, a governing board, and an exchange office, as well as an entity intervening in cases of dispute (Treibl 1903, pp. 409-416).

[7] The first listing of commodity prices dates back to 1869. In 1873, one year before the official introduction of futures trading, a reform of the listing system took place, as first unofficial futures trading was said to manipulate spot prices (Treibl 1903, pp. 112-126).

of the BSCE, newspapers had listed futures prices for grain. The purpose of officially introducing futures trading in Vienna as well was to be more competitive and involved in foreign trade, which had been limited by high tariffs (Treibl 1903, p. 224). The trade in commodity futures implied that both the delivery and payment were to happen in the future. Based on the written records of the exchanges' trading terms, buyers and sellers had to determine the price, date of delivery, and number of contracts. One contract implied a trade volume of 500 *Meterzentner*. One *Meterzentner* corresponded to 100 kilograms (Treibl 1903, pp. 12-14).[8]

As with other major grain exchanges in the early twentieth century, such as the Berlin Products Exchange, the Paris Grain Exchange (Bourse De Commerce), or Mark Lane in London, the Agricultural Products Exchange and the BSCE had clearing entities to ensure smooth settlement.[9] When grain was handed over at the Agricultural Products Exchange, sellers received a transaction certificate with the secretary's stamp and an identification number. This had to be filled out by the seller, providing the name of both contracting parties, quantity, and price as well as the transaction date and foreseen handover.[10] If the buyer's intention was to resell, a transaction certificate had to be given to the new buyer. The eventual buyer could undergo clearing in the secretary's office, where he received permission to inspect and buy the grain (Treibl 1903, pp. 12-14).[11]

Similar to the Halle Aux Blés, serving as the grain trading centre of the Paris Bourse de Commerce, the Viennese and Budapest exchanges offered a large trading hall, providing a

[8] The exchange's trading terms determined the quality of the good, such as its composition and degree of purity, its weight per hectolitre as well as the time periods applying to a futures contract (Treibl 1903, p. 396).
[9] The clearing entity was located in the exchange's secretary's office. It supervised all transactions and its main responsibility was to conduct difference payments. Despite assuming no liability, transactions had to be legally declared (Kienböck 1897, 12-14).
[10] After filling out the transaction certificate, the seller or his authorised representative entered a dedicated hall and handed over the certificate. The time of handover was protocolled by the exchange (Treibl 1903, 12-13).
[11] Deliveries usually took place under the carrier's address, as receiving parties were mostly unknown. Recipients could be changed at the dispatching station's order (Treibl 1903, 371-72).

meeting point for sellers, buyers, and other stakeholders. Telegraphic connections enabled a constant interaction with major grain trading centres, such as Budapest, Berlin, Paris, London, Chicago, and New York.[12]

According to Treibl (1903), futures trading gave rise to speculation. An increasing number of non-commercial traders started to participate. They were not interested in the physical commodity, but resold futures contracts. When crops and storages were scarce, end consumers bought from speculators wishing to collect the grain. However, contracts by then often comprised too large and undeliverable amounts of grain and speculators were unable to perform their obligations.[13]

It was the persistent scepticism towards speculation which led to the eventual ban. On 27 November 1887, 37 Viennese grain trading companies declared they would not enter into business with speculators (Treibl 1903, pp. 226-233).[14] On 16 December 1893, the Exchange chamber, an important 36-represenatives body of the Agricultural Products Exchange, and responsible for regulations and disputes, published an announcement against the immorality of intervening with non-commerce-related parties (Kienböck 1897, p. 21). In 1896, the International Grain and Seeds Market, an annual convention held in Vienna since 1873, was shut down due to the opposition of local farmers, who claimed that the institution promoted speculation.[15]

[12] Compare *Neue Freie Presse*, 1900-1903.
[13] *Pester Lloyd*, 23 April 1903.
[14] Among the group of people suspected of speculation were all parties who were not directly related to the exchange's regular commerce: small merchants, farmers, lower staff, commissioned officers, clerics, journalists, artists, and women. The Agricultural Products Exchange introduced further measures such as access limited to selected commerce-related members, restricted information on listings, deposit fees or day passes (Treibl 1903, pp. 226-233).
[15] *Wiener Landwirtschaftliche Zeitung*, 22 June 1898. The International Grain and Seeds Market was one of the most important evaluators of the European grain trade, in its first 15 years of existence attended by 2000-3000 representatives (Deutsches Volksblatt, 11 January 1903).

The movement to ban futures trading was initiated by a number of parties, one of which was the Austrian government.[16] The parliament's agricultural department held meetings in January 1897 to discuss the practice of futures trading. The experts at the meeting recommended curbing speculation, but not banning futures trading (Kienböck 1897, pp. 8-9). This recommendation was not acted upon. In autumn 1900, an inquiry was launched, which eventually led to the prohibition of futures trading.[17] A legal draft to reform the exchange foresaw curbing any illegal advantage drawn from speculation. In 1902, an economic committee nominated by the government revised the draft, fearing that the new regulations could drive away traders. It was decided to ban any trade in futures by 1 May 1903 (Treibl 1903, pp. 386-89).

The ban went through as part of the New Law of 4 January 1903, which came into effect on 10 April 1903. The period between January and April was designed to allow a smooth settlement of remaining contracts. On 4 and 5 April 1903, the newspapers *Neues Wiener Tagblatt* and *Ostdeutsche Rundschau* reported on an announcement made by the Exchange chamber: the last futures contracts to be liquidated had to be registered by 10 April, with liquidation of existent futures contracts possible until 30 April. The last futures prices were listed on 9 April 1903, described by newspapers as the day futures trading ended.

[16] A growing resentment against the exchange during the 1890s led to an 1896 attempt to legally establish a right for farmers associations to participate in the pricing process. This measure, however, was said to curb the exchange's autonomy (Treibl 1903, p. 333).

[17] In early 1900, following the exchange chamber elections, the Lower Austrian Mill Association raised a protest. A right to vote had been given to persons with non-Austrian nationalities. This sparked an inquiry entitled "Enquete über den börsenmäßigen Terminhandel", which also was to deal with the practice of futures trading. It lasted from 11 October to 8 December 1900. An expert panel was formed by the president of the court of arbitration (replaced by a member of the governing board due to sickness), the head of the exchange office's legal department, the leading members of the exchange chamber, and a leading inquiry commission. The expert panel addressed 47 questions. Ten of these were related to the definition, development and effects of futures trading. Another five questions were to determine whether a limitation or entire ban of futures trading would be more effective in curbing "undue" speculation. A section entitled "Reform" contained nine questions regarding the changes in standardised trading terms that had to be considered along with a reformed futures trade. The section "Sanction" comprised 19 questions and was to determine what had to be done to ensure compliance. The last four questions dealt with limiting the exchange's autonomy (Treibl 1903, pp. 366-68).

The new law also changed the organisation of the exchange. Any futures trade in agricultural commodities in and outside of the Agricultural Products Exchange was forbidden. Futures trading based on the exchange's clearing entity or price listings and trading terms was subject to legal prosecution. Despite resistance from other Austrian exchanges in a delegate conference against the new measures, the new law, finally ratified as "Law of New Exchange Organisation", passed through on 10 May 1903, setting in stone the permanency of the ban (Treibl 1903, p. 404). The Agricultural Products Exchange lost autonomy. Pricing and one third of the Exchange chamber representatives were now determined by the government. (Treibl 1903, p. 395).[18] New personnel were introduced to the exchange.[19] To Austrian citizens, futures trading at other locations, particularly at the BSCE, was not allowed.[20] This loss in autonomy to the state, as well as the lost pricing power of the Agricultural Products Exchange, impeded a reestablishment of futures trading in the Viennese grain market.

The Exchange chamber, in charge of the development of trade at the Agricultural Products Exchange, published a report on the adverse effects of the ban, fearing a substantial harm done to the spot trade.[21] On 10 April, one day after the last listings of futures prices, *Die Zeit* had confirmed that the Agricultural Products Exchange was in danger of losing members. Newspapers reported that both national as well as international producers avoided the market and supplies decreased, despite high stocks and a successful 1902 harvest. Producers tried to store whilst waiting for the return of favourable market conditions. Some Viennese firms

[18] Among the elected representatives had to be twelve grain traders, five millers, two bakers, and five freely elected members of different professions (Treibl 1903, p. 395).
[19] After having operated as a joint body, the exchange council, the Agricultural Products Exchange's governing body, had to be separated from the exchange's court of arbitration. The 36 council members, however, still had to serve as officials within the court of arbitration, together with 12 judges elected by the exchange members, as well as professional judges determined by the Chamber of Trade and Association of Agriculture (Treibl 1903, p. 396).
[20] *Wiener Landwirtschaftliche Zeitung*, 8 May 1907.
[21] In late March 1903, the *Neue Freie Presse* reported that especially Bohemian traders had lost interest in entering business in Vienna, as wheat prices were substantially lower in Prague. Bohemian farmers, producers themselves, who had been known as both hedgers and speculators, pulled back from the Viennese market.

started to use the Budapest spot market.[22] Figure 1 shows that in the year following the ban, despite a peak in October 1903, the quantities of wheat sold at the BSCE spot market, however, did not increase. Producers mainly turned to direct sales in the Austrian provinces.[23]

<<INSERT FIGURE 1>>

What happened to speculators after the ban? Did they simply disappear? Newspapers at the time described speculators as undeterred about which market or asset they speculated in. According to an article in the *Ostdeutsche Rundschau* on 9 March 1902, a speculator would "not care whether today he speculated in grain, tomorrow in leather and the day after tomorrow in antiserum". Grain speculators would easily switch to company shares, the *Arbeiter-Zeitung* pointed out[24]. The 1903 futures trading ban thus caused both producers and speculators to abstain from using the Viennese grain market.[25] The main alternative was not the Budapest market, but other assets and commodities for speculators and direct spot sales for producers.

Data

In order to test the effect of the Viennese ban on futures trading, I collected the daily spot and futures price minima and maxima at market close for wheat, rye, oats, and corn from Vienna and Budapest, as well as the number of futures contracts sold in both cities for the period October 1902 to October 1903.[26] Prices from Vienna were taken from quotation lists of the Agricultural Products Exchange archives. Data for Budapest was collected from the newspapers *Pester Lloyd* and *Ostdeutsche Rundschau*.

[22] *Deutsches Volksblatt*, 10 August 1904.
[23] *Wiener Landwirtschaftliche Zeitung*, 19 April 1903.
[24] *Arbeiter-Zeitung*, 30 March 1902.
[25] *Neue Freie Presse*, 1 March 1903.
[26] While futures prices are standardised, spot price ranges correspond to different types of wheat, rye, oats and corn. Theiss is the main wheat type sold at both trade locations (in terms of quantity). In the case of other grain types, Hungarian rye, oats and corn, are used for the analysis. These are also subject to trade in both cities.

Both cities sold equal plus some additional types of wheat, rye, and oats. Wheat, rye and oats were the only grain types for which a futures trade existed in both cities and are thus used to test for the effects of the ban on spot price volatility. Corn was traded on the Budapest futures market, but ceased to be traded on the Viennese futures market in November 1902, well before the ban. Spot prices from corn thus provide an alternative control for the Viennese market.

Price listings at the Agricultural Products Exchange were officially published around 2.30 pm each afternoon (Kienböck 1897, p. 14).[27] The 1902-1903 listings had the annotation "prices of 12:30". The minimum and maximum closing prices served as an orientation for buyers and sellers in each trading session. As grain quality differed, there was a quality standard for grain sold at the exchange. This quality standard was given in ranges. In April 1903, at the Agricultural Products Exchange, wheat, for example, could be sold if it had a quality weight of 78-82 kilograms per hectolitre – at the BSCE, it had to have a quality weight of 78-81 kilograms per hectolitre. While this weight range stayed constant throughout the analysed window and was only altered one to three times a year and only by about 1 kilogram, the daily price spread was subject to frequent changes reflecting price volatility. Minimum-maximum price ranges in quotation lists differed from bid-ask spreads, as they were determined by the exchange's pricing commission after observing the high-lows that had occurred during the previous trading session.

Because 9 April 1903 corresponds to the last day futures prices were listed, I treat 10 April 1903 as the first day without futures trading. Investors at the Agricultural Products Exchange could enter into spring, summer and autumn contracts. For all grain types, the spring period lasted from 1 March to 30 April, and the autumn period from 1 September to 31 October. The maturity period for summer contracts varied between May-June and August-September

[27] A commission elected by the exchange's governing board together with the exchange commissioner were responsible for the determination of prices (Kienböck 1897, p. 14).

(Treibl 1903, pp. 12-13, 360). In Budapest, April, May and October futures contracts were sold for wheat, rye, and oats, and May, June, July, August, September and October contracts were sold for corn.

In Vienna, spring futures prices were listed between August and April of each year. In late March, the listing of May-June futures prices started for wheat, rye and oats.[28] From October 1902 until the ban came into effect, traders were able to enter into futures contracts with maturity in autumn 1902 or spring 1903. This is equivalent to the years prior to the ban. As the ban came into effect in early April, no summer or autumn contracts were sold before late March. Therefore, speculators were able to make use of the Viennese futures market as usual in the months prior to the ban and there is no evidence of reduced usage of futures before the ban came into effect.

There are other factors which can cause a potential bias in the assessment of commodity price movements: in particular, seasonality. Seasonality is linked to weather conditions and harvests. Kaldor (1960, p. 12) argued that agricultural crops have unstable and inelastic supply curves due to frequent and unpredictable shifts caused by weather, which also affect prices and provoke fluctuations. According to Arismendi et al. (2016, pp. 53-54), seasonality can appear at the price level, but there is also seasonality in volatility, mainly driven by the supply side. Therefore, I examine the 1902 and 1903 grain harvests, which could affect the analysed window in Figure 2.

<<<INSERT FIGURE 2>>>

Table 1 provides 1902 and 1903 harvest statistics and compares them to the previous years.[29] The Hungarian part of the Monarchy was dependent on Austrian buyers, with 75-80

[28] For corn, contracts with May-June maturity started to be sold in the autumn period.

[29] In the Austro-Hungarian Empire, wheat, rye and oats were harvested in the summer period, between June and August. Corn harvests were scheduled for the period October to November (compare Wiener Landwirtschaftliche Zeitung, 1900-1903).

percent of Hungary's grain surplus sold in Austria.[30] Apart from corn, the 1902 grain harvest yields surpassed the previous years (K.K. Statistische Zentral Kommission, 1903).[31] This ensures that enough grain was available at the time of the ban. In 1903, the Austro-Hungarian harvest amounted to approximately the same overall quantity. While the 1902 harvest is important for the period of analysis in terms of grain quantities available, the expected outcome of the 1903 harvest might also have influenced pricing behaviour. On 13 June 1903, *Die Zeit* reported that this year's harvest was falling slightly below 1902. Weather and environmental conditions, however, were described as very favourable.[32] In some parts of Austria, such as Styria, an extraordinary harvest had been expected for summer 1903, especially for oats.[33] Continual rain, however, did slightly affect harvests, but stores of grain from the previous seasons' harvests were high at the time of the ban.[34] The quality weight of wheat, rye and oat turned out to be one kilogram per hectolitre higher in 1903 compared to 1902. The quality and harvest yields of corn, however, were expected to be lower in 1903.[35] This shows that harvest expectations and actual harvests were relatively stable for the period analysed and are unlikely to have caused stronger fluctuations or a bias in the analysis conducted. The uncertainty around the 1903 harvest of corn, however, is likely to cause seasonality patterns for this commodity, which we use as an additional control only. Intra-year seasonality is dealt with through the difference-in-difference analysis with Vienna and Budapest - two markets with almost equal weather and harvest conditions.

<<<INSERT TABLE 1>>>

[30] *Wiener Landwirtschaftliche Zeitung*, 20 August 1902.
[31] Newspapers reported on a qualitatively and quantitatively bad corn harvest in Hungary and the Danube countries, which drove up prices. This resulted in high imports of Romanian corn in Budapest and Russian as well as American corn in Vienna – the latter two sold at considerably lower prices than the domestic commodity (compare Neue Freie Presse, 1903).
[32] *Neues Wiener Journal*, 29 April 1903.
[33] *Wiener Zeitung*, 19 August 1903.
[34] *Grazer Volksblatt*, 20 November 1903.
[35] *Pester Lloyd*, 1 September 1903.

Table 2 provides summary statistics of spot price minima-maxima ranges for wheat, rye, oats and corn in Vienna. It can be observed that there are more extremes in rye and oats prices after the ban. This is not the case for corn, which was traded on the spot market only. Commodities, for which a futures trade existed, are expected to show a clear reaction to the ban. This effect clearly comes through for rye and oats.

<<<INSERT TABLE 2>>>

The effect of the ban

Empirical Strategy

I hypothesise that the 1903 futures trading ban in the Viennese grain market caused an increase in spot price volatility, as the information-transmission and risk-allocation function of futures markets was no longer maintained. As information no longer flows from the futures to the spot market, I expect the pricing of cash transactions to become inaccurate. This should be reflected in a larger intra-day spread of spot prices. To test this, I run a difference-in-difference analysis with the intraday-variation of spot prices, using prices from Budapest as a control. Before that, I visualise the conditional standard deviation of spot prices as a GARCH-modelled series, to get a general idea of highs in volatility and volatility clustering after the ban. I then look at summary statistics of intra-day variation and compare them to day-by-day variation. I also assess Granger causality between the futures and spot markets of Vienna and Budapest, to see whether after the Viennese ban, information for pricing spot transactions started to flow in from the Budapest futures market, which might lessen the effect of the ban on intra-day variation.

The intra-day spread of spot prices is a measure for daily price fluctuations. These are kept down as long as information flows in from the futures market, because futures prices provide precise estimates for pricing cash transactions (Jacks 2007, p. 346). Each trading day's minima-maxima ranges are based on the high-lows of the previous trading session. They are

also linked to a quality range. According to Brunt and Cannon (2015, pp. 74-81), pre-1914 grain data is often shaped by unobserved quality variation, and two-thirds of the price differential in price ranges derive from differential grain weights. Especially the quality of oats tends to fall throughout the year. Quality variation in the Vienna und Budapest data, however, is kept constant, as quality ranges only changed one to three times a year and, once set, had to be adhered to. This was controlled by the exchange. If there was no weight guarantee and grain to be sold did not meet the quality weight by 700 grams or more (Treibl, 1903, p. 214), grain counted as "not deliverable" (Treibl, 1903, p. 143). Small deviations from the quality weight were financially compensated between buyers and sellers. The bonus paid for "too high quality" grain was not reflected in the price spread, because it was paid extra as a so-called "bonification".[36] In Vienna and Budapest, there was therefore constancy in the quality weight, while the corresponding price spread was subject to fluctuation independently of quality. While the price spread had been kept down before the ban through accurate pricing, it is expected to have increased in its aftermath, as information no longer flew in from the futures market. A high spread translates into larger intra-day volatility. This process would continue, until either the exchange's pricing committee artificially lowered the minimum-maximum range, or until traders used less extreme prices. A growing intra-day spread is also a measure for market stability, and thus suitable for testing the effects of interrupted information transmission caused by the abolishment of futures trading.

Measuring volatility

A first intuition of spot price volatility can be gained when graphing the GARCH-modelled conditional standard deviations of grain spot prices, shown in Figures 3 and 4. This can help to learn if volatility peaked a specific time after the ban or showed some clustering patterns. The

[36] see also *Linzer Tages-Post*, 22 July 1902; *Pester Lloyd*, 13 November 1901 and 29 December 1901

volatility of rye and oats spot prices clearly increased after the ban. The volatility of wheat spot prices also increased, but wheat shows a stronger seasonal pattern. While rye and oats had gained importance in world trade from 1887 onwards, wheat was the most important grain type by quantity traded in both cities.[37] Figure 4 shows that contrary to the other commodities, the volatility of corn, which was not traded on the Viennese futures market, decreased after the ban. This supports the first hypothesis, that the ban on futures trading in the Viennese grain market increased the volatility of spot prices for grain that had been traded on the futures market prior to the ban.

<<<INSERT FIGURES 3 AND 4>>>

The intra-day variation of spot prices, which we study in the following difference-in difference analysis, is used as a measure for how strongly prices fluctuated each day, taking into account past volatility. It therefore also measures the stability of the spot market. Table 3 provides some idea of how the intra-day variation of spot prices developed after the Viennese ban in comparison to Budapest. The mean and median values of spot price intra-day variation in Vienna increased after the ban, while in Budapest they decreased. This also supports the hypothesis of a volatility increase after the Viennese ban.

<<<INSERT TABLE 3>>>

As a robustness check, I also compare the period 8 October 1902 to 3 January 1903 (pre ban) to 14 April to 7 July 1903 (post ban). As outlined in the Data section, in the months prior to the ban, futures contracts were sold as in the previous years. Still, it is possible that the announcement alone affected speculators and their disposition to speculate. The robustness check thus excludes the interval between 4 January, when the New Law of exchange reorganisation passed, and 9 April, when the futures trading ban came into force. The summary

[37] *Neue Freie Presse*, 24 August 1900.

statistics of this robustness check can be found in Appendix Table I. These point to a slightly lower intra-day variation of spot prices after the ban.

Looking at day-by-day volatility, the increase in variation after the ban still holds true for rye and oats. In Appendix Table II, I compare the coefficients of variation before and after futures trading was prohibited, using Feltz and Miller's (1996) Asymptotic Test. We find intra-day variation to give a more detailed idea of actual grain prices used and the lack of pricing information after the ban.

Granger causality between futures and spot prices

In line with the theoretical assumptions on the information-transmission and pricing function of futures towards cash markets, this section looks at whether information flows change after the ban. Information does not necessarily have to flow between the futures and spot market of one trade location: it can also flow in from other futures markets. As futures trading no longer existed in Vienna after the ban, information for pricing cash transactions might have come from the futures market in Budapest. In early May 1903, the newspaper *Neues Wiener Tagblatt* reported that the uncertainty following the prohibition of futures trading had led to an increased price dependence on the Hungarian capital. This dependence could potentially lessen the ban's effect on spot price volatility in Vienna.

To assess the degree of price dependence between the two cities before and after the ban, I test for Granger causality between the two markets, following the approach of Kutner and Sweeney (1991). A distinction is made between the maturity of futures contracts in Budapest: at the time futures trading ended in Vienna, investors in Budapest could enter into futures contracts with maturity in May or October for wheat, rye and oats, and in the case of corn with maturity in May, June, July, August or September.

Table 4 shows that before the ban, futures prices in each city Granger-caused spot prices in the other. Notably, the Granger causality between Viennese futures prices and Budapest spot prices was strongest. After the ban, Viennese spot prices were not Granger-caused by Budapest futures prices listed for contracts that reach maturity in May. However, futures prices listed for contracts reaching maturity in summer or autumn, Granger-caused spot prices in Vienna after the ban. No or only weak Granger causality is found between futures prices of oats in Budapest and the respective spot prices in Vienna. These findings show that over the months following the ban, spot prices in Vienna were Granger-caused by Budapest futures prices. Granger causality was strongest for wheat. This implies that information for an accurate pricing of cash transactions in Vienna was available, preventing a distortion of prices. The information flow might have been strongest for wheat because it was the most important and mostly traded grain type at both exchanges.

<<<INSERT TABLE 4>>>

The outcomes in Table 4 suggest a new Monarchy-wide setup of information flows after the ban, which, in the medium term, was more strongly determined by the Budapest futures market. Strong Granger causality between the spot prices of a grain type in Vienna and the equivalent futures market in Budapest might dampen the effects of the ban on spot price volatility. This is likely to apply in the case of wheat, whose coefficient of variation unexpectedly decreases after the ban. The information transmission between futures prices in one city and spot prices in the other, reflected in strong Granger-causality, can thus counteract the destabilising effects of a futures trading ban. This supports the second hypothesis, that information flows from futures to cash markets changed after the ban. However, they were not fully reduced, as information was still flowing in from the Budapest futures market.

Effects on spot price volatility using Budapest and corn as controls

This section examines the effects the futures trading ban had on the intra-day variation of spot prices, using a difference-in-difference method. Spot prices from Budapest are used as a main control, and corn, which, however, was subject to some volatility patterns, as an additional control. Corn was traded exclusively on the spot market and serves as a control to examine whether grain types, for which a futures trade existed, showed a unidirectional reaction to the ban.

An important precondition for using Budapest as a control is that futures trading did not migrate to Budapest after the Viennese ban. Figure 5 shows that the number of futures contracts concluded in Budapest was at a high before and shortly after the ban, possibly pointing to a short-term pressure in concluding contracts. However, as can be seen in Figure 5, no longer-term migration appears to have taken place because Austrian traders were not permitted to engage in futures trading in Budapest or elsewhere.[38] In Figure 1, I had already shown that spot trading also did not migrate to Budapest.

<<<INSERT FIGURE 5>>>

Given there was no large-scale migration to Budapest, I now perform a difference-in-difference analysis assessing the effect of the ban on the intra-day variation of spot prices. Tables 5 and 6 provide the difference-in-difference results. In Table 5, the intra-day variation of wheat, rye, oats and corn as the dependent variables is explained by the variables *Vienna*, a dummy taking on 1 for prices from the Viennese market, *Post ban*, a dummy taking on 1 for the period after the ban, and the interaction term *Post ban***Vienna*, taking on 1 if both factors hold true. The significance of the interaction term's coefficient shows whether there is a significant difference in the intra-day variation of spot prices in Vienna compared to Budapest after the ban.

[38] *Wiener Landwirtschaftliche Zeitung*, 8 May 1907.

Using spot prices from Budapest as a control, the intra-day variation of wheat, rye and oats spot prices in Vienna, which had been traded on the Viennese futures market prior to the ban, significantly increased after futures trading was prohibited. With a coefficient of 0.107, the factor *Post ban*Vienna* shows the strongest impact in the case of rye. For wheat, the interaction term has a coefficient of 0.078, and for oats, a coefficient of 0.020. These small coefficients, however, translate into a significant impact of the ban on how strongly spot prices fluctuated each day. As minimum-maximum ranges of spot prices reflect recommended intervals for prices to be set by buyers and sellers, based on the prices of each previous trading session, an increased intra-day variation after the ban implies a stronger dispersion and fluctuation in the prices used and lower pricing accuracy.

In the case of corn, the factor *Post ban*Vienna* has a slightly negative regression coefficient. This implies that the intra-day variation of corn decreased after the ban in comparison to Budapest, which is the opposite effect to the increased volatility of the other grain types. This might be due to a higher corn price variation in Budapest or attributed to seasonality. This result is important, as it points to the fact that the volatility of commodities traded on the futures market is affected in an unambiguous way, a way that differs from the price behaviour of commodities that are traded only on the spot market.

<<<INSERT TABLE 5>>>

In Table 6, the intra-day variation of Viennese spot prices as a dependent variable is explained by the regressors *Corn*, *Post ban* and the interaction term *Post ban*Corn* using corn as a control. Corn is used as an additional, but not fully unambiguous control, because, based on newspaper assessment, adverse harvest expectations might have caused some seasonal fluctuations for this commodity. It can be observed that after the ban, the intra-day variation of wheat, rye and oats, traded on the futures market prior to the ban, significantly differed from corn, a commodity traded exclusively on the Viennese spot market. In comparison to corn, the

intra-day variation of wheat, rye and oats increased. When comparing wheat to corn, the regressor *Post ban*Corn* brings down the intra-day variation of spot prices by -0.039. In the case of rye and oats, the coefficients of the factor *Post ban*Corn* are -0.052 and -0.44, respectively. Therefore, the intra-day variation of rye increased more strongly after the ban than corn. This implies that there was a clear effect of the ban on the spot price volatility of commodities that had been subject to futures trading, and this effect differed from commodities traded on the spot market only.

<<<INSERT TABLE 6>>>

As a robustness check, I also compare the period 8 October 1902 to 3 January 1903 (pre ban) to 14 April to 7 July 1903 (post ban), excluding the interval between 4 January until the ban came into effect. The results of the robustness check are displayed in Appendix Tables III and IV. The volatility-increasing effect of the ban, using spot prices from Budapest as a control, still holds, with a comparable coefficient size. The intra-day variation of grain traded on the futures market prior to the ban differed from corn after the prohibition of futures trading. The results of the robustness check support the finding that spot price volatility in Vienna increased after the ban.

Discussion

Market regulations are a doubled-edged practice. Giving a voice to farmer's associations and local mills, who feared the threat of speculators, the Austrian parliament set an end to futures trading in the Viennese grain market. The 1903 futures trading ban did more than increase the volatility of spot prices – it caused the market to lose attractiveness. Producers refrained from the Viennese spot market after the ban, and the Agricultural Products Exchange further lost importance with the dissolution of the Austro-Hungarian Empire in 1918. It closed down 1938 and reopened again after World War II, but never regained its pioneering role in the

international grain trade. The BSCE was no viable alternative for Austrian grain trading parties: I did not find evidence for an increased spot or futures trade in Budapest. The BSCE closed down in 1948 and was re-established in 1990 (Korányi and Szeles 2005).

Austrian producers started to sell in the provinces, international producers searched for other markets. A question that remains is what happened to the ability of end-users to hedge risk after the ban in the Viennese grain market. According to the *Arbeiter Zeitung*, *Ostdeutsche Rundschau*, *Die Zeit* and other newspapers, speculators, instead of engaging in futures trading in other grain markets, switched to company shares, according to the *Pester Lloyd* particularly industrial shares, or other commodities such as cotton or coffee.[39]

A possible substitute for hedging could have been forwards contracts. This trade form had existed prior to the ban but was not used for speculative ends. Forwards contracts were non-standardised and thus rather loose agreements to buy a commodity at a prearranged time and price in the future. Parties involved in forwards trading were usually large-scale consumers and producers of grain. Forwards contracts were protocolled using the wording "sold per" or "sold with delivery in" followed by a distinct month or season. This way, buyers could lock in a price, but could not speculate on potential profit gains.

The newspaper *Wiener Landwirtschaftliche Zeitung* reported on forwards contracts of wheat, rye, and oats sold on Saturday markets. I collected the number of forward contracts in Vienna, published on a weekly basis. Between 8 October 1902 and 9 April 1903, 0.54 forwards contracts were sold on average on a Saturday market. After the prohibition of futures trading, between 10 April and 9 October 1903, an average of 2.29 forwards contracts was sold each Saturday. Despite this increase after the ban, forwards trading did not receive a higher status in the Viennese grain market and did not constitute a viable alternative to the futures market,

[39] *Ostdeutsche Rundschau*, 9 March 1902; *Arbeiter-Zeitung*, 30 March 1902; *Pester Lloyd*, 6 April 1905; *Die Zeit*, 14 September 1905.

possibly contributing to why numerous sellers and end-users abstained from the Viennese market.

Conclusions

This paper has examined the consequences of a permanent prohibition of futures trading on spot price volatility. Using the 1903 futures trading ban in the Viennese grain market as a natural experiment, I find that this unique prohibition of futures trading increased the volatility of grain spot prices. Two hypotheses were tested: I) the ban increased the volatility of spot prices, as the risk-allocation and information-transmission functions of the futures market were no longer maintained; and II) the ban altered information flows from futures to cash markets. The first hypothesis was found to hold true: the intra-day variation of spot prices in Vienna significantly increased after the ban. The volatility of grain types traded on the futures market prior to the ban were found to react differently to the new law than commodities traded exclusively on the cash market. As regards the second hypothesis, information flows between futures and spot markets were found to have altered. After the ban, especially for wheat, the most important grain type in terms of trading volume, information flew in from the Budapest futures market, which potentially dampened the volatility-increasing effect of the ban. Despite the availability of some pricing information, the Viennese grain market lost importance. International producers left, local producers switched to direct sales and speculators to other assets and commodities.

The consequences were to be more severe than expected by contemporaries: the Viennese grain market lost attractiveness at both the local and international level. The socio-political strings pulled to carry through this permanent prohibition of futures trading were strongly linked to populism and a fear of “undue”, uncontrollable speculation. Strangling speculation, however, may have come at too high a cost: the market was abandoned and the supply of grain

severely affected.[40] Even in neighbouring countries such as Germany or Bohemia, contemporary newspapers reported on the Viennese market losing its status, after it had once held an important position as a centrepiece of grain trade.[41]

Further research is required to determine the long-run effects on the Viennese grain market and the effect of the ban on the stock market. Historical events, such as the 1903 Viennese futures trading ban, provide fruitful opportunities to learn more about the characteristics of speculation and political aversion against it, as they constitute concluded events captured within static legal frameworks and regulations. The effects of futures trading regulations on the wider economy and international trade should be subject to further investigation.

[40] *Neues Wiener Journal*, 29 April 1903.
[41] *Neue Freie Presse*, 29 March 1903.

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Table 1: Harvest statistics of the Austro-Hungarian Empire, in million tons

	Austria				Hungary (incl. Croatia and Slavonia)			
	1903	1902	1901	1900	1903	1902	1901	1900
Wheat	1.25	1.35	1.20	1.11	4.40	4.90	3.62	4.14
Rye	2.06	2.09	1.92	1.39	1.20	1.47	1.20	1.17
Oats	1.86	1.82	1.72	1.71	1.27	1.29	1.07	1.11
Corn	0.41	0.34	0.45	0.37	3.45	2.6-2.8	2.86-3.25	

Sources: K.K. Statistische Zentral Kommission (1903), *Wiener Landwirtschaftliche Zeitung* (20/08/1902) and *Pester Lloyd* (04/09/1902 and 31/01/1904). *Notes:* The corn harvests in 1901 and 1902 Budapest are based on estimates obtained by newspaper analysis.

Table 2: Summary statistics of daily grain spot prices in Vienna, in crowns per 100 kilograms

	Wheat MIN	Wheat MAX	Rye MIN	Rye MAX	Oats MIN	Oats MAX	Corn MIN	Corn MAX
St. Dev – before ban	0.24	0.20	0.15	0.11	0.12	0.13	0.51	0.51
St. Dev. – after ban	0.16	0.14	0.29	0.27	0.21	0.20	0.09	0.09
Mean – before ban	8.41	8.85	6.86	7.07	6.56	6.76	6.36	6.56
Mean – after ban	8.22	8.66	6.62	6.85	6.02	6.23	6.60	6.77
Median – before ban	8.50	8.90	6.90	7.10	6.55	6.75	6.48	6.75
Median – after ban	8.20	8.65	6.45	6.70	5.95	6.15	6.60	6.75
lowest – before ban	7.75	8.50	6.50	6.70	6.30	6.45	5.75	5.90
lowest – after ban	7.85	8.35	6.20	6.50	5.75	5.95	6.35	6.60
highest – before ban	8.70	9.20	7.05	7.20	6.75	6.95	7.15	7.25
highest – after ban	8.50	8.95	7.15	7.35	6.40	6.60	6.80	7.00

Sources: Quotation lists of the Agricultural Products Exchange in Vienna. *Notes:* The analysed window is 12 October 1902 to 9 October 1903 (N=284, 142 before and after ban).

Table 3: Summary statistics on the intra-day variation of grain spot prices

	Vienna				Budapest			
	Wheat	Rye	Oats	Corn	Wheat	Rye	Oats	Corn
Mean – before ban	0.43	0.21	0.20	0.20	0.40	0.28	0.27	0.17
Mean – after ban	0.44	0.23	0.21	0.17	0.37	0.19	0.26	0.18
Median – before ban	0.40	0.20	0.20	0.15	0.44	0.30	0.25	0.15
Median – after ban	0.45	0.25	0.20	0.15	0.35	0.20	0.25	0.15
MIN – before ban	0.25	0.15	0.10	0.05	0.25	0.01	0.05	0.25
MIN – after ban	0.30	0.10	0.15	0.10	0.30	0.10	0.05	0.05
MAX – before ban	0.75	0.40	0.25	0.45	0.75	0.40	0.45	0.85
MAX – after ban	0.60	0.30	0.25	0.40	0.75	0.30	0.90	0.35

Sources: Quotation lists of the Agricultural Products Exchange in Vienna; *Ostdeutsche Rundschau* for Budapest.
Notes: The analysed window is 12 October 1902 to 9 October 1903 (N=284, 142 before and after ban).

Table 4: Commodity-wise Granger causality between futures and spot prices in Vienna and Budapest before and after 9 April 1903

	BEFORE: Grang. Caus. Futures Prices Vienna and Spot Prices Budapest	BEFORE: Granger Causality Futures Prices Budapest and Spot Prices Vienna		AFTER: Granger Causality Futures Prices Budapest and Spot Prices Vienna						
Month applying to futures contract	Spring 1903	April 1903	May 1903	May 1903	July 1903	August 1903	September 1903	October 1903	April 1904	May 1904
	f-stat	*f-stat*	*f-stat*	*f-stat*	*f-stat*	*f-stat*	*f-stat*	*f-stat*	*f-stat*	*f-stat*
Wheat - MIN	10.241***	19.08***		1.312				16.696***	0.558	
Wheat - MAX	10.992***	8.199***		2.363				11.88***	1.149	
Rye - MIN	7.449***	5.470*						5.375***	2.061	
Rye - MAX	5.651***	5.625***						8.065**	5.199*	
Oats - MIN	3.867**	0.449		0.481				3.437*	3.795	
Oats - MAX	2.243	1.686		0.310				3.227*	2.314	
Corn - MIN			2.927	6.369*	29.255***	6.723***	6.810*			0.210
Corn - MAX			1.623	3.915	25.92***	4.795**	3.417			0.418

Sources: Quotation lists of the Agricultural Products Exchange in Vienna; *Pester Lloyd*, *Ostdeutsche Rundschau* for Budapest. *Notes:* The table distinguishes between different maturities foreseen for futures contracts. Prior to the ban, only futures prices foreseeing contracts with spring maturity were listed: these are denominated "spring" prices for Vienna, and "April" or "May" prices for Budapest. Throughout the months after the ban, prices foreseeing May and October 1903 up to May 1904 maturities for wheat, rye and oats, and May, July-October 1903 and April and May 1904 maturities for corn were listed for Budapest. Granger causalities are assessed between minima (maxima) ranges of futures and minima (maxima) ranges of spot prices throughout the time period futures prices with respective maturities are listed. F-stats and the significance of Granger causality test results on pairwise futures-spot VAR models are given.

Table 5: Difference-in-difference results on the intra-day variation of spot prices from Vienna and Budapest

	Wheat	Rye	Oats	Corn
Post ban *Vienna	0.078*** (0.013)	0.107*** (0.01)	0.020* (0.01)	-0.039* (0.017)
Post ban	-0.074*** (0.009)	-0.090*** (0.007)	-0.011 (0.007)	0.004 (0.012)
Vienna	-0.006 (0.009)	-0.069*** (0.007)	-0.077*** (0.007)	0.028* (0.012)
Intercept	0.441*** (0.007)	0.281*** (0.005)	0.274*** (0.005)	0.175*** (0.017)
Adj. R^2	0.130	0.238	0.238	0.012
F-Stat.	29.14***	60.06***	60.00***	3.353***

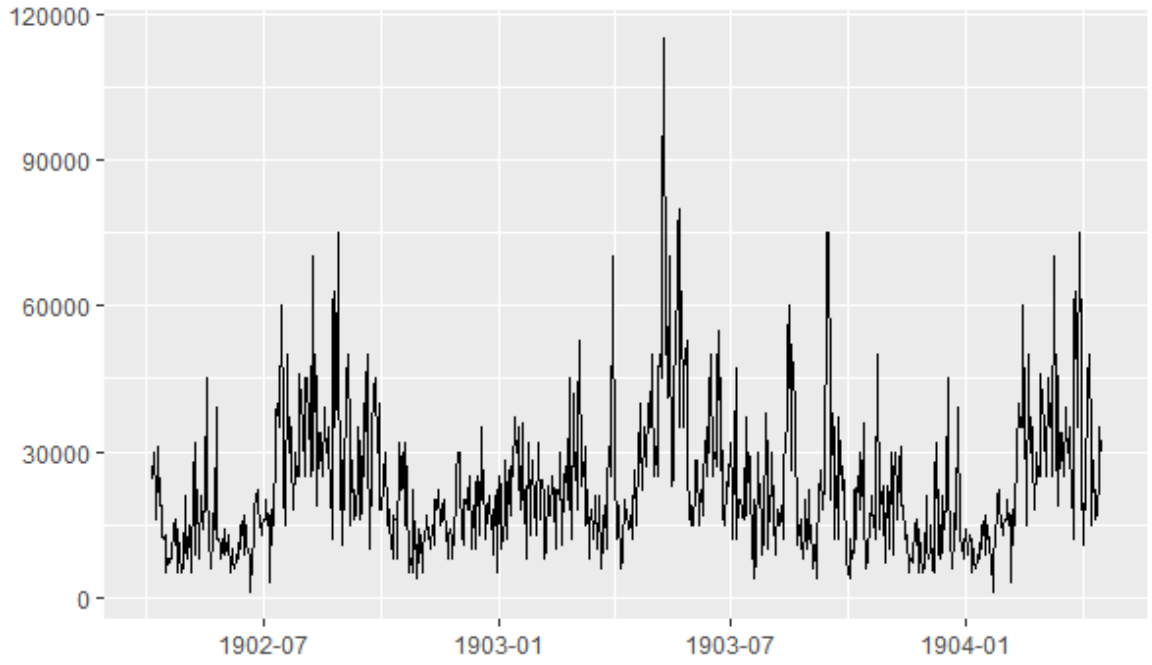
Sources: Quotation lists of the Agricultural Products Exchange in Vienna; *Ostdeutsche Rundschau* for Budapest.
Notes: The analysed window is 12 October 1902-9 October 1903 (N=284). The intra-day variation of spot prices of the equivalent grain types in Budapest is used as a control group.

Table 6: Difference-in-difference results on the intra-day variation of spot prices within Vienna

	Wheat and corn	Rye and corn	Oats and corn
Post ban*corn	-0.039*** (0.013)	-0.052*** (0.006)	-0.044** (0.01)
Post ban	0.004 (0.009)	0.017* (0.008)	0.009 (0.007)
Corn	-0.232*** (0.009)	-0.009 (0.008)	0.006 (0.007)
Intercept	0.435*** (0.006)	0.212*** (0.007)	0.197*** (0.005)
Adjusted R^2	0.732	0.087	0.057
F-Stat.	518.00***	19.11***	12.5***

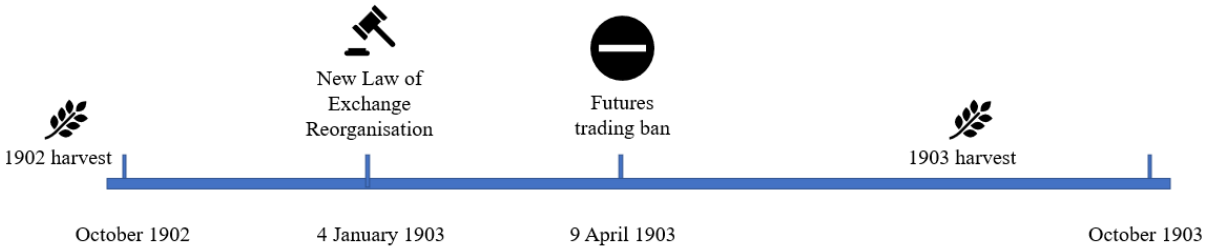
Sources: Quotation lists of the Agricultural Products Exchange in Vienna. *Notes:* The analysed period is 12 October 1902-9 October 1903 (N=284). The intra-day variation of Viennese corn spot prices is used as a control group. In Vienna, there had been no futures trade in corn between November 1902 and April 1903.

Figure 1: Quantities of wheat traded on the spot market of the Budapest Stock and Commodity Exchange, in *Meterzentner*



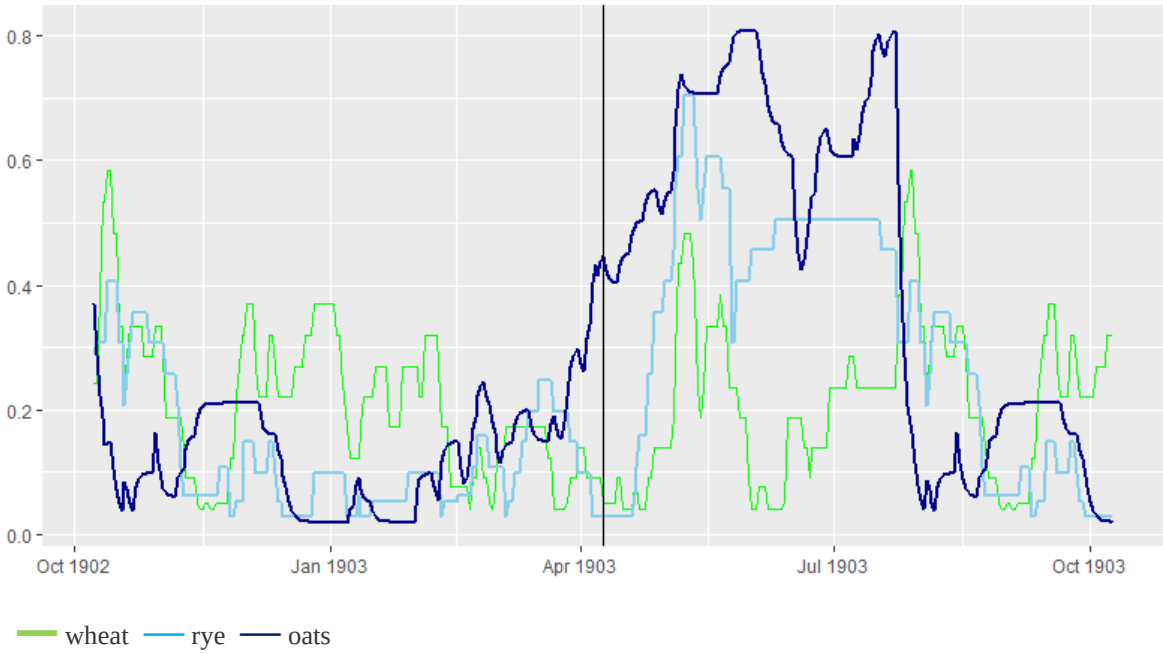
Source: Pester Lloyd, 1902-1904. *Notes:* One *Meterzentner* corresponded to 100 kilograms.

Figure 2: Timeline of harvests and the futures trading ban



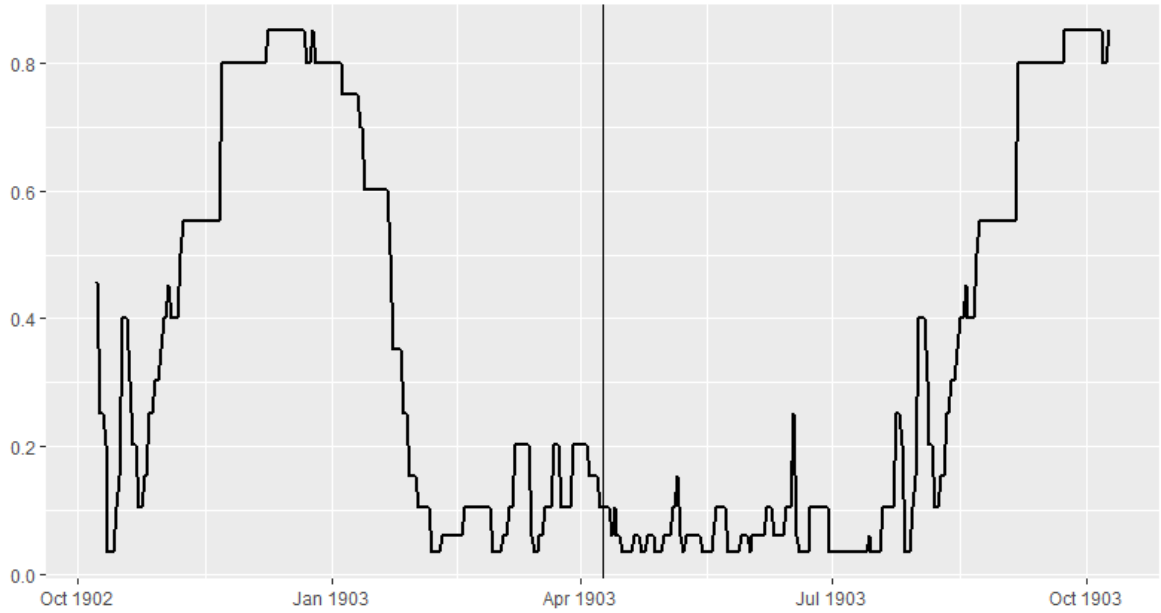
Sources: Austria. ANNO – AustriaN Newspapers Online. http://anno.onb.ac.at/; Treibl (1903)

Figure 3: Conditional standard deviation of wheat, rye, and oats spot prices in Vienna



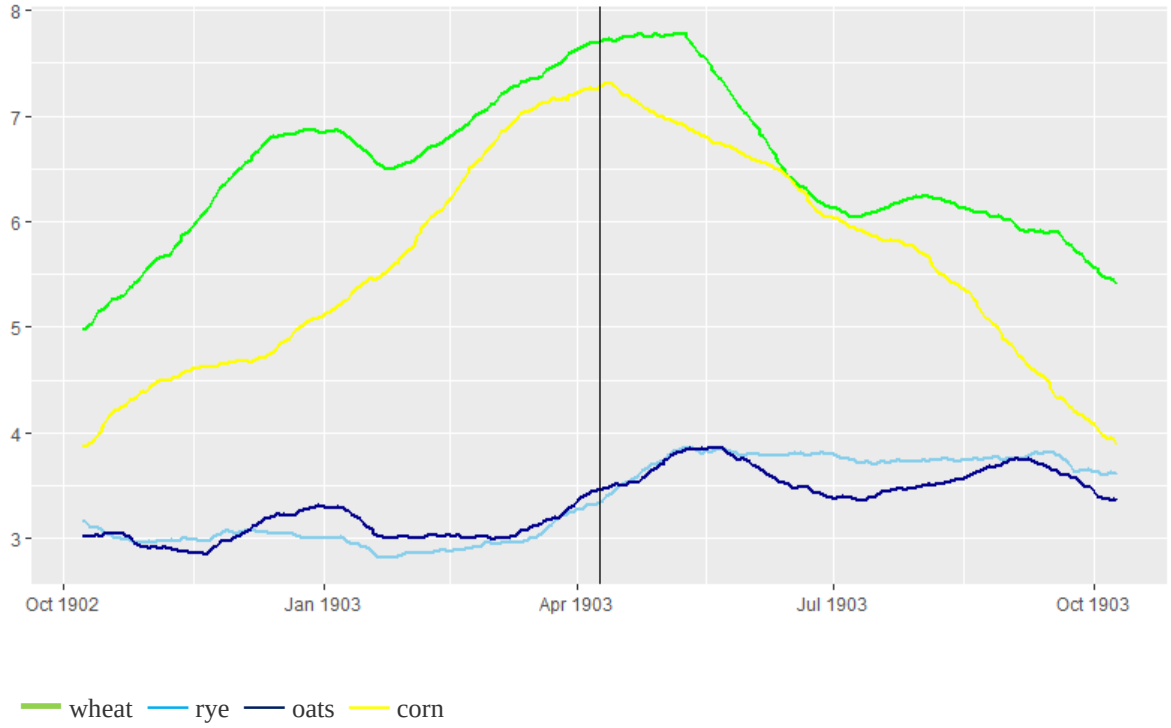
Sources: Quotation lists of the Agricultural Products Exchange in Vienna. *Notes:* The conditional standard deviation of spot prices is modelled as time changing. The volatility clustering is explained by a GARCH (1,2) process for wheat, and a GARCH (1,1) process for rye and oats. For reasons of clear graphical arrangement, only the GARCH-modelled spot price minima are plotted. Spot prices are in crowns per 100 kilograms.

Figure 4: Conditional standard deviation of Hungarian corn spot prices in Vienna



Sources: Quotation lists of the Agricultural Products Exchange in Vienna. *Notes:* The conditional standard deviation of corn spot prices is modelled as time changing. The volatility clustering is explained by a GARCH (1,1) process. For reasons of clear graphical arrangement, only the GARCH-modelled spot price minima are plotted. Spot prices are in crowns per 100 kilograms.

Figure 5: Number of futures contracts concluded in Budapest per day, moving averages



Source: Pester Lloyd. *Notes:* The summer months (July-September) count as the peak months of trade at Austro-Hungarian grain exchanges.

Appendix

Appendix Table I: Summary statistics on the intra-day variation of grain spot prices

	Vienna				Budapest			
	Wheat	Rye	Oats	Corn	Wheat	Rye	Oats	Corn
Mean – before ban	0.48	0.23	0.20	0.11	0.49	0.34	0.29	0.09
Mean – after ban	0.44	0.21	0.20	0.10	0.37	0.19	0.27	0.21
Median – before ban	0.50	0.20	0.20	0.17	0.50	0.35	0.25	0.10
Median – after ban	0.45	0.20	0.20	0.15	0.35	0.20	0.25	0.25
MIN – before ban	0.30	0.15	0.10	0.05	0.25	0.01	0.05	0.01
MIN – after ban	0.35	0.15	0.15	0.10	0.30	0.10	0.05	0.05
MAX – before ban	0.75	0.40	0.25	0.15	0.75	0.40	0.45	0.25
MAX – after ban	0.55	0.30	0.25	0.25	0.75	0.21	0.90	0.27

Sources: Quotation lists of the Agricultural Products Exchange in Vienna; *Ostdeutsche Rundschau* for Budapest.
Notes: The period 8 October 1902-3 January 1903 (pre ban, N=68) is compared to 14 April-7 July 1903 (post ban, N=68), leaving out the possibly contaminated episode of ban announcement.

Appendix Table II: Differences in the coefficients of variation of daily spot price ranges in Vienna before and after the ban

*/**/*** if significant difference	Coefficient of variation – before ban	Coefficient of variation – after ban	*t*-statistic
Wheat – MIN	2.801	1.968	17.181***
Wheat – MAX	2.216	1.618	13.738***
Rye – MIN	2.160	4.410	66.007***
Rye – MAX	1.540	3.951	108.589***
Oats – MIN	1.856	3.496	52.917***
Oats – MAX	1.852	3.271	43.219***
Corn – MIN	7.974	1.428	272.238***
Corn - MAX	7.735	1.282	287.616***

Sources: Quotation lists of the Agricultural Products Exchange in Vienna. *Notes:* The analysed window is 12 October 1902 to 9 October 1903 (N=284, 142 before and after ban). Coefficients of variation of spot prices of wheat, rye, oats and corn are compared using Feltz and Miller's (1996) Asymptotic Test.

Appendix Table III: Difference-in-difference results on the intra-day variation of spot prices from Vienna and Budapest

	Wheat	Rye	Oats	Corn
Post ban *Vienna	0.087***	0.138***	0.018	-0.060***
	(0.022)	(0.015)	(0.020)	(0.011)
Post ban	-0.126***	-0.150***	-0.020	0.115***
	(0.016)	(0.010)	(0.014)	(0.008)
Vienna	-0.009	-0.110***	-0.090***	0.018*
	(0.016)	(0.010)	(0.014)	(0.008)
Intercept	0.492***	0.336***	0.288***	0.094***
	(0.011)	(0.007)	(0.010)	(0.006)
Adj. R^2	0.224	0.463	0.188	0.483
F-Stat.	27.10***	79.02***	21.88***	85.41***

Sources: Quotation lists of the Agricultural Products Exchange in Vienna; *Ostdeutsche Rundschau* for Budapest. *Notes:* The period 8 October 1902-3 January 1903 (pre ban) is compared to 14 April-7 July 1903 (post ban), N=136. The intra-day variation of spot prices of the equivalent grain types in Budapest is used as a control group.

Appendix Table IV: Difference-in-difference results on the intra-day variation of spot prices within Vienna

	Wheat and corn	Rye and corn	Oats and corn
Post ban*corn	0.095*** (0.014)	0.067*** (0.012)	0.057*** (0.007)
Post ban	-0.040*** (0.010)	-0.012 (0.008)	-0.002 (0.005)
Corn	-0.372*** (0.010)	-0.115*** (0.008)	-0.087*** (0.005)
Intercept	0.483*** (0.007)	0.226*** (0.006)	0.198*** (0.003)
Adjusted R^2	0.885	0.460	0.618
F-Stat.	696.70***	77.98***	147.10***

Sources: Quotation lists of the Agricultural Products Exchange in Vienna. *Notes:* The period 8 October 1902-3 January 1903 (pre ban) is compared to 14 April-7 July 1903 (post ban), N=136., leaving out the possibly contaminated episode of ban announcement. The intra-day variation of Viennese corn spot prices is used as a control group. In Vienna, there had been no futures trade in corn between November 1902 and April 1903.