MARKET CONDITIONS IN PREINDUSTRIAL POLAND, 1500–1772

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ABSTRACT

In this paper I investigate commodity market integration, market efficiency and market performance in preindustrial Eastern Europe. In particular, I look at the Polish rye market between 1500 and 1772. I analyse annual rye price data from seven cities. The results suggest that market conditions in Poland in the sixteenth century were relatively favourable. The market disintegrated in the seventeenth century. Afterwards, Polish markets remained relatively segmented, in contrast to many Western European countries whose markets thrived in the eighteenth century. This supports the hypothesis that even before the Industrial Revolution there was the Little Divergence in economic development between western and eastern Europe. The disintegration crisis in Poland was linked to the separation of landlocked cities from the common market. After the seventeenth century, cities located on the Vistula river enjoyed better market conditions and remained better integrated than the landlocked ones. The long-term market crisis may have resulted from the devastating warfare in the mid-seventeenth century.

Keywords: market integration, market efficiency, market performance, Poland, the Little Divergence

JEL codes: N13, N73
INTRODUCTION

Long-term changes in market conditions have become a popular research topic in economic history. Improvement in market conditions is a multifaceted process of changes in, among other things, market integration, market efficiency and market performance. Favourable market conditions stem from an environment conducive to trade and economic specialization within and between geographically separated markets (Persson 1999; Özmucur & Pamuk 2007; Unger 2007; Bateman 2012). Improvement in market conditions is both a part and a cause of overall economic development. Discussions about market conditions in preindustrial Europe relate to the Little Divergence debate, which centres on when and why Western Europe’s economy pulled ahead of that of the rest of the continent. In a recent study of annual wheat prices across markets, Bateman (2011: Tables 3–5) identified an improvement in domestic market conditions in numerous Western European countries in the sixteenth century, followed by disintegration around the seventeenth century and recovery in the eighteenth century. Investigating wheat prices in western cities, Studer (2008, 404) found that regional and intraregional markets in western Europe in the first half of the eighteenth century were already closely connected and became even more integrated through the century. Özmucur and Pamuk (2007, Table 3.1, 80), who studied prices of numerous commodities, say ‘there is some evidence that parts of [Western] Europe were becoming more integrated … during the early modern era’. In particular, they identified a progressive convergence of the prices of most, but not all, of the studied commodities.

There has been no systematic study of long-term changes in domestic market conditions in preindustrial Eastern Europe. This paper helps to fill this gap in the literature by providing an account of the market integration, efficiency and performance of the Polish rye market between 1500 and 1772 – the date of the First Partition of Poland. The study demonstrates that the Polish rye market was fairly well developed in the sixteenth century, fragmented in the seventeenth century, and failed to recover in the eighteenth century. It contributes to the Little Divergence debate by demonstrating that, while market conditions in Western Europe continued to develop in the eighteenth century, Eastern Europe’s markets declined.

The problem of market conditions in preindustrial Poland has already been addressed by several scholars (for example Rusiński 1954; Wyrobisz 1966, 1981; Kula 1976; Bateman 2012). Mielczarski (1962) identified a progressive convergence

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See Federico (2012) on differences between integration and efficiency and Van der Spek, Van Leeuwen and Van Zanden (2015), who recently advocated adding the dimension of market performance to the research agenda.

The countries that followed the pattern were Austria, Spain, France, England and Italy. However, in the case of the last two Bateman did not identify a significant market crisis in the seventeenth century.

Studer’s sample focused mainly on western Europe, but it also included prices from Cracow and Vienna.

Özmucur and Pamuk’s sample focused mainly on western Europe, but also included prices from Sopron and Istanbul.
of weights and measures across the country in the sixteenth century. Using modern statistical methods, Baten and Wallusch (2005) analysed prices on the Polish grain market in the eighteenth century and found the market conditions poor. To bridge the gap between the two studies and construct a long-term account of market conditions in preindustrial Poland, I investigate annual rye prices from seven Polish cities between 1500 and 1772. I look at Cracow, Gdańsk, Warsaw, Koenigsberg, Wrocław, Lublin, and Lviv, the first three situated on the Vistula river. I measure market integration by examining year-by-year changes in the coefficient of variation of rye prices from across the country. I also look at market efficiency by estimating the correlation of prices across markets. I analyse market performance by studying conditional volatility in discrete markets. I look at various subsets of the cities, situated on or away from the Vistula, to gauge the effects of geography. I base the analysis on two datasets: a basic dataset of historical annual rye prices from the seven cities and – perhaps more controversially – an enhanced dataset that includes rye prices extrapolated from prices of wheat and oats in the same market. The results indicate that market conditions in Poland in the sixteenth century were relatively favourable. But the market disintegrated in the seventeenth century and, in contrast to many Western European countries, remained segmented in the eighteenth. The disintegration crisis in Poland resulted from the separation of landlocked cities from the common market. After the seventeenth century, cities located on the Vistula enjoyed better market conditions and remained better integrated than landlocked ones.

**METHODOLOGY**

In this paper I investigate three qualities of the Polish rye market – its integration, efficiency, and performance. Market integration, a gradual transformation of discrete independent markets into one economic unit, is related to a drop in transaction and transport costs. I assume that markets become more integrated if in the long term the costs decrease and prices converge. I link the process to the ‘law-of-one-price’ (Jacks 2004; Federico 2012). The law-of-one-price is demonstrated by Equation 1. It states that any increase in the price gap between two cities above the transaction and transportation costs will immediately be taken advantage of in the form of arbitrage by the merchants.

$$|\text{Price}_{a,t} - \text{Price}_{b,t}| \leq \text{Transaction and transportation costs}_{ab,t}$$ (1)

To measure price convergence, Federico (2011) advocates the use of the coefficient of variation (hereafter the CV) of all the prices across the common market at any given year. This measure captures the convergence of all the prices in a market to the mean value. It focuses on the unification of the whole system rather than the integration of individual pairs of cities. According to Federico (2011), the CV has been the standard measure of integration since the 1960s mainly because it is simple to compute, intuitive, and easy to compare across time and space. The method
allows me to estimate the situation of the whole market in any given year and thus track short-term changes. Equation 2 proposes how to measure the CV: \( p_{i,t} \) denotes the rye price in the \( i \)-th market and \( \mu_t \) represents the mean price.

\[
\text{CV}_t = \frac{SD_t}{\mu_t} = \left( \frac{1}{n} \left[ \sum (p_{i,t} - \mu_t)^2 \right] \right)^{0.5}/\mu_t
\] (2)

However, Van Bochove (2008) and Federico (2012) point out a crucial problem with the use of decreases in the price gap as indicators of market integration. They note that markets that do not interact could still have – accidentally – similar price levels. For example, segmentation could result in an increase in prices in the cheaper market and a consequent narrowing of the price gap. Such a development can create a false impression of integration.

Furthermore, the law-of-one-price rests on the assumption that traders know the current prices on the markets. Fama (1970) defines such situation as weak efficiency, as opposed to strong efficiency that relates also to other types of information. Furthermore, the author defines a market as fully efficient if ‘prices always “fully reflect” the available information’ (see Federico 2012, 476). Building on this literature, here I define market efficiency as having access to information and being to reflect the information in prices. In this paper I analyse only price data and therefore focus solely on weak efficiency. Federico (2012) argues that the assumption that prices always reflect all the information on the market may be too optimistic. Looking solely at price convergence may therefore give a misleading picture of market conditions. To create a more coherent picture of market conditions, I also account for market efficiency. Given that transport costs tend to be stable in the short term, a logical conclusion of the law-of-one-price is that in an efficient market an external shock to one price will also affect the other price. The price series from across an efficient market must therefore be highly positively correlated. In this case, Van Bochove (2008) also cautions that co-movement in prices can be ‘spurious’ as it can be a result of a common shock such as war. We should be able to avoid this ‘danger’ as long as we keep in mind the historical context.

Federico (2012, 480) says that to measure market efficiency we can test the transfer of information between markets by – among other methods – seeing whether arbitrage forces prices to converge (co-movement tests). Weir (1989) proposes a method of measuring sympathetic movements of prices in a broad market composed of numerous local markets with a known price series. Weir claims that the variance of the mean of all the regional price series will increase with the progressive correlation across the individual series. In other words, ‘the year-to-year variance of the [regional] market will increase … with greater correlation across [individual] markets’ (Weir 1989, 206; Jacks 2004, 293). Weir uses the following equation to formalize this assertion:

\[
R = \frac{\text{Var(regional)}}{\sum_{i} \text{Var}(i)/n^2} - 1 = \frac{1}{(n-1)} \sum_{i} \text{Var}(i)/n^2 - 1
\] (3)
where \( \text{Var} (\text{regional}) \) is the variance of a new time series composed of the year-by-year average prices of all the discrete prices series. Moreover, \( \text{Var}(i) \) is the variance of each \( i \)-th price series. \( R \) with some loss of statistical precision can be interpreted as the average correlation coefficient across regions. For this reason, for the sake of simplicity, \( R \) can be called ‘Weir’s correlation coefficient’.

Weir’s method makes it possible to discover how well markets transfer information about regional shocks between cities and represent the information in the prices. I am also interested in the ability of each discrete market to adapt to these shocks. Van der Spek et al. (2015), after Földvari and Van Leeuwen (2011), define market performance as the ability of markets to cope with shocks – i.e. the effects of unexpected events. To avoid confusion, I must caution that, due to the unfortunate looseness of the definitions prevalent in the literature on market conditions, many studies not only treat ‘market integration’ and ‘efficiency’ as interchangeable but also use these terms when discussing what Van der Spek et al. call ‘market performance’ (Van der Spek et al. 2015, 3; see Federico 2012 on the looseness of definitions). Van der Spek et al. (2015, 4) explain the concept with an example:

In a perfectly working market an external shock due to, for example, a failed harvest will lead to rising prices, which will trigger trade, the sale of grains from storage houses, etc. Hence, even though prices will increase to some extent, the increase in the price of food will be mitigated by economic adaptations, and the degree to which this will occur will be related to the quality of the institutional (and geographical) framework.

In short, perfectly working markets respond well to shocks and, as a result, are less volatile. Földvari and Van Leeuwen (2011) argue that market performance can be directly affected by improvements in trade, storage, consumption diversification and technological development.

Földvari and Van Leeuwen (2011) also argue that the most popular method of studying price volatility, i.e. looking at the CV of prices over time (as opposed to across space in the convergence test), often produces overestimated results due to the persistence of the shocks to the price series. Furthermore, the measure can also be biased by inflationary and deflationary tendencies. Instead, they suggest we observe market performance by studying the residual variance of commodity prices, using an autoregressive conditional heteroscedasticity (ARCH) model.

In more detail, they explain that differences in prices between two consecutive years are partly driven by a trend and partly random. They assume that the size of shocks is, on average, zero and homoscedastic.\(^6\) To gauge the degree of unexpected volatility the authors suggest we analyse the residual variance (or conditional variance) instead of the variance of the price series themselves. They say a trend-like

\(^6\)However, they admit that although ‘the assumption about the homoscedasticity of [the size of shocks] within the same country or region sounds feasible, it is less likely that the shocks have the same variance across all regions as well, making this method not ideal for cross-country comparisons’ (Földvari & Van Leeuwen 2011, 174).
behaviour in the residual variance can be interpreted as a sign of the market’s ability to cope with the effect of shocks. The residual variance will reflect the share of shocks in the total variance that is the effect of unexpected events on price volatility. This means that, in order to measure market performance, we should first model the prices and further analyse only that part of the variation that was random and unexpected (see more in Van der Spek et al. 2015).

In practice, due to the gaps in the time series, the ARCH model cannot be estimated directly. Thus, as instructed by Földvari and Van Leeuwen, we calculate the conditional variation of the price series using a two-step procedure. First we estimate the main equation as follows:

\[
\text{Price}_t = \text{Constant} + A\text{Price}_{t-1} + B\text{Price}_{t-2} + \Gamma \text{Price}_{t-n} + u_t \quad (4)
\]

The greater the volatility and therefore the (under)performance, the less of the variance is explained by the previous prices and therefore the greater the error term \(u_t\).

We then use the variance equation to gauge the changes in volatility over time in the whole domestic market. The equation builds on the theory that the variation in the price, and therefore also the error, is likely to be related to its past variations. For this reason, the model controls for the lags of the dependent variable. To quantify the markets’ reaction to shocks in the long run, the estimates from different discrete price series (Equation 4) can be pooled and regressed on a set of time dummies (Equation 5).

\[
\hat{u}_{i,t}^2 = \text{Constant} + \alpha \hat{u}_{i,t-1}^2 + \beta \hat{u}_{i,t-2}^2 + \gamma \hat{u}_{i,t-n}^2 + \sum_p \delta_p x_p + e_{i,t} \quad (5)
\]

where \(\hat{u}\) denotes fitted values obtained from Equation 4, \(p\) denotes \(n\) different time period dummies, and \(i\) denotes different discrete markets. The larger the coefficient \(\delta_p\), the greater the conditional volatility in the corresponding period.

In the case of both the main and the variance equation, the appropriate number of lags of the dependent variable is determined by the results of an analysis of their statistical significance.

TWO DATASETS

To investigate market conditions, I use two datasets. The first one consists of annual grain price data between 1500 and 1772 for seven cities – Cracow, Gdańsk, Warsaw, Koenigsberg, Wrocław, Lublin, and Lviv. I call this the basic dataset, and because there are numerous gaps in that dataset I also construct an enhanced dataset. I use the information on the prices of wheat and oats from the same market to extrapolate missing observations. I base the analysis of market performance on the basic dataset. For the continuous series of the CV and Weir’s correlation coefficient, I use the enhanced dataset.
The basic unit of observation is a series of annual retail rye prices for each of the seven cities. I chose rye for this study as it was the most commonly traded grain on the domestic market. It was also the most basic source of calories for the population (Wyczanski 1969). Not all of these seven cities were part of the country. Königsberg was located in Ducal Prussia, which was a fief of the Polish king after 1525. Wrocław was located in the historical region of Silesia, which had been a part of the domain of the Polish King back in the eleventh century. At that time, it was considered one of the main capitals of the kingdom. In 1335 it became part of the Czech domain and in 1526 it was claimed by the Habsburgs. Subsequently, in 1742, the city was assimilated by the Kingdom of Prussia. According to Wolański (1961), in spite of the border Wrocław retained close economic ties with Poland. Warsaw was incorporated into the Polish Kingdom in 1526. The other four cities were part of Poland between 1500 and 1772.

Annual grain price data for Gdańsk, Kraków, Lviv, Warsaw, Lublin and Wrocław – the last only until 1618 – were collected from primary archival material (Hoszowski 1928, 1934; Furtak 1935; Adamczyk 1935, 1938; Siegel 1936; Pec 1935, 1937, Wolanński 1993) and standardized to a uniform measure of a price in grams of silver for one litre by the Global Price and Income History Group (http://gpih.ucdavis.edu/). Standardized prices for Königsberg were taken from the Allen-Unger Global Commodity Prices Database (http://www.gcpdb.info/data.html). Prices for Wrocław for the eighteenth century were taken from David Jacks’ webpage (http://www.sfu.ca/~djacks/data/prices/Poland/index.html) and required standardization. See Table 1.

There are numerous gaps in the basic dataset. Calculation of the CV of all the prices and Weir’s correlation coefficient requires numerous simultaneous observations and is sensitive to gaps in the series. I thus had to fill the gaps in the basic dataset by creating the enhanced one. Jacks (2004), computing market integration between ports located at the North and Baltic seas, struggled with a similar shortage of data for Poland. He used information on the simultaneous prices of the same grain from different markets and used panel data analysis to predict the missing observations. I fill some of the gaps in the basic dataset in a similar fashion by using correlations within the same market.

I extrapolate missing prices of rye in each discrete market in three steps. First, I extrapolate the unknown prices of rye from known prices of wheat. I use a simple linear OLS regression (Equation 6) of the annual rye price on the corresponding wheat price and predict rye prices for the years with a known wheat price but an unknown rye price. I use this procedure for each of the seven cities separately.

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7Rye prices in Jacks’s dataset are presented in silbergroschen per Berliner Scheffel. One Spesiztaler was worth 30 silbergroschen. In the late seventeenth century the taler contained 25.9839 g of fine silver. From 1740 onward this was reduced to 19.4879 g. In 1750 Prussia debased the taler further to 16.7039 g and kept it at this level until the end of the studied period. The silver content in the period 1756–63 is unclear and the prices from that time were left out of the dataset. One Berliner Scheffel was 62.3 litre. (Information from Praun 1784; Ebeling & Brodhagen 1789, 490; Engel 1855.)
Second, I predict the remaining missing prices of rye from the prices of oats, using the same procedure. I do not use the rye prices previously predicted from wheat in this second operation. As the third and final step, I fill the remaining gaps in the time series by using a linear interpolation, provided a gap is not wider than five years.

\[
\text{rye\_price}_{t} = \text{Constant} + \alpha \text{price\_of\_other\_grain}_{t} + \epsilon_{t}
\]  

(6)

How do I know that I can use wheat and oats prices to extrapolate data on rye prices? Both grains were consumed by people and – to some extent – can be regarded as substitutes for rye (Wyczan\’ski 1969). Furthermore, production and pricing of all the grains produced in one region were dependent on the same weather conditions and, in general, were subjected to similar shocks. For this reason, two series consisting of paired commodities, one for rye and wheat and the other for rye and oats, can both be expected to have been highly positively correlated. Table 2 presents the results of the regressions of rye prices on prices of wheat and prices of oats separately. Because these correlations can be spurious due to a possible common time trend, I look both at levels\(^8\) and changes\(^9\) in prices. The results of the regression analysis indicate that the prices of rye have been correlated with the prices of wheat and the prices of oats. Specifications I and II indicate that both the constant and the coefficients next to wheat or oats are statistically different from zero. Furthermore, for all the cities except Lublin, the average ratio between the studied prices was statistically different from the constant as well as from the relation in the city of reference – Gdańsk. And according to Mielczarski (1962) and Guzowski (2011), in early modern Poland, the ratio of the price of rye to the price of oats was relatively stable and particular to each individual market. All of

\[\text{rye\_price}_{t,i} = \text{Constant} + \alpha \text{price\_of\_other\_grain}_{t,i} + \sum_{k}^{n} \beta_k \text{city\_dummy}_{k,i} + \epsilon_{t,i}\]

\[\text{rye\_price}_{t,i} - \text{rye\_price}_{t-1,i} = \text{Constant} + \alpha(\text{price\_other\_grain}_{t,i} - \text{price\_other\_grain}_{t-1,i}) + \epsilon_{t,i}\]
this suggests that Equation 6 can be used to predict missing rye prices for each city separately.

Table 3 provides descriptive statistics of the enhanced dataset. It shows that the additional data points were created mostly for Cracow, Lviv, Warsaw, and Lublin. The $R^2$ values of the regressions of rye prices on wheat prices are, in general, relatively high (apart from the $R^2$ value for Lviv). This suggests that the rye prices extrapolated from wheat prices are a close approximation of the historical prices (see also the high $R^2$ value in specification I in Table 2). The $R^2$ values from the regressions of different rye series on corresponding oats series are high for Lviv and Lublin and low for Cracow and Warsaw.\footnote{This might indicate that in Lviv and Lublin – the poorer cities – oats, which were cheaper, were more often used as a substitute for the more expensive rye.}

Table 2: Results of regression of rye prices on prices of wheat or oats

| Rye_price_i | I   | II  | III  | IV  |
|------------|-----|-----|------|-----|
| Method     | Levels | Levels | First-differences | First-differences |
| Constant   | –0.028** (0.05) | 0.029*** (0.01) | –0.003 (0.70) | 0.000 (0.82) |
| Wheat      | 0.663*** (0.00) | 1.727*** (0.00) | 0.543*** (0.00) | 1.26*** (0.00) |
| Oats       | 0.032*** (0.00) | –0.03*** (0.01) | –0.012 (0.31) |
| Warsaw     | 0.03*** (0.00) | –0.012 (0.31) |
| Cracow     | 0.03*** (0.01) | –0.056*** (0.00) |
| Lviv       | 0.007 (0.64) | 0.005 (0.81) |
| Lublin     | 0.005 (0.81) |
| No.        | 245 | 429 | 150  | 307 |
| $R^2$      | 0.86 | 0.76 | 0.45  | 0.31 |

Note: P-values based on heteroscedasticity robust standard errors in brackets. **, *** denote significance at the 5% and 1% level respectively. Gdańsk used as the city of reference. Based on the basic dataset.
Table 3: Descriptive statistics of the annual rye price data in the enhanced dataset

| Period                | Gdańsk Period 1501–1772 | Cracow Period 1504–1772 | Lviv Period 1519–1759 | Warsaw Period 1526–1772 | Lublin Period 1570–1772 | Wrocław Period 1509–1618 & 1696–1772 | Koenigsberg 1700–1772 |
|-----------------------|--------------------------|--------------------------|------------------------|--------------------------|--------------------------|----------------------------------------|------------------------|
| No. observations     | 256                      | 263                      | 241                    | 211                      | 155                      | 163                                    | 68                     |
| Coverage (%)          | 94                       | 98                       | 95                     | 86                       | 76                       | 87                                     | 93                     |
| Mean                  | 0.25                     | 0.08                     | 0.26                   | 0.20                     | 0.35                     | 0.3                                    | 0.23                   |
| SD                    | 0.12                     | 0.03                     | 0.17                   | 0.07                     | 0.16                     | 0.19                                   | 0.09                   |
| No. from the basic dataset | 228                      | 148                      | 73                     | 67                       | 42                       | 163                                    | 68                     |
| No. extrapolated from wheat | 12                      | 10                       | 19                     | 7                        |                          |                                        |                        |
| No. extrapolated from oats | 9                       | 81                       | 133                    | 63                       | 49                       |                                        |                        |
| No. from a lineal interpolation | 19                      | 22                       | 25                     | 62                       | 56                       |                                        |                        |
| No. of years with known rye-oats pairs | 145                      | 138                      | 62                     | 60                       | 29                       |                                        |                        |
| R² of regression on wheat | 0.80                     | 0.49                     | 0.83                   | 0.61                     |                          |                                        |                        |
| R² of regression on oats | 0.70                     | 0.28                     | 0.72                   | 0.16                     | 0.66                     |                                        |                        |

Note: Prices in grams of silver for one litre of rye.
Table 4: Composition of the enhanced dataset of annual rye prices by source of data by city and period

|          | Cracow | Gdańsk | Lviv | Warsaw | Lublin |
|----------|--------|--------|------|--------|--------|
| Coverage / share original / share from wheat / share from oats / share intrapolated (in %) |
| 1525–49 | 100/60/12/24/4 | 100/44/0/16/40 | 100/8/4/88/0 | 56/50/7/14/29 |
| 1550–74 | 100/56/0/44/0 | 100/80/0/4/16 | 100/24/0/76/0 | 100/16/28/20/36 |
| 1575–99 | 100/68/4/28/0 | 100/96/0/4/0 | 100/16/0/80/4 | 100/20/4/32/44 |
| 1600–24 | 100/32/0/68/0 | 100/88/0/8/4 | 100/44/4/32/20 | 100/20/4/44/32 |
| 1625–49 | 100/0/0/100/0 | 100/100/0/0/0 | 100/28/4/68/0 | 28/0/0/86/14/47 |
| 1650–74 | 76/47/0/21/32 | 100/100/0/0/0 | 100/0/0/84/16 | 68/12/0/47/41 | 100/32/4/36/28 |
| 1675–99 | 100/44/8/24/24 | 100/100/0/0/0 | 100/32/12/36/20 | 100/24/0/32/44 | 100/36/4/32/28 |
| 1700–24 | 100/52/24/8/16 | 100/100/0/0/0 | 100/64/4/20/12 | 100/56/8/16/20 | 56/29/0/36/36 |
| 1725–49 | 100/100/0/0/0 | 100/100/0/0/0 | 100/36/8/28/28 | 100/44/20/28/8 | 76/32/16/0/53 |
| 1750–72 | 100/100/0/0/0 | 100/100/0/0/0 | 40/80/0/20/0 | 100/56/8/20/16 | 68/47/12/12/29 |

Note: * starts in 1570.

and Lublin had to be extrapolated. The data for the eighteenth century required much less extrapolation (in the case of Gdańsk and Cracow almost none). In contrast, for the sixteenth and the seventeenth centuries around 60% of data in the enhanced dataset were synthesized on average. For the eighteenth century, only 33% of the data had to be extra- or interpolated.

**TRENDS IN MARKET CONDITIONS IN THE POLISH RYE MARKET**

Figure 1 plots the estimates of the CV of the prices from the enhanced dataset. The data has been smoothed by using the five-year-centred moving average and the Hodrick-Prescott filter. The two methods of smoothing produce similar results. The positions of the local minimums and maximums can be linked to Polish socio-political history (I discuss the long-term trends later in this section).
The story begins with the elevated values in 1525 and 1526. At that time, Gdańsk rebelled against the magistrate. Trade was for a short time redirected to a nearby port, which increased the transaction costs. Military intervention by the king restored trade to Gdańsk. Subsequently, the Gdańsk market was progressively integrated with Warsaw’s market, after the Mazowia region, which includes Warsaw, was incorporated into the Crown in 1526. The general downward trend in the CV lasted until 1564, which coincided with a reform of political and fiscal institutions instigated by the middle nobility and the beginning of the war for possession of the Duchy of Livonia (1563–70). In 1569 the regions of present-day Ukraine were taken from the Grand Duchy of Lithuania and incorporated into the Polish Kingdom. Later that year, Poland and Lithuania united into one political entity known thenceforth as the Commonwealth of the Two Nations. Political disturbances intensified around 1572 when the last king from the hereditary Jagiellonian dynasty died and the kingdom became an elective monarchy. Between 1576 and 1577 Gdańsk, which had supported the election of a candidate from the Hapsburg family, was at war with the elected King Stefan Batory. Military intervention by Batory and foreign mediation ended the conflict and restored trade. The wars, together with various political shocks, destabilized the Polish economic system. Nonetheless, until the low CV point around 1606, the markets were fairly well integrated. These findings correspond to what is known about the Polish economy at the time. Many authors have noted the progressive specialization between the cities and sectors in the second half of the sixteenth century (Baranowski 1919; Wyrobisz 1966, 1981).

The pan-European General Crisis of the seventeenth century hit Poland hard. At the beginning of the seventeenth century, the country not only had to fight
Sweden, Russia, and Turkey but also had to resolve domestic military conflicts. This caused a continuous increase in the CV after around 1606. Between 1626 and 1629, Swedish armies occupied much of the Polish coastline. Subsequently in 1632, Russia invaded the country and besieged the important stronghold of Smoleńsk. This turbulent period concluded with ceasefires with Sweden and Russia signed in 1634 and 1635. The CV plateaued in the 1630s and 40s.

The peace did not last long. The disintegration was especially bad after the 1650s when the Ukrainian uprising (1648–55), Swedish Deluge (1655–60), and the war with Russia (1654–67) hit the country around the same time. According to numerous studies, the wars of the mid-seventeenth century were devastating to the Polish economy. Not only did Poland lose more territories to Russia, but – more importantly – its population was decimated (Przyboś 1957). The war crisis brought the CV values to the highest levels in the studied period. The trend changed around 1686, the date of the signing of a peace treaty with Russia and the beginning of two decades of relative stability.

Disintegration began again towards the end of the seventeenth century and lasted until the 1730s. The year 1704 marks the beginning of another grim period in Polish history – the outbreak of a massive bubonic plague that lasted until 1713. Compounding this, Poland joined the Great Northern War (1700–21), which was nearly as devastating as the wars of the mid-seventeenth century. The war was followed by a period of political chaos and civil wars that concluded with the War for the Polish Succession (1733–38). At that time, foreign military powers and magnates were fighting for political influence in the country. The war ended with the victory by Russia and Saxony that forced out the Polish candidate for the Crown. The end of war resulted in an improvement in market conditions. However, the progressive foreign influence gradually led to the first partition of the country in 1772 by Austria, Russia, and Prussia.

It has been commonly argued in the historiography (for example by Rusiński 1954) that 1764 was a turning point in the economic history of the country. At that date, Russia agreed to a wide range of reforms in order to secure the election of its candidate to the Polish throne. The reforms included the standardization of measures and moneys. According to Rusiński, the second half of the eighteenth century was a period of progressive specialization across the Polish cities. The CV series indicate a slight convergence in prices between 1764 and 1772, but not down to the levels typical for the sixteenth century.

Thus far I have analysed only the short-term changes in market integration. I also wish to identify and possibly explain the long-term changes. First, I identify major break points. I propose some possible explanations for these long-term changes in the next section of the text. Regarding the long-term changes, the straightforward and most important conclusion of Figure 1 is that the values in the sixteenth century were lower than those in the eighteenth century. The Chow Break Point Test confirms this difference between CV estimates from before and after 1650 at a 10% significance level. The difference is statistically significant both for the values based on the basic dataset and for those based on the enhanced dataset.
I investigate the identified disintegration in more detail. Figure 2 presents the ratios of various cities’ rye prices to Gdańsk’s rye price. The figure is based on the basic dataset. It is a well-established fact that Gdańsk was the centre of Polish grain markets and the outlet for most of the grain exports from the country (Małecki 1968). In an integrated market, the price of rye in Gdańsk should be the highest in the country. The figure suggests that this was the case until around the 1650s, when the prices in Lviv and Lublin rose high above the threshold set by Gdańsk. These cities were located off the Vistula and were connected with the other cities via the network of small towns that was destroyed in the middle of the seventeenth century. I return to this point in the next section.

To double-check the argued trends in market conditions established by investigating the CV of prices, I test for co-movement of prices in a broad market with the method proposed by Weir (1989). I investigate three sets of cities: (1) only the ones located on the Vistula (Gdańsk, Warsaw, and Cracow), (2) only the ones located off the Vistula plus Cracow, and (3) all the cities. With the second specification, I hope to observe the extent to which the higher prices in the landlocked cities were the result of not having access to river transport. The results of Weir’s correlation coefficient are based on the enhanced dataset. The results indicate a progressive decline in market efficiency in early modern Poland. Figure 3 shows that exchange of information between the cities may have been more efficient in the sixteenth than the eighteenth century when I look at the domestic market – I find there was little or no correlation of prices in the second half of the eighteenth century. The closer correlation of prices before the 1650s can be also observed by studying the Pearson product-moment correlation coefficient of all the individual pairs of cities.11

Figure 2: Ratios of rye prices in four cities to Gdańsk’s rye price in selected years, 11-year centred average, 1550–1772
Source: Basic dataset.

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11This analysis, based on the basic dataset, is not included in this paper.
When I compare the landlocked cities with those on the Vistula, I find different trends. The results show that the exchange of information between cities located on the Vistula was more efficient both in the sixteenth and in the eighteenth centuries. The cities located off the river showed signs of a sympathetic co-movement in prices in the sixteenth century, but they disintegrated in the eighteenth century. The inflated estimates of co-movement observed for the seventeenth century were—most probably—a result of a common shock to the system; both of the sample periods were characterized by devastating military operations inside the Polish territory that increased prices all over the country. The landlocked cities were particularly subjected to this shock.

I also study long-term changes in unexpected price volatility across the markets by looking at residual variance. Table 5 shows the results of the main regression. It presents estimates obtained from the analysis of the basic dataset, so, unlike the measures of the CV and Weir’s coefficient, it does not suffer from the shortcomings of the enhanced dataset. Specification I indicates that the third lag of the dependent variable is only weakly significant. The third lag becomes insignificant if I account for city-specific fixed effects (specification II). It also becomes insignificant if I account for the trend in the data (not included). As a result, I estimate error terms for every city individually by regressing the dependent variable on only two lags (see Equation 4).

Table 6 presents the results of the variance equation (Equation 5). Specification I shows that the third lag of the dependent variable is not statistically significant. Therefore, specifications II to V use two lags of the dependent variable.\(^\text{12}\) The results of specification V of the panel data analysis indicate that the cross-market volatility in the period 1700–50 was significantly higher than that of

\(^\text{12}\)If I incorporate a third lag into the analysis the general conclusions do not change, however.
the reference period 1500–50. Specification II indicates that – where the whole studied period is concerned – the volatility was significantly lower in the cities located on the Vistula. The results of specification III indicate that the volatility across all of the cities was significantly higher in the period of crisis, 1650–1772. Different specifications of the beginning of the crisis do not change this result. Lastly, specification IV includes an interaction term between the ‘being located on the Vistula’ dummy and the ‘operating during the disintegration crisis’ – i.e. after 1650 – dummy. This inclusion yields some explanatory power as it nearly doubles the overall $R^2$. The interaction terms entirely negate the adverse effect of the crisis. This indicates that market performance in the cities located on the Vistula was not significantly affected by the disintegration crisis, whereas prices in the cities located off the river were significantly more volatile in the period of their disintegration.

In summary, this inquiry into the long-term changes in conditions on the Polish rye market indicates that the market was better integrated, more efficient, and performed better in the sixteenth than in the eighteenth century. Measures of market integration and market performance both indicate that the observed protracted market crisis could have originated around the middle of the seventeenth century. Furthermore, market disintegration was caused by a relative increase in prices in the landlocked cities. The results of the analyses of market efficiency and performance indicate that market conditions in the landlocked cities in the eighteenth century were worse than in the cities located on the Vistula.

Table 5: Results of the main equation (equation 4)

|                  | I                  | II                 | III                |
|------------------|--------------------|--------------------|--------------------|
| Constant         | 0.045*** (0.00)    | 0.287*** (0.00)    | 0.057*** (0.00)    |
| AR (1)           | 0.984*** (0.00)    | 0.949*** (0.00)    | 0.938*** (0.00)    |
| AR (2)           | -0.356*** (0.00)   | -0.372*** (0.00)   | -0.148*** (0.00)   |
| AR (3)           | 0.124* (0.08)      | 0.107 (0.12)       |                   |
| AR (4)           | 0.104** (0.04)     | 0.066* (0.07)      |                   |
| City-specific fixed effects | NO | YES | NO |
| No.              | 401                | 401                | 465                |
| $R^2$            | 0.69               | 0.71               | 0.67               |

Note: P-values based on heteroscedasticity robust standard errors in brackets. *, **, *** denote significance at the 10%, 5% and 1% level respectively. Based on the basic dataset.
Table 6: Results of the variance equation (equation 5)

| û²       | I        | II       | III      | IV       | V        |
|----------|----------|----------|----------|----------|----------|
| Constant | 0.0048*** (0.00) | 0.0085*** (0.00) | 0.0022*** (0.00) | 0.0024*** (0.00) | 0.0022 (0.34) |
| ARCH (1) | 0.246*** (0.01) | 0.1714** (0.03) | 0.1815** (0.02) | 0.0981 (0.29) | 0.1775** (0.02) |
| ARCH (2) | 0.162** (0.04) | 0.1332* (0.09) | 0.1434* (0.06) | 0.0601 (0.55) | 0.14* (0.07) |
| ARCH (3) | –0.08 (0.11) |          |          |          |          |
| 1551–1600a |          |          |          |          | 0 (0.99) |
| 1601–1650a |          |          |          |          | 0.0001 (0.97) |
| 1651–1700a |          |          |          |          | 0.0014 (0.63) |
| 1701–1750a |          |          |          |          | 0.0065* (0.07) |
| 1751–1772a |          |          |          |          | 0.0024 (0.5) |
| On Vistulaa | – 0.0059** (0.02) |          |          | 0.0006 (0.53) |          |
| During the crisisa (1650–1772) |          | 0.0042*** (0.01) |          | 0.0183*** (0.01) |          |
| On Vistula during the crisisa |          |          | 0.0183*** (0.01) |          |          |
| No.       | 381      | 401      | 401      | 401      | 401      |
| Within R² | 0.08     | 0.07     | 0.08     | 0.13     | 0.08     |
| Between R² | 0.99    | 0.57     | 0.77     | 0.23     | 0.38     |
| Overall R² | 0.11    | 0.11     | 0.1      | 0.17     | 0.11     |

Note: P-values based on heteroscedasticity robust standard errors in brackets. *, **, *** denote significance at the 10%, 5% and 1% level respectively. Based on Equation 5 plus additional specifications. a denote dummy variables. Based on the basic dataset.

POSSIBLE CAUSES OF THE PROTRACTED MARKET CRISIS

What are the probable causes of the observed long-term changes in market conditions? I suggest two possible complementary explanations that require further
empirical verification, which is beyond the scope of this paper. I suggest that the disintegration accelerated because of the already-mentioned devastating military conflicts around the middle of the seventeenth century that decimated the population and crippled the trade network. Furthermore, I suggest that the disintegration persisted because of ongoing political fragmentation of the country in the late seventeenth and early eighteenth centuries.

Regarding the impact of the devastating wars of the mid-seventeenth century, Figure 4 shows available estimates of the average annual war casualties in wars fought by Poland and/or Lithuania. It demonstrates that between 1648 and 1667 the country experienced an unprecedented loss in population. According to Reed (1973), there are economics of scale in the transactions sector and, as a result, the costs of exchange are negatively correlated with the size of the population. For example, low population means that fixed costs of infrastructure have to be spread among many people. Moreover, the more actors there are on the market, the more likely potential buyers are to meet potential sellers and the more easily information spreads by word-of-mouth. According to Bateman (2012, 130), population shocks affect market conditions because ‘if population falls, people tend to retreat from the market, which then lowers the benefits to others of remaining in the market’. The population of Poland (current borders), after a period of continuous growth dropped from 7.6 to 6.1 million between 1655 and 1660 and, due to the devastating warfare in the first quarter of the eighteenth century, remained relatively low and recovered only by the late eighteenth century (Wójtowicz 2006, 44). This could have contributed to the spike in market disintegration that occurred after the 1650s (see Figure 1) and the relatively low levels of market integration thereafter.

Devastating warfare could also have affected market conditions by crippling the land trade network. According to Unger (2012), markets in the late medieval and early modern period could have become integrated via the dense network of

Figure 4: Rough estimates of the average annual casualties in wars fought by Poland and/or Lithuania in selected periods, 1501–1772
Source: Malinowski 2015.
small towns that were mushrooming at the time. It has been shown on several occasions that such a dense network of urban dwellings was present in Polish lands as early as the late Middle Ages (Wyrozumski 1980; Wiesiołowski 1980; Maćczak and Smout 1991). This network most likely contributed to the relatively good integration of the sixteenth century. It was destroyed as a result of the mid-seventeenth-century warfare. According to Bogucka and Samsonowicz (1986), most urban settlements were levelled and most of the urban population slain. Figure 5 scatterplots the population in 65 urban dwellings located around the country from before and after the most wars. It is based on urban population data assembled by Malinowski (2016). It shows an average decline in the size of urban dwellings of around 70%.

The destruction of the network could have affected the landlocked cities differently, as the cities on the Vistula were still connected by the river. The destruction of towns could have hampered trade on land as well as increasing transaction and transport costs. This could explain the disintegration of the landlocked cities presented in Figure 2 and the identified decrease in market performance. Moreover, the destruction of the trade network could also have impeded the transfer of information between the landlocked cities and the Vistula region. This could explain the decline in market efficiency in the landlocked cities presented in Figure 3. This issue, however, requires further empirical investigation, which is beyond the scope of this paper.

Given that the population and urbanization levels gradually recovered from the low post-1650s levels (Wójtowicz 2006) and that the second half of the eighteenth century was relatively peaceful (see Figure 4), warfare and obstruction of the trade network could explain a temporary decline but not the persistent change in market conditions. In a companion paper I propose a hypothesis that the poor market conditions...
conditions persisted through the eighteenth century because of the adverse political setup of the country at the time (Malinowski 2015). Mačzak (1982, 1987) hypothesized that the wars of the seventeenth century induced a sharp increase in wealth inequality within the political elite as they provided a few wealthy families with opportunities to buy up estates devastated during military actions. This led to the rise of the so-called ‘Magnate Oligarchy’ that shifted the balance of power from the central level – the parliament – to the local level – mini-states controlled by the wealthy families. Whereas the sixteenth century was dominated by relatively strong central institutions (a hereditary dynasty and active parliament) that kept the magnates in check, in the eighteenth century the parliament was, for the most of the time, ineffective and the king was dependent on the magnates’ support to be elected. This political change could have affected market conditions. According to Epstein (2000), centralization of sovereignty can help enforce convergence of institutions. Political centralization deprives local elites of jurisdictional power and displaces rent-seeking from the local to the national arena. This makes rent-seeking more transparent and therefore harder to implement. Furthermore, political centralization reduces the costs of coordination, allowing for concerted decisions and policies. This should result in a convergence of legal, monetary and measurement systems that lowers transaction costs. Moreover, according to Bateman (2012, 156) political fragmentation deters market development because it prevents the use of economies of scale in the provision of public services, thus keeping transaction costs high.

Next to warfare and political economy, I can suggest one more complementary or alternative explanation of the trends I have observed in market conditions. As discussed, a price gap between a pair of cities can be small and prices on discrete markets can move in tandem, even if the cities do not interact with each other. It is possible that the identified trends in market integration and market efficiency were caused not by changes in the dynamic of the Polish domestic market but by changes in the international one. According to Jacks (2004, Figure 7), prices on the Polish grain market in the sixteenth century were highly co-dependent with prices in Amsterdam (and those in London, but to a much smaller degree). Every week, the Amsterdam Commodity Exchange issued and distributed a financial newspaper reporting current prices in the city (Price Currant), which was distributed throughout Europe (McCusker & Gravestein 1991). Given the availability of information on prices in Amsterdam and the large scale of the grain export (Biernat 1962), it is possible that changes in prices in Polish cities were strongly influenced by changes in prices in Amsterdam. This links to an observation made by Baten and Wallusch (2005), that prices in cities across Poland were more dependent on changes in the price in Gdańsk (the export port and thus the point of contact with Amsterdam) than on changes in other cities. Various students of the Dutch-Polish grain trade also suggest that prices in Gdańsk could have been dependent much more on changes in Amsterdam (Lemmink & Koningsbrugge 1990; Van Bochove 2008). If it is the case that the Polish cities were, through the information from Gdańsk, in effect following prices from Amsterdam, then the
resulting similarity in their prices might be misinterpreted as evidence of integration in Polish markets. Moreover, the prices on such a market would also move in tandem, which would wrongly imply high efficiency.

This possible dependence on the foreign markets could partly explain the observed decline in market conditions after the seventeenth century. According to Jacks, the connection between Amsterdam and Poland weakened throughout the seventeenth and the eighteenth centuries – prices in the two areas became less co-dependent. This coincided with a decline in export of rye from Poland (Biernat 1962), which could mean that information on rye prices in Amsterdam became less important to grain merchants trading in the commodity. Without a ‘leader’, Polish cities would have to start setting their prices independently. One could hypothesize that without the outside coordination, market conditions were left to the forces on the domestic market, which resulted in the decline in market conditions. The question of whether market conditions in Poland were driven by domestic or international connections (and to what degree) requires further investigation, which is beyond the scope of this paper.

CONCLUSION

This study provided new estimates of market conditions in preindustrial Poland. It showed that the Polish rye market disintegrated in the mid-seventeenth century after a period of a relative integration. It advanced empirical evidence that the disintegration came about because the landlocked cities became separated from the markets in other cities. The study also showed that the cities on the Vistula remained relatively integrated. The domestic market in Poland remained disintegrated in the eighteenth century, at the time of a relative improvement in market conditions in a range of Western European counties. The difference in the general trends in market development between eastern and western Europe supports the notion of the Little Divergence in economic development within Europe before the Industrial Revolution.

This paper also suggested that the market crisis could have been a result of the wars of the mid-seventeenth century, which decimated the population and crippled the trade network. The wars could have had a lasting and negative effect on market development by encouraging wealth inequality within the political elite. As I explain in a companion paper, the rise of the magnates who bought the devastated estates of the rank-and-file nobility led to a shift of political power from the central to the local level, which hampered the convergence of legal, monetary and measurement systems on the common market (see Malinowski 2015). According to the conventional knowledge, military conflicts accelerated state development in the West that, in turn, promoted an environment conducive to trade. The notion that wars could have had different political and economic consequences in the East invites more comparative research into the character and intensity of military conflicts in the two regions.
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