

# Supplementary Appendix

## Grain Prices in Pre-industrial Germany, Fifteenth to Nineteenth Centuries

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The main paper describes our database of grain prices in 70 German cities. This Supplementary Appendix complements the main paper in two ways. Section SA1 is devoted to specific data types that require a conversion to a common time reference, the calendar year. The section provides the corresponding details. Section SA2 documents the Data Appendix. It consists of entries for each city that we cover and reports details on currency and volume conversion, sources, and their combination to the final series for all grains.

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## SA1 Conversion to calendar year prices and interpolation

Section SA1.1 reproduces the steps that are necessary to convert *Martini* or crop year prices to calendar year averages. In some cases, this entails the interpolation of missing values. Section SA1.2 documents interpolated datapoints.

### SA1.1 Conversion of Martini and crop year prices to calendar year prices

#### SA1.1.1 Martini prices

In cities where both *Martini* and calendar year prices are available, we extrapolate missing calendar year prices on the basis of *Martini* prices using the parameters of the city-specific relationship between the two type of prices; see below. For cities where only *Martini* prices available we have established a general or generic extrapolation rule (Albers and Pfister, 2021, SA2.1, p. S36):

$$p_t = \alpha_r \cdot \bar{m}_{\text{time series Martini}} + 0.5 \cdot m_t + 0.5 \cdot m_{t-1}, \quad (\text{S1})$$

where  $p_t$  is the calendar year price in year  $t$ ,  $m_t$  the *Martini* price in year  $t$  and  $m_{t-1}$  the *Martini* price in the preceding year.  $\alpha_r$  is the constant from a restricted panel regression. It differs between different types of grain. For rye (grain  $r=1$ )  $\alpha_1 = 0.0185$ , for barley (grain  $r=2$ )  $\alpha_2 = 0.0467$  and for wheat (grain  $r=3$ )  $\alpha_3 = 0.0202$ . There is no general extrapolation rule for oats; for cities for which we have only *Martini* prices we cannot provide calendar year prices for oats.

Parameter estimates of city-specific OLS regressions of calendar year prices on *Martini* that we use below to extrapolate missing values of calendar year prices for the respective cities are shown in Tables S1 to S6 (Albers and Pfister, 2021, SA2.1, pp. S34–S35).

**Table S1:** City-specific time series relationships between calendar year and Martini prices (part A)

	Emden			Göttingen		
	rye 1797–1850	barley 1797–1825	oats 1797–1850	wheat 1797–1825	wheat 1765–1863	rye
Intercept	0.0177 (0.0214)	−0.0136 (0.0255)	0.0406** (0.0169)	0.0149 (0.0408)	−0.0337 (0.0304)	0.0036 (0.0267)
Martini price	0.3970*** (0.1107)	0.4799*** (0.0317)	0.5439*** (0.0466)	0.6157*** (0.0880)	0.5571*** (0.0607)	0.5390*** (0.0511)
Lag 1 Martini price	0.5640*** (0.0975)	0.5426*** (0.0406)	0.3291*** (0.0407)	0.3243*** (0.0862)	0.5012*** (0.0745)	0.4544*** (0.0741)
R <sup>2</sup>	0.9220	0.9296	0.8278	0.9160	0.9100	0.9063
Adj. R <sup>2</sup>	0.9149	0.9222	0.8114	0.9072	0.9081	0.9043
Num. obs.	25	22	24	22	99	99

Note: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Dependent variable: calendar year price. Newey and West (1987) standard errors in ().

**Table S2:** City-specific time series relationships between calendar year and Martini prices (part B)

	Göttingen		Halle			
	barley	oats	wheat	rye	barley	oats
	1765–1850		1692–1834			
Intercept	0.0005 (0.0378)	−0.0018 (0.0152)	0.0281*** (0.0067)	0.0129 (0.0110)	0.0126* (0.0065)	0.0147** (0.0058)
Martini price	0.5521*** (0.0956)	0.5947*** (0.0774)	0.4698*** (0.0200)	0.5142*** (0.0172)	0.4970*** (0.0305)	0.4602*** (0.0674)
Lag 1 Martini price	0.4729*** (0.1376)	0.5268*** (0.0816)	0.4590*** (0.0241)	0.4273*** (0.0478)	0.4600*** (0.0398)	0.5012*** (0.0637)
R <sup>2</sup>	0.8082	0.7824	0.9593	0.9461	0.9081	0.8964
Adj. R <sup>2</sup>	0.8036	0.7772	0.9583	0.9448	0.9057	0.8938
Num. obs.	86	86	82	83	82	82

Note: \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ . Dependent variable: calendar year price. Newey and West (1987) standard errors in ().

**Table S3:** City-specific time series relationships between calendar year and Martini prices (part C)

	Hanover			Lüneburg		
	wheat	rye	oats	barley	barley	oats
	1765–1850			1766–1850		
Intercept	0.0052 (0.0290)	0.0061 (0.0226)	0.0055 (0.0105)	−0.0198 (0.0179)	−0.0428 (0.0257)	0.0200 (0.0195)
Martini price	0.3956*** (0.0498)	0.4067*** (0.0376)	0.4968*** (0.0540)	0.4763*** (0.0511)	0.7640*** (0.1303)	0.4756*** (0.0507)
Lag 1 Martini price	0.6311*** (0.0692)	0.6116*** (0.0676)	0.5868*** (0.0740)	0.6106*** (0.0780)	0.4139** (0.1540)	0.5164*** (0.0863)
R <sup>2</sup>	0.8795	0.9184	0.8762	0.8914	0.8864	0.8898
Adj. R <sup>2</sup>	0.8761	0.9160	0.8726	0.8883	0.8791	0.8826
Num. obs.	73	72	72	73	34	34

Note: \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ . Dependent variable: calendar year price. Newey and West (1987) standard errors in ().

**Table S4:** City-specific time series relationships between calendar year and Martini prices (part D)

	Lüneburg		Minden			
	rye	wheat	barley	oats	rye	wheat
	1766–1850		1777–1850			
Intercept	−0.0421 (0.0333)	0.0680 (0.0414)	−0.0100 (0.0248)	0.0020 (0.0136)	0.0205 (0.0228)	0.0485* (0.0260)
Martini price	0.5663*** (0.1245)	0.4045*** (0.0533)	0.5330*** (0.0572)	0.6126*** (0.0770)	0.4155*** (0.0669)	0.4178*** (0.0806)
Lag 1 Martini price	0.5507*** (0.1498)	0.5173*** (0.0687)	0.5661*** (0.0994)	0.4699*** (0.0929)	0.5887*** (0.0812)	0.5452*** (0.0738)
R <sup>2</sup>	0.8366	0.8789	0.8634	0.7117	0.8670	0.8717
Adj. R <sup>2</sup>	0.8245	0.8711	0.8591	0.7027	0.8628	0.8677
Num. obs.	30	34	67	67	67	67

Note: \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ . Dependent variable: calendar year price. Newey and West (1987) standard errors in ().

**Table S5:** City-specific time series relationships between calendar year and Martini prices (part E)

	Münster				Paderborn	
	barley	oats	rye	wheat	barley	oats
	1816–1863				1811–1833	1809–1833
Intercept	0.0780** (0.0356)	0.0542** (0.0223)	0.0294 (0.0311)	0.0380 (0.0601)	−0.0061 (0.0377)	0.0077 (0.0193)
Martini price	0.3474*** (0.0974)	0.3358*** (0.0709)	0.5519*** (0.0590)	0.5160*** (0.0552)	0.7250*** (0.1795)	0.7580*** (0.1569)
Lag 1 Martini price	0.5655*** (0.0780)	0.6054*** (0.0705)	0.5073*** (0.0654)	0.5475*** (0.0660)	0.3743** (0.1495)	0.3695** (0.1437)
R <sup>2</sup>	0.8400	0.8353	0.9192	0.8937	0.8051	0.7035
Adj. R <sup>2</sup>	0.8318	0.8268	0.9149	0.8881	0.7856	0.6766
Num. obs.	42	42	41	41	23	25

Note: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Dependent variable: calendar year price. Newey and West (1987) standard errors in ().

**Table S6:** City-specific time series relationships between calendar year and Martini prices (part F)

	Paderborn	
	rye 1809–1833	wheat 1803–1833
Intercept	0.0679 (0.0580)	−0.0011 (0.0465)
Martini price	0.4559*** (0.1092)	0.5283*** (0.0795)
Lag 1 Martini price	0.3434*** (0.0788)	0.4245*** (0.0877)
R <sup>2</sup>	0.6878	0.7544
Adj. R <sup>2</sup>	0.6594	0.7369
Num. obs.	25	31

Note: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Dependent variable: calendar year price. Newey and West (1987) standard errors in ().

### SA1.1.2 Crop year prices

In cities where both crop year and calendar year prices are available, we extrapolate missing calendar year prices on the basis of crop year prices using the parameters of the city-specific relationship between the two type of prices; see below. For cities no local time series relationship is available we have developed the following equation to extrapolate calendar year prices (Albers and Pfister, 2021, SA2.2, p. S42):

$$p_t = \beta_{1r} \cdot h_t + \beta_{2r} \cdot h_{t-1} + \beta_{3r} \cdot h_{t-2}, \quad (\text{S2})$$

where  $h_t$ ,  $h_{t-1}$  and  $h_{t-2}$  are crop year prices in year  $t$ ,  $t - 1$  and  $t - 2$ , and  $\beta_{.r}$  denote grain-specific coefficients. The values of the  $\beta_{.r}$  are documented in Table S7.

**Table S7:** Parameters for extrapolation of calendar from crop year prices (August to July)

Parameter	barley	oats	rye	wheat
$\beta_{1r}$	0.43	0.38	0.41	0.34
$\beta_{2r}$	0.70	0.71	0.67	0.74
$\beta_{3r}$	-0.13	-0.09	-0.08	-0.08

Source: (Albers and Pfister, 2021, SA2.2, p. S42)

Parameter estimates of city-specific OLS regressions of crop year prices on calendar year prices that we use below to extrapolate missing values of calendar year prices for the respective cities are shown in Tables S8 and S9 (Albers and Pfister, 2021, SA2.2, pp. S41–S52).

**Table S8:** City-specific time series relationships between calendar and crop year prices (part A)

	Augsburg rye 1750–1799	Munich oats 1692–1773	Munich rye 1693–1773	Munich barley 1698–1820	Munich wheat 1691–1797
	<i>Kammerrechnungen</i>			<i>Heilig-Geist</i>	
Intercept	0.0126 (0.0227)	-0.0182** (0.0079)	-0.0196 (0.0135)	0.0646*** (0.0203)	0.0328 (0.0446)
Crop y.	0.5336*** (0.0525)	0.5743*** (0.0487)	0.4421*** (0.0434)	0.3626*** (0.0803)	0.1415* (0.0722)
Lag 1 crop y.	0.5252*** (0.0914)	0.5769*** (0.0481)	0.6704*** (0.0576)	0.7705*** (0.0584)	0.8139*** (0.1787)
Lag 2 crop y.	-0.0395 (0.0311)	-0.0568 (0.0500)	-0.0526 (0.0524)	-0.3228*** (0.0373)	0.0642 (0.0937)
R <sup>2</sup>	0.9450	0.8885	0.9617	0.9660	0.8788
Adj. R <sup>2</sup>	0.9408	0.8843	0.9599	0.9619	0.8694
Num. obs.	44	82	69	29	43

Note: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Dependent variable: calendar year price. Newey and West (1987) standard errors in ().

**Table S9:** City-specific time series relationships between calendar and crop year prices (part B)

	Würzburg rye 1656–1777	Würzburg wheat 1658–1776	Munich oats 1691–1799	Munich rye 1692–1800
	Elsas		<i>Heilig-Geist</i>	
Intercept	-0.0083 (0.0130)	-0.0074 (0.0244)	0.0142 (0.0247)	0.0231 (0.0343)
Crop y.	0.4385*** (0.0507)	0.2696*** (0.0357)	0.6287*** (0.1720)	0.4680*** (0.1265)
Lag 1 crop y.	0.5218*** (0.0595)	0.6563*** (0.0514)	0.2023 (0.2235)	0.5475*** (0.1331)
Lag 2 crop y.	0.0445 (0.0316)	0.0968* (0.0498)	0.1727 (0.2357)	-0.0296 (0.0971)
R <sup>2</sup>	0.9242	0.9115	0.8069	0.9503
Adj. R <sup>2</sup>	0.9219	0.9071	0.7827	0.9379
Num. obs.	103	65	28	16

Note: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Dependent variable: calendar year price. Newey and West (1987) standard errors in (). The latter two relationships from the *Heilig-Geist* hospital are not part of the panel regressions.

## SA1.2 Interpolation of missing values

The following table documents the values that were linearly interpolated with neighbouring observations.

**Table S10:** Interpolated years in dataset

Grain type	City	Interpolated values										
<b>Barley</b>	Augsburg	1480	1491	1550	1576	1607	1653					
	Duisburg	1696										
	Frankfurt (Main)	1639	1646	1722	1735	1740	1743	1772	1781			
	Leipzig	1580	1610	1641	1660	1670	1689	1767				
	Munich	1559	1562	1584	1598	1610	1684	1687				
	Rendsburg	1722										
	Spandau	1661	1683									
	Speyer	1569	1622	1627	1650	1683	1686	1705	1720	1786		
	Überlingen	1731										
	Vreden	1845										
<b>Oats</b>	Augsburg	1465	1470	1541	1562	1759						
	Frankfurt (Main)	1460	1493	1498	1502	1505	1549	1572	1624	1629	1647	1729
		1745	1767	1781	1786							
	Leipzig	1619	1647	1767								
	Munich	1492	1510	1513	1530	1538						
	Speyer	1578	1599	1607	1627	1635	1670	1677	1721	1758		
	Würzburg	1580	1584	1594	1626	1639	1704	1712	1724	1740	1750	
	Überlingen	1666	1684	1697	1702	1711						
<b>Rye</b>	Augsburg	1504	1506	1523	1528	1538	1557	1562	1650	1759		
	Duisburg	1696										
	Frankfurt (Main)	1477	1484	1488	1495	1506	1606	1610	1620	1634	1643	1747
		1755	1780	1785								
	Leipzig	1574	1606	1635	1655	1660	1681	1687	1767			
	Munich	1499	1509	1541	1568	1604	1609	1632	1689			
	Rendsburg	1722	1753									
	Spandau	1653	1661	1683	1685							
	Speyer	1599	1602	1618	1625	1638	1677	1686	1698	1799		
	Überlingen	1669	1684	1693	1718	1731						
	Vreden	1666	1669	1679	1697	1701	1703					
	Würzburg	1480	1542	1546	1618	1636	1639	1645	1685	1687	1779	1791
<b>Wheat</b>	Duisburg	1696										
	Frankfurt (Main)	1443	1503	1640	1646	1651	1660	1706				
	Leipzig	1613	1621	1641	1664	1666	1675	1697	1701	1758		
	Munich	1547	1590	1595	1616	1652	1662	1666	1682			
	Rendsburg	1702										
	Speyer	1648	1758									
	Würzburg	1564	1580	1615	1624	1641	1654	1690	1695	1697	1792	

*Note:* Years refer to interpolated values in crop year and *Martini* price series which were used for the conversion to calendar year prices. We divided the period under study into three sub-periods: 1371–1510, 1511–1650, 1651–1790, 1791–1850. The shares of interpolated values per existing observations is always  $\leq 5\%$  for each period. Interpolation method: mean of neighbouring years.



## SA2 Description of individual grain price series

This section documents the database of grain prices in 70 German cities. Table S11 provides an overview of the cities and time periods covered by individual series.

**Table S11:** Overview: covered period by city and grain type

City	Barley	Oats	Rye	Wheat
Aachen	1784 – 1871	1784 – 1871	1784 – 1871	1784 – 1871
Altenburg	1505 – 1844	1505 – 1844	1505 – 1863	1530 – 1844
Augsburg	1461 – 1871	1459 – 1871	1459 – 1871	1670 – 1871
Berlin	1652 – 1871	1652 – 1871	1652 – 1871	1652 – 1871
Boizenburg	1771 – 1870	1771 – 1870	1771 – 1870	1771 – 1870
Brandenburg	1696 – 1871	1811 – 1871	1696 – 1871	1811 – 1871
Braunschweig	1513 – 1850	1513 – 1850	1513 – 1850	1513 – 1850
Bremen			1705 – 1850	1699 – 1850
Breslau	1741 – 1871	1741 – 1871	1741 – 1871	1741 – 1871
Celle	1727 – 1871	1727 – 1846	1727 – 1871	1727 – 1871
Cologne	1532 – 1871	1532 – 1871	1532 – 1871	1532 – 1871
Detmold	1770 – 1850	1770 – 1850	1770 – 1850	1770 – 1850
Dresden	1602 – 1782	1602 – 1782	1602 – 1869	1602 – 1869
Duderstadt	1650 – 1850	1656 – 1850	1650 – 1850	1672 – 1850
Duisburg	1693 – 1782		1693 – 1782	1693 – 1782
Düsseldorf	1769 – 1871	1769 – 1871	1769 – 1871	1769 – 1871
Elberfeld	1816 – 1865	1816 – 1865	1769 – 1865	1769 – 1865
Emden	1780 – 1850	1780 – 1850	1780 – 1850	1780 – 1850
Erfurt	1696 – 1871	1651 – 1871	1651 – 1871	1651 – 1871
Frankfurt (Main)	1604 – 1797	1372 – 1799	1352 – 1799	1421 – 1799
Frankfurt (Oder)	1812 – 1871	1812 – 1871	1765 – 1871	1812 – 1871
Gdansk	1501 – 1871	1501 – 1871	1501 – 1871	1703 – 1871
Görlitz	1816 – 1871	1816 – 1871	1763 – 1871	1763 – 1871
Göttingen	1632 – 1850	1634 – 1850	1632 – 1867	1632 – 1867
Grabow	1780 – 1870	1780 – 1870	1780 – 1870	1780 – 1870
Halberstadt	1639 – 1871	1816 – 1871	1639 – 1871	1639 – 1871
Halle	1601 – 1871	1601 – 1871	1601 – 1871	1601 – 1871
Hamburg	1736 – 1871	1736 – 1871	1540 – 1871	1736 – 1871
Hanover	1590 – 1863	1590 – 1863	1590 – 1863	1590 – 1863
Heilbronn	1816 – 1843	1744 – 1843	1744 – 1843	
Herdecke	1780 – 1850	1780 – 1850	1780 – 1850	1780 – 1850
Herford	1771 – 1850	1771 – 1850	1771 – 1850	1771 – 1850
Hildesheim	1568 – 1863		1568 – 1863	1568 – 1863
Jena			1662 – 1855	
Kassel			1766 – 1855	

Note: continued next page.

**Table S11:** Overview: covered period by city and grain type (continued)

City	Barley	Oats	Rye	Wheat
Königsberg	1688 – 1871	1688 – 1871	1688 – 1871	1688 – 1871
Landshut	1584 – 1871	1584 – 1871	1584 – 1871	1584 – 1871
Leipzig	1574 – 1820	1587 – 1820	1574 – 1871	1574 – 1871
Leisnig			1772 – 1871	1772 – 1871
Lueneburg	1728 – 1863	1718 – 1863	1617 – 1863	1606 – 1863
Magdeburg	1667 – 1871	1740 – 1871	1642 – 1871	1642 – 1871
Mainz	1824 – 1871	1824 – 1871	1636 – 1871	1824 – 1871
Mannheim	1791 – 1854	1791 – 1856	1791 – 1853	1791 – 1852
Minden	1651 – 1871	1640 – 1871	1641 – 1871	1724 – 1871
Muenster	1570 – 1871	1570 – 1871	1570 – 1871	1570 – 1871
Munich	1514 – 1871	1452 – 1871	1452 – 1871	1512 – 1871
Nordhausen	1669 – 1871	1669 – 1871	1669 – 1871	1669 – 1871
Nuremberg	1815 – 1871	1815 – 1871	1490 – 1871	1498 – 1871
Osnabrück	1615 – 1861		1615 – 1861	1625 – 1861
Paderborn	1677 – 1871	1677 – 1871	1641 – 1871	1641 – 1871
Parchim	1799 – 1870	1799 – 1870	1799 – 1870	1799 – 1870
Quedlinburg	1750 – 1855	1750 – 1855	1750 – 1855	1750 – 1855
Regensburg	1786 – 1871	1786 – 1871	1786 – 1871	1786 – 1871
Rendsburg	1701 – 1734		1701 – 1853	1701 – 1734
Rostock	1771 – 1870	1771 – 1870	1410 – 1870	1771 – 1870
Schweinfurt	1725 – 1782	1725 – 1782	1725 – 1782	1725 – 1782
Schwerin	1771 – 1870	1771 – 1870	1771 – 1870	1771 – 1870
Spandau	1623 – 1783		1622 – 1783	1700 – 1783
Speyer	1519 – 1871	1530 – 1871	1530 – 1871	1572 – 1871
Stettin	1740 – 1871	1740 – 1871	1740 – 1871	1740 – 1871
Strasbourg	1313 – 1681	1315 – 1681	1313 – 1681	1342 – 1681
Trier	1550 – 1871	1550 – 1871	1567 – 1871	1665 – 1871
Überlingen	1723 – 1811	1663 – 1811	1661 – 1811	
Vreden	1824 – 1871		1657 – 1871	1844 – 1871
Wetzlar	1784 – 1871	1784 – 1871	1784 – 1871	1784 – 1871
Wismar	1771 – 1870	1771 – 1870	1771 – 1870	1771 – 1870
Wittenberg	1630 – 1764	1630 – 1764	1630 – 1764	1656 – 1764
Würzburg	1816 – 1871	1464 – 1871	1481 – 1871	1502 – 1871
Xanten	1371 – 1819		1371 – 1819	1371 – 1819
Zwickau			1764 – 1824	1764 – 1824

*Note:* Years refer to first and last observations. The indicated period can contain gaps. See description of individual series for details.

What follows presents data sources and procedures of data handling on the level of the individual cities in alphabetical order. Each city section begins with an explanation of the principles and sources underlying the conversion of data in historical currencies and volumes to grams of silver per litre. The second part of each section documents the sources of the price data and the procedures followed in processing and if necessary connecting data from different sources. Years in parentheses indicate the period covered by information on prices. If possible we specify the stage of marketing and quality of the grain for which report prices; the absence of further information indicates that prices are retail prices and refer to the same quality. We also mention extant data that we did not include and give the reason why we did not consider them.

For the purpose of extrapolation of missing values we carry out linear regressions (ordinary least squares estimator) on prices in grams of silver per litre unless indicated otherwise. We report heteroscedasticity and autocorrelation consistent standard errors according to Newey and West (1987; 1994); codes of statistical significance are as follows if not indicated otherwise: \*\*\*: 0.001, \*\*: 0.01 and \*: 0.05. Additionally, we provide information on model fit ( $R^2$ ). All estimates are rounded to four digits (two digits for  $R^2$ ).

### **SA2.1 Aachen**

#### *Currency and volume conversion*

Currency conversion follows Berlin; see entry for Berlin.

#### *Barley, oats, rye and wheat (1784–1871)*

Calendar year prices 1784–1819 in *Reichstaler* per *Berliner Scheffel* from Kopsidis (1994, Appendix Table V.a/8). Calendar year prices 1820–1871 in *Guten Groschen* (until 1821) or *Silbergroschen* (from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1820–1859 are from Geheimes Staatsarchiv Berlin (a); those for 1818, 1824, 1860–1864 from Königlich Preussisches Statistisches Bureau (1867, 117, 121, 126, 130); and data for 1865–1871 from Königlich Preussisches Statistisches Bureau (1866–1872).

Crop year prices (July–June) in silver equivalents and metric litres for 1532–1783 are available from Rahlf (1996, 150–56). However, these data are not used, because it is impossible to establish a stable relationship between this type of crop year prices and calendar year prices, which prevented the extrapolation of calendar year prices based on this dataset (Albers and Pfister, 2021, SA2.2, p. S43).

### **SA2.2 Altenburg**

#### *Currency and volume conversion*

From 1500 to 1569, conversion of currency units to grams of silver is based on intrinsic value of small currency in Saxony in 1500, 1507, 1525, 1534 and 1558 as given by (Schwinkowski, 1917, 368–71). From 1570, currency conversion follows Leipzig; see entry for Leipzig. Litre equivalent of local *Scheffel* from Anonymous (1864, 412).

*Barley and oats (1505–1844), and wheat (1530–1844)*

Kresse (1845) provides calendar year prices in 1505–1844 in *Reichstaler, Groschen* and *Pfennig* compiled from various sources.

*Rye (1505–1863)*

Data from 1637 to 1745 as above; see barley oats and wheat. Rye prices from 1746 to 1863 in *Reichstaler, Neue Groschen* and *Pfennig* from Anonymous (1864). Because the data description of Anonymous (1864) is more specific than the one provided by Kresse (1845) we give preference to the former source. The average difference of the rye price between the two sources in 1746–1750 is only 1.3 percent.

### **SA2.3 Augsburg**

*Currency and volume conversion*

Basic currency system in Augsburg (e.g., Kruse, 1782, 59): 1 *Gulden* = 60 *Kreuzer* = 240 *Denar*. Currency conversion until 1760 follows Pfister (2017, Supporting information S1, pp. 1–3, S4). Augsburg joined the *Konventionstaler* regime in 1760 (Kruse, 1782, 60). The new rate is used from 1761. 1 *Kölner Mark* = 10 *Konventionstaler* (Gerhard, 2002, 213). 1 *Konventionstaler* = 144 *Kreuzer* (Kruse, 1782, 60). This yields an intrinsic value of 0.406 grams of silver per *Denar*. This value is used until 1837.

For 1838–1857, we assess the silver content of *Kreuzer* based on the values implied by the Munich currency treaty of 1837: 1 *Gulden* = 1/24.5 *Mark* of Cologne; the latter equals 233.8555 grams of silver (Rittmann, 1975, 535–37). 1 *Gulden* = 60 *Kreuzer*; 1 *Kreuzer* = 4 *Pfennig*. From 1858 we implement the silver content of Bavarian currency implied by the Vienna treaty of 1857 (Gerhard, 2002, 278).

For all prices from the ledger of the urban hospital (*Hospitalrechnungen*) we follow the volume conversion rules applied by Allen (2001), based on Elsas (1936, 153–54); see Verdenhalven (1993, 49) for a very similar volume conversion rate. This holds for barley and wheat until 1744, for oats and rye until 1799, and spelt until 1807 (Elsas, 1936, 361–69, 382–85).

We apply the conversion rate given by Fassl (1988, 104, note 26) to all prices of the urban grain market (*Schrannenpreise*), which are reported in the *Intelligenzblätter* (Fassl, 1988, 104, note 26; Elsas, 1936, 361–69, 382–85). This holds for barley, husk spelt, and wheat for the period 1745–1813, and for oats and rye in 1800–1813 (Elsas, 1936, 361–69, 382–85). In 1811 the official volume measures changed because of the integration of Augsburg into Bavaria; the grain market stuck to the old volume measures until 1813, however (Fassl, 1988, 104, note 26; cf. Verdenhalven, 1993, 49 for a very similar rate). Additionally, a different volume for oats applies from 1814 (Witthöft, 1993, 76).

*Barley and oats (1459/61–1871)*

Until 1814 crop year prices (August to July) in *denar (Pfennig)* from Elsas (1936, 593–600). Data were taken from Allen's files (Allen, 2001) and checked with Elsas (1936). Calendar year prices are extrapolated according to the general commodity-specific relationships (Table S7).

1815–1855: Calendar year prices from Seuffert (1857, 284–85).

1856–1868: Weekly prices in *Gulden* and *Kreuzer* per *Scheffel* of Bavaria from *Ansbacher Morgenblatt* 1856–1860 and *Königlich-Bayerisches Kreis-Amtsblatt von Schwaben und Neuburg* 1861–1868. We aggregate data first to monthly averages, then from monthly averages to annual averages.

1869–1871: Monthly prices in *Gulden* and *Kreuzer* per *Scheffel* of Bavaria from *Zeitschrift des Königlich-Bayerischen Statistischen Bureau* 1869–1871.

*Rye (1459–1871)*

Until 1749 crop year prices (August to July) in *denar* (*Pfennig*) from Elsas (1936, 593–600). Data were taken from Allen's files (Allen, 2001) and checked with Elsas (1936). Calendar year prices are extrapolated using the coefficients from the local time series relationship in Table S8.

1750–1850: Calendar year prices in local currency per *Scheffel* based on quotes from the urban grain market (*Schrannenpreise*) from Fassel (1988, 421).

1851–1871: See barley and oats.

*Wheat (1670–1871)*

Until 1814 crop year prices (August to July) in *denar* (*Pfennig*) from Elsas (1936, 593–600). Data were taken from Allen's files (Allen, 2001) and checked with Elsas (1936). Missing values until 1744 are extrapolated by relating the weighted inter-annual growth rates of the price of husk spelt (Elsas, 1936, 593–600) and the last known observation for wheat. Growth rates ( $g$ ) of crop year prices in grams of silver per litre of wheat and husk spelt 1675–1820 are related as follows:  $g_{\text{wheat}} = 0.9047^{***} g_{\text{husk spelt}}$ ,  $R^2 = 0.83$ , constant is zero. Extrapolation using husk spelt rests on the idea that spelt is a type of wheat and thus, both grains react in a similar way to weather, a major determinant of the inter-annual variation (correlation of both series in levels is  $r = 0.96$ ; 1674–1820). Calendar year prices are extrapolated according to the general commodity-specific relationship (Table S7).

Data for 1815–1871: See barley and oats.

## SA2.4 Berlin

*Currency and volume conversion*

Information on the number of *Silbergroschen* per *Taler* and on the latter's silver content back to 1623 is drawn from Statistisches Reichsamt (1935, 309–10, 314–5). We follow the calculation in Statistisches Reichsamt (1935, 309, 314–5) and apply the Prussian *Mark* of 1816, which is equivalent to *Mark* of Cologne (233.85550  $\approx$  233.856 g). This is because a third source lists *Mark* of Cologne (233.856 g) as reference for coined *Reichstaler* in the early 18th century, i.e., 1 *Reichstaler* of *Graumann'scher Fuß* = 16.704 grams of silver (Schrötter, 1903, 568; Schrötter, 1908, 85). We apply the new silver content of the *Taler* based on the new Prussian *Mark* = 500 grams of silver from 1858 (and not from 1857). This is because the law as of May 1857 was implemented in practice only in 1858 (Statistisches Reichsamt, 1935, 310; Zich, 2009, 126).

Debasement of Prussian small coins in 1808–1821 (*Preußische Scheidemünzinflation*) is taken into account by using the Berlin specific adjustment factors from Statistisches Reichsamt (1935, 310) which are based on an *Agio*. The latter was due if payment was in *Scheidemünze*. Factors for Berlin in a related publication (Jacobs and Richter, 1935) are equal to those in Statistisches Reichsamt.

*Scheffel* are converted to litre following Witthöft (1993, 26), because Statistisches Reichsamt (1935, 314–5) does not provide evidence for frequent changes in volumes as indicated by Verdenhalven (1993, 49). Also following Statistisches Reichsamt (1935, 313) we apply new *Scheffel* only from 1817, not from 1816 as Witthöft. We did not use an extra measure for oats (available in Verdenhalven) because this is not indicated in the source.

### *Barley, oats, rye and wheat (1652–1871)*

Calendar year and crop year prices in *Silbergroschen* per *Scheffel* are from Statistisches Reichsamt (1935, 317–8). Data for rye and wheat 1624–51 are not included because the annual averages are based on five to six observations at best, and several values rest on only one observation (Statistisches Reichsamt, 1935, 308, 321). Without checking the original source it is not possible to distinguish between averages based on five observations and annual values resting on only one observation.

## **SA2.5 Boizenburg**

### *Currency and volume conversion*

The authors of the compilation of grain prices that we use have converted prices in historical currency to currency prevailing at the time of publication, which was at par with the Prussian *Taler* (Grossherzogliches Statistisches Bureau, 1873, 4). Hence, intrinsic content of *Taler* as given for Berlin applies.

The authors have also converted all local volumes to *Rostocker Scheffel* and they provide an equivalent in litre (Grossherzogliches Statistisches Bureau, 1873, 4).

### *Barley, oats, rye and wheat (1771–1870)*

Grossherzogliches Statistisches Bureau (1873, 46–97) presents monthly prices in *Schilling* per *Rostocker Scheffel*. We aggregate this information to calendar year averages. Prices are missing from January to November 1809 and from April to November 1813; hence, no annual prices were computed for 1809 and 1813.

## **SA2.6 Brandenburg**

### *Currency and volume conversion*

Currency conversion follows Berlin; see entry for Berlin.

Volume converted following Naudé and Schmoller (1901, 602) and Witthöft (1993, 26).

### *Barley and rye (1696–1871)*

1696–1800: Source is Anonymous (1803, 76–7); prices are in *Taler* and *Groschen*. The measure is not given, but prices must be in *Scheffel* (Naudé et al., 1910, 633). Values refer to *Martini* prices (Naudé et al., 1910, 632). We extrapolate calendar year prices applying the general extrapolation rule (eq. (S1)).

1800–1810: gap.

1811–1871: Calendar year prices in *Guten Groschen* (until 1821) or *Silbergroschen* (from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1816–1859 are from Geheimes Staatsarchiv Berlin (a); the gap in 1824 is closed with annual averages of monthly values from Geheimes Staatsarchiv Berlin (b). Data for 1860–1864 are annual averages of monthly values from *Preußischer Staatsanzeiger* (1860–1865); data for 1865–1871 are from Königlich Preussisches Statistisches Bureau (1866–1872).

### *Oats and wheat (1811–1871)*

Sources as for barley and rye; see above.

## SA2.7 Braunschweig

### *Currency and volume conversion*

Until 1660, prices were quoted in *Gulden* and *Schilling*, a mere money of account. There were 10 *Schilling* and 20 *Mariengroschen* per *Gulden* (Bode, 1847, 106; Jesse, 1962, 13). The intrinsic value of the *Gulden* is determined with the one of individual coins as follows: 1510–1532 *Mariengroschen*, 1533–1554 average of *Mariengroschen* and *Annengroschen*, 1555–1571 *Groschen*, 1572–1590, 1622–1660 *Mariengroschen* (Bode, 1847, 104; Jesse, 1962, 13, 17, 22, 26, 30, 69). Debasement of coin in 1591–1621 is tracked using the intrinsic silver content of *Groschen* relative to 1572, when the Imperial mint ordinance was implemented (Jesse, 1962, 42, 44, 53).

From 1661, grain prices were quoted in *Reichstaler*. There were 36 *Mariengroschen* per *Reichstaler*, and from 1817/43, the *Reichstaler* was divided into 24 *Gute Groschen* (Gerhard and Kaufhold, 1990, 29–30). In 1671, Braunschweig was conquered by the Duke of Wolfenbüttel; henceforth, the town followed the monetary policy of the Duchy of Braunschweig-Wolfenbüttel (Jesse, 1962, 96–7). According to Gerhard and Kaufhold (1990, 413), the Zinna convention (1667; 10.5 *Reichstaler* to be minted of one *Mark* of Cologne) was implemented in 1670, the Leipzig convention (1690; 12 *Reichstaler* per *Mark*) in 1690, the *Konventionstaler* (13 and one third *Taler* per *Mark*) in 1764, and Prussian currency (14 *Taler* per *Mark*) in 1834.

*Scheffel* are converted to litre following Gerhard and Kaufhold (1990, 398).

### *Barley, oats, rye and wheat (1513–1850)*

Calendar year averages of the sales of the collegiate church *St. Blasius* until 1744, then retail market prices (Gerhard and Kaufhold, 1990, 29, note 2 and 8). Scattered *Martini* prices for 1330–1512 were not included into the analysis.

## SA2.8 Bremen

### *Currency and volume conversion*

One *Reichstaler* equalled 72 *Grote* (Jesse, 1939, 184). During the years 1653–1667, so-called *Stadtgeld* ('town money'), which were large pieces of 12 and 24 *Groten*, were valued at 10  $\frac{2}{3}$  *Taler* per *Mark* of Cologne (Jesse, 1939, 189). Thus, the silver content of *Reichstaler* is set to 21.924 grams of silver. Following Jungk (1875, 110), the intrinsic value of the currency in Bremen remained stable from the 1650s to 1691, so silver content of *Reichstaler* as above is used.

In 1693, a devaluation of *Grote* occurred (Jungk, 1875, 110), and the silver content of the *Reichstaler* (20.30 grams of silver) is determined using the value of *Grote* from Jungk (0.282 grams of silver). The value of 1692 is set to the average of 1691 and 1693.

The Leipzig convention lowered the intrinsic value of the *Reichstaler* to 1/12 of one *Mark* silver, that is, 19.488 grams of silver. In 1705, local currency was devalued to this rate (Jungk, 1875, 110). Values in 1694–1704 are determined with exponential interpolation.

In the 1730s and 1740s, Bremen introduced a nominal gold currency based on the *Louis d'or*, which was equivalent to 5 *Reichstaler* (Jungk, 1875, 91–92; Jesse, 1939, 199–200). The intrinsic value of the *Louis d'or* was fixed at 6.584 to 6.593 grams of gold in 1754. We use the average of the latter values and the gold/silver price ratio of 15 provided for the year 1735 by Jungk (1875, 110), to calculate the intrinsic silver content of *Reichstaler* in 1735 (19.77 grams of silver).

From the early 1740s, the gold/silver price ratio fell. On the Bremen market, fluctuations in the gold/silver price ratio were expressed with the *agio* of *Grote* following the Leipzig Convention

(see values for 1705) over the *Taler*. Jungk (1875, 92–93) gives values for the *agio* in percent for some years in 1741–1757. We interpolate missing values with the mean of neighboring years. Based on this *agio*, we correct the silver content of *Reichstaler*.

For 1762–1810, the *agio* is from Jungk (1875, 95). Silver equivalent of *Reichstaler* in 1758–1761 is obtained with exponential interpolation.

Silver equivalent for *Reichstaler* in 1820 and 1832 is from Gerhard and Kaufhold (1990, 414), in 1840–1850 from Jesse (1939, 202).

Volume is converted as follows: from *Last* to *Scheffel* based on information in Gerhard and Kaufhold (1990, 399), from *Scheffel* to litre using the rates given in Witthöft (1993, 107).

#### *Rye (1705–1850)*

Nominal prices in *Reichstaler* and *Grote per Bremer Last* from Gerhard and Kaufhold (1990, 141–5) based on various original sources. We develop a rye price series that is mainly based on the series ‘*am Stecken*’, which is available for 1752–1811 and 1827–1850. Prices ‘*am Stecken*’ were quoted in weekly intervals by two brokers and were used to fix the official price of bread (Gerhard and Kaufhold, 1990, 146). We assume that this series reflects retail prices.

1705–1752: Values are extrapolated with the purchase price of public granaries multiplied with 1.1505, the ratio of the two prices (‘*am Stecken*’ and ‘purchase’) in 1752–1808. Purchase prices may reflect market conditions, whereas sales prices were probably set to serve market policies of the public authorities (Gerhard and Kaufhold, 1990, 145–6). Hence, we do not use sales prices (available from 1650 but with gaps).

1752–1811: series ‘*am Stecken*’.

1812–1826: Values in 1812–1826 are from the list showing average prices for these years, rounded to half *Reichstaler*.

1827–1850: series ‘*am Stecken*’.

#### *Wheat (1699–1850)*

Nominal data for 1700–1826 from Gerhard and Kaufhold (1990, 205), original source is a list of average prices, see rye for the period 1812–1826. Three isolated data points prior to 1699 were not used.

1827–1850: prices underlying official bread price (see rye, series ‘*am Stecken*’).

## **SA2.9 Breslau**

### *Currency and volume conversion*

Currency conversion as for Berlin except for the period of the war-related depreciation of currency in 1808–1823. During this period we adjust the silver content of currency according to the information for Breslau from Jacobs and Richter (1935, 20). We use the currency information from Berlin also for the period 1741–1762 because there is no important level difference between the converted rye prices in Breslau and Berlin before and after the 1760s. In 1750, the same division of coins applied as in the rest of Prussia (Schrötter, 1908, 552).

We convert old and new *Scheffel* as for Berlin.

### *Barley, oats, rye and wheat (1741–1871)*

Average of June and December prices 1740–1810 in *Reichstaler* per *Berliner Scheffel* from Königlich Preussisches Statistisches Bureau (1867, 113–4). Calendar year prices for 1811–1871 in *Guten*



*Groschen* (until 1821; except 1818) or *Silbergroschen* (1818 and from 1822) per *Berliner Scheffel* from various Prussian sources. Data for 1811–1859 are from Geheimes Staatsarchiv Berlin (a); those for 1818, 1824, 1860–1864 from Königlich Preussisches Statistisches Bureau (1867, 117, 121, 126, 130); and data for 1865–1871 from Königlich Preussisches Statistisches Bureau (1866–1872).

### SA2.10 Celle

#### *Currency and volume conversion*

Following Gerhard and Kaufhold (1990, 414) we applied the conversion rates for Hanover (see below). Additionally, we assumed that the first known silver content for *Denar* (*Pfennig*, respectively) for 1740 can be applied to the period 1727–1739.

#### *Barley, rye, wheat (1727–1871) and oats (1727–1846)*

Prices 1727–1846 in *Mariengroschen* and *Denar* per *Hannoversche Himten* from Gerhard and Kaufhold (1990, 31–3, 92–4, 148–50, 207–9); 1818 change in currency to *Gute Groschen* and *Pfennig*, 1854 to *Neue Groschen*, respectively. Prices in 1847–1871 are extrapolated from *Martini* prices (except oats). We applied the commodity-specific parameters from the panel data regressions (eq. (S1)), because overlapping data are available only for 1835–1846.

### SA2.11 Cologne

#### *Currency and volume conversion*

Prices from 1532 to 1796 in *Albus* (*Rechengeld*) per *Malter* were converted using *Rechenalbus Mittelkurse* from Metz (1990, 366–95). This series ends in 1790 and we assume that the ratio of 1790 can be applied until 1796. *Malter* are converted according to Verdenhalven (1993, 34) (cf. Schimmelfennig, 1820, 63; Ebeling and Irsigler, 1976, XI, note 3 give a different value). Data from Kopsidis (1994) and Prussian sources converted as for Berlin.

#### *Barley, rye and wheat (1532–1871)*

Data for 1532–1786 consist of arithmetic means of monthly data from Ebeling and Irsigler (1976, 536–663), accessed through GESIS Köln (2005b). For some years monthly observations are missing, and the mean consists of less than 12 prices. Because of too few observations (less than six months) or a weak coverage of the calendar year we omit the following years: 1531, 1541, 1787–1791. Calendar year prices 1787–1819 calendar year prices in *Reichstaler* per *Scheffel* from Kopsidis (1994) (cf. GESIS Köln, 2015a). Calendar year prices 1820–1859 from Geheimes Staatsarchiv Berlin (a). Prices are given in *Gute Groschen* (until 1821) or *Silbergroschen* (from 1822). 1824 and 1860–1864 from Königlich Preussisches Statistisches Bureau (1867, 117, 121, 126, 130); 1865–1871 from Königlich Preussisches Statistisches Bureau (1866–1872).

*Martini* prices are calculated as November-December averages from the monthly data for 1531–1796 (purpose: comparison to calendar year prices).

Rahlf (1996) provides a rye calendar year price series for the years 1531–1797 based on Ebeling and Irsigler (1976) (accessed through GESIS Köln, 2005a). We were able to reproduce both the calendar year series from Rahlf and the crop year series by Ebeling and Irsigler (1976) (except minor differences) using monthly data.

We do not include a mixed rye/wheat series 1443–1530 from Irsigler (1975, 519–21) *Kölnische Mark* (*Rechengeld*) per *Malter*, accessed through GESIS Köln (2005b). For 1445–1530 data refer to

the mean price of rye *and* wheat in *October* and November. Thus, too many assumptions would be necessary for extrapolating calendar year prices.

*Oats (1532–1871)*

Cf. description of the rye series. However, for oats we omitted data in 1541, 1678–79, 1683 and 1787–1791.

### **SA2.12 Detmold**

*Currency and volume conversion*

Conversion of local currency applies the *Konventionstaler* with 17.539 grams of silver, which was adopted by Lippe in 1765 (Ihl and Schwede, 2016, 282–3). One *Reichstaler* contained 36 *Mariengroschen*. The convention of Dresden (1838) led to the adoption of Prussia's currency by a number of states; see entry for Berlin for Prussia's currency. In Lippe, change of currency followed from accession to the *Zollverein* in 1841 (Ihl and Schwede, 2016, 357–73). New *Taler* coins were minted in 1843, but the conversion of small coin came only in 1847. Notation of grain prices also changed in this year (Gerhard and Kaufhold, 1990, 35). We change intrinsic content of *Reichstaler* in 1847. The adoption of Prussia's currency implied a change in the division of the *Reichstaler* from 36 *Mariengroschen* to 30 *Silbergroschen* from 1847.

Conversion factors for *Lippischer Scheffel* are from Witthöft (1993, 23).

*Barley, oats, rye and wheat (1770–1850)*

Averages of monthly prices with varying number of observations per year in *Reichstaler* and *Mariengroschen* (from 1847 *Silbergroschen*) per *Lippischer Scheffel* from Gerhard and Kaufhold (1990, 34–5, 95–6, 151–2, 210–1).

### **SA2.13 Dresden**

*Currency and volume conversion*

Currency conversion as for Leipzig. Volumes are converted following Witthöft (1993, 141).

*Barley, oats (1602–1782), rye and wheat (1602–1869)*

Calendar year prices 1602–1782 in *Taler Kurant* per *Scheffel* from Kraus (1808). Calendar year average prices for 1783–1869 were calculated based on monthly data from Uebele et al. (2013); original source is the weekly *Intelligenzblatt* of Leipzig (Uebele et al., 2013, 3). Data for 1825–1834 are missing.

### **SA2.14 Duderstadt**

*Currency and volume conversion*

From 1650 to 1706 one *Reichstaler* is divided into 30 *Groschen*, variously designated as *Fürstengroschen* or *Kaisergroschen* (Gerhard and Kaufhold, 1990, 38). In 1706, currency changes from *Fürstengroschen* to *Gute Groschen*, 24 per *Reichstaler* (Gerhard and Kaufhold, 1990, 39).

The silver content of *Reichstaler* is assessed as follows. Duderstadt and Erfurt were both part of the dominions of the Archbishop of Mainz. According to Bode (1847, 141–2), the currency policy of Duderstadt was oriented on the one prevailing in Thuringia and Saxony from the late fifteenth century. For the situation prevailing around 1770, see Gerhard (2002, 270–1). Hence, the same

intrinsic value of *Reichstaler* as in Erfurt is assumed until 1815. Following the Congress of Vienna, the lower part of the Eichsfeld, to which Duderstadt belonged, became part of the Kingdom of Hanover. Hence, from 1816 Hanover currency applies (Gerhard and Kaufhold, 1990, 414).

Volume is converted according to Gerhard and Kaufhold (1990, 401).

*Barley, oats, rye and wheat (1650/56/50/72–1850)*

Nominal price data from Gerhard and Kaufhold (1990) downloaded from GESIS Köln (2015b). Calendar year prices are in *Reichstaler* and *Groschen* per *Untereichsfelder Malter*.

## SA2.15 Duisburg

*Currency and volume conversion*

Both Duisburg and Xanten belonged to the Duchy of Cleves, which is was part of Brandenburg-Prussia on a provisional basis from 1614 (finally confirmed in 1666) until 1794 (Keyser, 1956, 133, 434).

Price data are from a list compiled by Prussian authorities after 1815 (Jägers, 2001, 253). The authors converted historical currency and measures to Prussian units. *Silbergroschen* were usually used after 1822. Thus, we applied the silver content of *Taler* in *Graumannscher Fuß* and the new *Berliner Scheffel* of 1816/17. Alternative currency conversions were considered but led to implausible results.

*Barley, rye and wheat (1693–1782)*

Nominal *Martini* prices from Jägers (2001) downloaded from GESIS Köln (2009) are in *Reichstaler*, *Silbergroschen* and *Pfennig* per *Berliner Scheffel* (Jägers, 2001, 254, 256, 378–80). Calendar year prices are obtained by applying the general extrapolation rule from equation (S1).

The source also provides *Martini* prices for oats. Because there is no general conversion rule for this grain, we do not provide calendar year prices in grams of silver.

## SA2.16 Düsseldorf

*Currency and volume conversion*

Until 1806, Düsseldorf was the capital of the Duchy of Jülich-Berg. In the 1760s, the territory introduced the *Konventionstaler* whereby 16 *Reichstaler* were to be minted of a Mark of silver (Gerhard, 2002, 270–1). Until 1802 the source reports prices in *Reichstaler* divided into 80 *Albus*. Data from 1816 are in Prussian currency; see entry for Berlin.

Volume conversion until 1802 according to Verdenhalven (1993, 34); from 1816 we apply the conversion factor for Berlin.

*Barley, oats, rye and wheat (1769–1871)*

1769–1802: Source is *Gülich und bergische wöchentliche Nachrichten* 1769–1802. Until 1795, this weekly newspaper reports grain prices for up to nine market towns of the Duchy of Jülich-Berg. Until October 1794, there are only two missing values. After October 1794, this information peters out, and from 1796 the newspaper reports official grain prices (so-called *Fruchttaxen*) for Düsseldorf only. These remained unchanged over several weeks, so that there are only one to two observations per month. Data were first aggregated to monthly prices and then to annual averages.

1816–1871: Calendar year prices in *Guten Groschen* (until 1821) or *Silbergroschen* (from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1816–1859 are from Geheimes Staatsarchiv Berlin (a); the gap in 1824 is closed with annual averages of monthly values from Geheimes Staatsarchiv Berlin (b). Data for 1860–1864 are annual averages of monthly values from *Preußischer Staatsanzeiger* (1860–1865); data for 1865–1871 are from Königlich Preussisches Statistisches Bureau (1866–1872).

### SA2.17 Elberfeld

#### *Currency and volume conversion*

Until 1806, Elberfeld was part of the Duchy of Jülich-Berg, and grain prices were published along with those of Düsseldorf. Hence, until 1794 currency and volume conversion is the same as for Düsseldorf; see entry for Düsseldorf. From 1816, currency and volume conversion follows Berlin; see entry for Berlin.

#### *Barley and oats (1816–1865), rye and wheat (1769–1865)*

1769–1794: Source is as for Düsseldorf, but data end in October 1794 and are confined to prices of rye and wheat.

1816–1865: Calendar year prices in *Guten Groschen* (until 1821) or *Silbergroschen* (from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1816–1859 are from Geheimes Staatsarchiv Berlin (a); the gap in 1824 is closed with annual averages of monthly values from Geheimes Staatsarchiv Berlin (b). Data in 1860–1864 are annual averages of monthly values from *Preußischer Staatsanzeiger* (1860–1865); data for 1865 are from Königlich Preussisches Statistisches Bureau (1866–1872) (there are no data for 1866–1871 in this source).

### SA2.18 Emden

#### *Currency and volume conversion*

Conversion of currencies and volumes follows Gerhard and Kaufhold (1990, 402, 414–5). We assumed that the conversion rates for *Gemeiner Taler* and *Stüber* for the year 1788 can be applied to the period 1780–1787, and those for *Reichstaler* and *Gute Groschen* for the year 1820 to 1796–1819.

#### *Barley, oats and wheat (1780–1850)*

Prices 1780–1813 in *Gemeinen Taler* and *Stüber* per *Emder Last* from Gerhard and Kaufhold (1990, 40–2, 100–2, 215–7); 1814–1837 in *Dalern*, and 1838–1850 in *Reichstaler* and *Guten Groschen*. We omit data 1746–1779 due to unclear currency conversion. The price for the year 1838 is the mean of both values given in different currencies by Gerhard and Kaufhold (1990). Calendar year prices for the period 1807–1813 are extrapolated from *Martini* prices (in *Reichstaler* and *Guten Groschen*) according to the results in Table S1.

Further omitted price series include a series for *Sommergerste* (spring barley) for the same period. These prices are not taken into account, because *Sommergerste* should be considered as a different commodity (Gerhard and Kaufhold, 1990, 43–4). This also holds for *Brau-Hafer* (oats, brewing quality) (1772–1850), which is likely to be of particularly good quality (Gerhard and Kaufhold, 1990, 102–3). There are price series for *Ostsee-Weizen* (wheat, imported from the Baltic Sea, 1748–1832) and *Ostsee-Roggen* (rye, imported from the Baltic Sea, 1748–1842) which are both shorter and do not offer opportunities for extrapolation. Furthermore, there are more *Martini* prices for rye,

barley, and oats in Oberschelp (1986, 86–97) for which, however, the currency conversion remains unclear to us, because they are listed in the currency that usually applies to Hanover.

#### *Rye (1780–1850)*

Cf. barley, oats, wheat. Prices are from Gerhard and Kaufhold (1990, 156–8). Additionally, prices for 1780–1783 are extrapolated from the series *getrockneter Roggen* (dried rye) by adjusting these prices for the mean level difference for the years 1775 and 1784 (-14.29%).

### **SA2.19 Erfurt**

#### *Currency and volume conversion*

Until 1821, a *Reichstaler* consisted of 24 *Groschen*. Silver content of the *Reichstaler* until 1775 is derived as follows. According to the Imperial mint ordinance of 1566, 9 *Taler* were to be minted of 1 *Mark* of Cologne. We assume that this rate held until 1657 and that debasement began in 1658 (see entry for Leipzig). Values in 1658–1667 are determined by exponential interpolation. Following the Zinna convention (1667), 10.5 *Taler* were to be minted of 1 *Mark*. We assume that local currency adjusted to the Zinna regime in 1668 and that the latter held until 1690. With the Leipzig convention (1690), the ratio changed to 12 *Taler* per *Mark*. We assume that local currency adjusted to the Leipzig regime in 1691. Furthermore, we assume that local currency adjusted to the *Konventionstaler* regime in 1764 (13 1/3 *Taler* per *Mark*; Gerhard, 2002, 270–1). To account for gradual debasement of coins during the first part of the 18th century, the intrinsic silver content of *Reichstaler* between 1691 and 1764 is determined using exponential interpolation. From 1816, Prussian currency as for Berlin applies, including the factor accounting for depreciation of Prussian currency in 1808–1823; see entry for Berlin.

Local volume converted following Witthöft (1993, 160). From 1816 Prussian measures apply; see entry for Berlin.

#### *Barley (1696–1775, 1816–1871), oats, rye and wheat (1651–1775, 1816–1871)*

1651/96–1775: Monthly nominal prices in *Reichstaler* and *Groschen* per *Malter* from Rosenthal (1784, 4–27). Original sources are so-called *Fruchtpreisbücher*, which correspond to daily ledgers of market prices. Rosenthal (1784, 3) has calculated monthly averages. We aggregated these data to calendar year averages.

1776–1811: gap.

1816–1871: Calendar year prices in *Guten Groschen* (until 1821) or *Silbergroschen* (from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1816–1859 are from Geheimes Staatsarchiv Berlin (a); the gap in 1824 is closed with annual averages of monthly values from Geheimes Staatsarchiv Berlin (b). Data for 1860–1864 are annual averages of monthly values from *Preußischer Staatsanzeiger* (1860–1865); data for 1865–1871 are from Königlich Preussisches Statistisches Bureau (1866–1872).

### **SA2.20 Frankfurt am Main**

#### *Currency and volume conversion*

Currency conversion based on Metz (1990, 426–32), volume conversion on Elsas (1940, 21–2).

*Barley (1604–1797), oats (1372–1799), rye (1352–1799) and wheat (1421–1799)*

Crop year prices (August to July) in *Pfennig* per *Achtel* from Elsas (1940, 461–9). Barley price refers to raw barley. Calendar year prices were obtained by extrapolation according to eq. (S2) using the commodity-specific parameters in Table S7.

### **SA2.21 Frankfurt/Oder**

*Currency and volume conversion*

Currency and volume conversion follows Berlin.

*Barley, oats and wheat (1812–1871)*

Calendar year prices in *Guten Groschen* (until 1821) or *Silbergroschen* (from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1816–1859 are from Geheimes Staatsarchiv Berlin (a); the gap in 1824 is closed with annual averages of monthly values from Geheimes Staatsarchiv Berlin (b). Data for 1860–1864 are annual averages of monthly values from Preußischer Staatsanzeiger (1860–1865); data for 1865–1871 are from Königlich Preussisches Statistisches Bureau (1866–1872).

*Rye (1765–1787, 1812–1871)*

1765–1787: Skalweit (1931, 66) reports the rye price in Berlin in *Reichstaler* and *Groschen* per *Scheffel* together with the difference of the rye price in several cities relative to Berlin in 1765–1787, among them Frankfurt/Oder and Halle. For Berlin and Halle we show that there is no statistically or economically relevant difference between the rye price in grams of silver per litre according to this source and the price series developed for these two cities in Albers and Pfister (2021) (see excel file, sheet 34 Notes). Specifically, regressing the series based on this source on the series in Albers and Pfister (2021) yields a constant close to zero and a slope that does not differ from unity at the 5 percent level of statistical significance. Against the background of these results, we construct an implied rye price on the basis of this source.

1778–1811: gap.

1812–1871: Sources as for barley, oats and wheat; see above.

### **SA2.22 Gdansk**

*Currency and volume conversion*

Price data for 1500–1815 from Furtak (1935) and Pelc (1937) is in *zloty* (*Gulden*). Furtak (1935, 76–8) and Pelc (1937, 2–6) provide series of the silver equivalent of *grosz* (*Groschen*). There were 30 *Groschen* per *Gulden* (Kruse, 1766, 112). Price data from official sources for 1814–1871 is in the currency of the Kingdom of Prussia. To account for war-related depreciation of Prussian currency in 1808–1822, we apply the adjustment factors for Königsberg; see entry for Königsberg.

Volume conversion of data from Furtak (1935) and Pelc (1937) according to Furtak (1935, 38) and Verdenhalven (1993, 21). Conversion of data from official sources for 1814–1871 follows Berlin.

*Barley, oats, rye (1501–1871) and wheat (1703–1871)*

Calendar year prices for 1501/1703–1815 in *zloty* per *last* from Furtak (1935, 121–26) and Pelc (1937, 47–50). Calendar year prices for 1814–1871 in *Guten Groschen* (until 1821; except 1818) or

*Silbergroschen* (1818 and from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1814–1859 are from Geheimes Staatsarchiv Berlin (a); those for 1818, 1824, 1860–1864 from Königlich Preussisches Statistisches Bureau (1867, 117, 121, 126, 130); and data for 1865–1871 from Königlich Preussisches Statistisches Bureau (1866–1872).

Values in 1814 and 1815 are averages of data from Furtak and Prussian sources starting in 1814. The relative movement for the two overlapping years (1814 and 1815) is similar but means differ: On average, prices for barley, oats, rye and wheat of the Furtak series are 32 percent lower than those based on Prussian sources. The difference is partly related to the fact that Furtak's values for the intrinsic value of the Groschen suggests a higher rate of war-time depreciation than our Reichstaler series. A systematic shift of either series is unlikely because the 10-year-mean around the overlapping years shows that rye and wheat prices from Furtak are about 13 percent higher in 1806–1815 than those based on Prussian data in 1814–1823. Therefore, we simply average the values of the two series in 1814 and 1815.

### SA2.23 Görlitz

#### *Currency and volume conversion*

For the years 1763–1815 we apply the silver content of the *Pfennig* series developed for Leipzig; see entry for Leipzig. From 1816, Prussian currency as for Breslau applies, including the factor accounting for depreciation of Prussian currency in 1808–1823; see entry for Breslau.

Until 1815 volume is converted using the rate for Dresden; see Witthöft (1993, 141). From 1816 Prussian measures apply; see entry for Berlin.

#### *Barley and oats (1816–1871)*

Calendar year prices in *Guten Groschen* (until 1821) or *Silbergroschen* (from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1816–1859 are from Geheimes Staatsarchiv Berlin (a); the gap in 1824 is closed with annual averages of monthly values from Geheimes Staatsarchiv Berlin (b). Data for 1860–1864 are annual averages of monthly values from Preußischer Staatsanzeiger (1860–1865); data for 1865–1871 are from Königlich Preussisches Statistisches Bureau (1866–1872).

#### *Rye and wheat (1763–1871)*

1763–1815: Calendar year averages based on monthly data from Uebele et al. (2013); original source is the weekly *Intelligenzblatt* of Leipzig (Uebele et al., 2013, 3). Nominal prices are in *Taler* per *Dresdener Scheffel*. We do not calculate a calendar year average for 1808 because monthly data for the second half of the year are missing.

1816–1871: Sources as for barley and oats; see above.

### SA2.24 Göttingen

#### *Currency and volume conversion*

Currency and volume conversion follows Hanover; see Gerhard and Kaufhold (1990, 403, 405, 415).

#### *Barley and oats (1632/34–1850), rye and wheat (1632–1867)*

Prices from Gerhard and Kaufhold (1990, 45–9, 104–7, 161–5, 219–22) in *Reichstaler* and *Mariengroschen* per *Hannoversche Malter*, from 1832 (rye and wheat from 1834) in *Reichstaler* and *Guten*

*Groschen*. Rye and wheat from 1859 in *Reichstaler* and *Neuen Groschen*. Calendar year prices of barley, oats, rye and wheat in 1632–1715 are extrapolated from *Martini* prices according to the regression results in Tables S1 and S2. Regressions are based on *Martini* prices for 1764–1863 in *Groschen* and *Denar* per *Hannoversche Himten* from Oberschelp (1986, 82–97). For 1716–1766 there are two prices for each year covering market conditions in spring (*Frühjahrspreis*) and autumn (*Herbstpreis*). For this period we take the mean of the two prices. From 1767 calendar year prices as such are provided (exception: barley and oats in 1812–13; for these years we calculated the calendar year price as for the period 1716–1766).

### SA2.25 Grabow

*Currency and volume conversion*

see Boizenburg.

*Barley, oats, rye and wheat (1780–1870)*

Grossherzogliches Statistisches Bureau (1873, 46–97) presents monthly prices in *Schilling* per *Rostocker Scheffel*. We aggregate this information to calendar year averages.

### SA2.26 Halberstadt

*Currency and volume conversion*

Intrinsic value of *Taler* follows Berlin (including adjustment for depreciation of Prussian currency in 1808–1821). Change from *Gute Groschen* to *Silbergroschen* is applied in 1822.

Volume conversion applies  $1 \text{ Halberstädter Wispel} = 22.5 \text{ Berliner Wispel}$ ;  $1 \text{ Berliner Wispel} = 24 \text{ Berliner Scheffel}$  (Naudé and Schmoller, 1901, 563–4); the latter converted as for Berlin.

*Barley, wheat (1639–1740, 1816–1871) and oats (1816–1871)*

*Martini* prices of barley and wheat in 1638–1740 from Naudé and Schmoller (1901, 561–3). Data are in *Taler* per *Halberstädter Wispel*; from 1720 per *Berliner Wispel*. Calendar year prices extrapolated from *Martini* prices applying the general extrapolation rule (eq. (S1)).

1741–1815: gap.

1816–1871: Calendar year prices in *Guten Groschen* (until 1821) or *Silbergroschen* (from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1816–1859 are from Geheimes Staatsarchiv Berlin (a); the gap in 1824 is closed with annual averages of monthly values from Geheimes Staatsarchiv Berlin (b). Data for 1860–1864 are annual averages of monthly values from *Preußischer Staatsanzeiger* (1860–1865); data for 1865–1871 are from Königlich Preussisches Statistisches Bureau (1866–1872).

*Rye (1639–1740, 1765–1787, 1816–1871)*

Sources as for barley, oats and wheat; see above. In addition, Skalweit (1931, 66) reports the rye price in Berlin in *Reichstaler* and *Groschen* per *Scheffel* together with the difference of the rye price in several cities relative to Berlin in 1765–1787, among them Halberstadt. See notes on Frankfurt/Oder for a discussion of this source. We use this information to calculate the implied rye price in Halberstadt.



## SA2.27 Halle

### *Currency and volume conversion*

Intrinsic value of *Taler* follows Berlin (including adjustment for depreciation of Prussian currency in 1808–1821). Change from *Gute Groschen* to *Silbergroschen* is applied in 1822/23 (in accordance with source of prices). 1 *Hallesche Scheffel* = 1.4 *Berliner Scheffel*; 1 *Wispel* = 24 *Berliner Scheffel* (Naudé and Schmoller, 1901, 516, 541); the latter converted as for Berlin.

### *Barley, oats, rye and wheat (1601–1871)*

Calendar year prices in 1601–1691, 1757–1815 and 1818 extrapolated from *Martini* prices applying the local time series relationship (Table S2). Prices 1692–1739 are averages of annual minimum and maximum prices from Naudé and Schmoller (1901, 541–3) and Naudé et al. (1910, 623); original list by Löwe published in 1789 (Naudé and Schmoller, 1901, 514). Units are *Reichstaler* and *Groschen* per *Wispel*. Prices 1740–1756 in *Reichstaler* and *Groschen* per *Berliner Scheffel* from Naudé et al. (1910, 615–22). Prices for 1816–1871 in *Guten Groschen* (until 1821) or *Silbergroschen* (from 1822) per *Berliner Scheffel* are from Prussian sources. Data for 1816–1859 are from Geheimes Staatsarchiv Berlin (a); the gap in 1824 is closed with annual averages of monthly values from Geheimes Staatsarchiv Berlin (b). Data for 1860–1864 are annual averages of monthly values from *Preußischer Staatsanzeiger* (1860–1865); data for 1865–1871 are from Königlich Preussisches Statistisches Bureau (1866–1872).

*Martini* prices 1600–1749 in *Guten Groschen* per *Hallesche Scheffel* (until 1713) or *Berliner Scheffel* (from 1714). *Martini* prices 1600–1749 from Jacks (2016), who took them from the Beveridge papers. Original list was published in 1750 by Dreyhaupt (see discussion in Naudé and Schmoller, 1901, 512–6), an accessible later publication is Königlich Preussisches Statistisches Bureau (1867, 108–9). *Martini* prices 1749–1834 in *Groschen* (until 1822) and in *Silbergroschen* (from 1823) per *Berliner Scheffel* kindly provided by Katrin Moeller from Historisches Datenarchiv Sachsen-Anhalt; originally from Runde (1933).

## SA2.28 Hamburg

### *Currency and volume conversion*

Currency conversion of data from Gerhard and Engel (2006) and Gerhard and Kaufhold (1990) follows Pfister (2017, Supporting information S1, pp. 6–7, S4). Volumes are converted according to Gerhard and Kaufhold (1990, 404) but (as Pfister, 2017) we use the old *Fass* rate valid until 1829 from Gerhard and Engel (2006, 317).

Prices from Statistisches Reichsamtsamt (1935) (identical with series in Jacobs and Richter, 1935) for the period 1792–1850 were first reconverted from *Goldmark* of 1873 per 1000 kg to original local currency and units. Second, local currencies and units were converted to grams of silver per litre. Thus, we apply 1 *Mark banco* of Hamburg = 1.517 *Mark* (Jacobs and Richter, 1935, 17) to obtain prices in *Mark banco*. We then apply the exchange rate of *Mark courant* per *Mark banco* used by Jacobs and Richter (1935, 18). This yields prices in *Mark courant* which were converted to silver equivalents using the grams of silver per *Schilling* series (1 *Mark courant* = 16 *Schilling*) from Pfister (2017). From 1851, prices are converted using the silver equivalent of the *Goldmark* of 1873 (5.5556 grams of silver).

Volumes are converted by deriving the kg per litre ratio from the kg per *Last* values (different

for each grain type) from Jacobs and Richter (1935, 16) and the litre content of *Last* from Gerhard and Kaufhold (1990, 404) taking into account changes in litre volumes of *Last*.

#### *Barley, oats and wheat (1736–1871)*

Principal source (price 1) are wholesale ask prices in *Reichstaler* and *Schilling* (1823–42 in *Mark* and *Schilling*) per *Hamburger Last* from Gerhard and Kaufhold (1990, 50–2, 108–9, 223–4). We reduced these prices by 4.5% in order to approximate actual market prices (Gerhard and Kaufhold, 1990, 50, note 1, 395). This source peters out in the late 1840s and we replace it with stock market prices in *Mark* per 1000 kg from GESIS Köln (2008) (original: Statistisches Reichsamt, 1935, 300–7) (price 2).

Barley: Change from price 1 to price 2 is in 1850. Whereas in 1821–1826 prices 1 and 2 are virtually identical, values of the latter series tend to be somewhat higher overall. Hence, we also reduce price 2 by a factor of 4.5%.

Oats: Levels between prices 1 and 2 differ considerably. Comparison of the oats/barley price ratio with other markets and calculation of the specific weight of oats implicit in the calculations of Statistisches Reichsamt (1935) suggest that the level of price 1 is more plausible than the one of price 2. Hence, we transformed price 2 with the average ratio between the two series in 1820–1845. Change from price 1 to price 2 is in 1845. Missing values in price 1 in 1801 and 1804 are also replaced using price 2 and the ratio just mentioned.

Wheat: Change from price 1 to price 2 is in 1851. The level of price 2 exceeds the level of price 1 by 2.0 percent in 1792–1850 and by 5.6 percent in 1840–1850. Hence, we again reduce price 2 by a factor of 4.5%.

#### *Rye (1540–1871)*

The core of the series are prices of the *St. Hiob* hospital (1540–1821) in *Mark* and *Schilling* per *Wispel* from Gerhard and Engel (2006, 108–13) (price 1). Missing values in 1540–1821 and data after 1821 are extrapolated as follows.

(1) Values for 1546, 1551, 1557, 1580, 1595, 1600, 1604 are extrapolated based on prices of *St. Georg* hospital (price 2) (Gerhard and Engel, 2006, 108–9; volumes refer originally to *Scheffel*). The estimated relationship 1540–1612 is:  $\alpha = 0.0159$ ,  $\beta_1 = 0.8484^{***}$ ,  $R^2 = 0.68$ , dependent variable: price 1; explanatory variable: price 2. We avoided backwards extrapolation of the values for rye 1443–1475, 1500, 1510–1539 with prices from *St. Georg* hospital due to the relatively weak model fit.

(2) Values for 1795, 1798–1800, and 1822–1871 are extrapolated from stock market prices (price 3) (GESIS Köln, 2008, original Statistisches Reichsamt, 1935, 292–94; in *Mark* per 1000 kg). To adjust price 3 to the level of price 1, we use the average ratio between the two series in 1807–1821.

(3) Value for 1656 is extrapolated based on an unspecified rye series from Gerhard and Kaufhold (1990, 166–9) (price 4). The relationship 1638–1790 is:  $\alpha = 0.0606^{***}$ ,  $\beta_1 = 0.9043^{***}$ ,  $R^2 = 0.74$ , dependent variable: price 1; explanatory variable: price 4.

(4) Value for 1806 is extrapolated based on the rye (*Mecklenburg*) series from Gerhard and Kaufhold (1990, 170–1) (price 5). The relationship 1736–1821 is:  $\alpha = 0.0024$ ,  $\beta_1 = 1.0688^{***}$ ,  $R^2 = 0.88$ , dependent variable: price 1; explanatory variable: price 5.

## SA2.29 Hanover

### *Currency and volume conversion*

Conversion to grams of silver follows Gerhard and Kaufhold (1990, 415–6) and Oberschelp (1986, 101) but is modified for the period 1591–1622 to reflect the debasement of coins in Northern Germany; the debasement of coins is assumed to have followed the same course as in Braunschweig.

We decided to apply the rate for the volumes prior 1714 according to Verdenhalven (1993, 23, 49, 72), because the value from Gerhard and Kaufhold (1990, 405) is not plausible and because the date of introduction of the new volume is inconsistent with other literature (cf. Oberschelp, 1986, 27, 47). After 1714 we follow Gerhard and Kaufhold (1990, 405); these rates are very similar to those given by Verdenhalven.

### *Barley, oats, rye and wheat (1590–1863)*

Prices 1590–1691 in *Mariengroschen* per *Scheffel* from Oberschelp (1986, 13–15) (for oats we calculated the mean of the two qualities *rauh* and *weiß*); 1700–1749 calendar year averages based on monthly data in *Thaler* and *Mariengroschen* per *Himten* from Oberschelp (1986, 20–45) (original source is Unger, 1752, 237–62); 1750–1817 in *Mariengroschen* and *Denar* per *Himten*, from 1818 in *Guten Groschen* and *Pfennig* from Gerhard and Kaufhold (1990, 53–5, 111–2, 172–3, 225–6). The observation in 1847 is a calendar year average from a different primary source. In 1817 and 1834 there are two calendar year averages provided for each year; hence, we used the average of the two.

*Martini* prices are calculated as November–December averages from the monthly data for 1700–1849; for 1764–1863 they are taken from Oberschelp (1986, 82–97).

Missing values in the calendar price series for the years 1796–1808 (oats and rye until 1810) and 1851–1863 are extrapolated from *Martini* prices according to the results from Table S3.

## SA2.30 Heilbronn

### *Currency and volume conversion*

We assume that Heilbronn, which was an independent Imperial city until 1803, followed the currency regime of Württemberg. Generally, the currency system applied the following relationships: 1 *Reichstaler* = 1.5 *Gulden*, and 1 *Gulden* = 60 *Kreuzer*.

From 1743 to 1749, Württemberg minted large coin at 8 *Taler* per Mark of silver at a fineness of 14 Lot, 11 grain; hence, 1 *Reichstaler* contained 26.6945 grams of silver. This *Reichstaler* valued  $2\frac{1}{3}$  *Gulden*, which yields 11.953 grams of silver per *Gulden* (Binder, 1846, 206–7). In 1755, authorities in Swabia adopted the *24-Gulden-Fuß* (Binder, 1846, 209), that is, 24 *Gulden* were to be minted per Mark of silver (1 *Gulden* = 9.744 grams of silver).

Württemberg followed the general course of currency depreciation during the Seven Years' War (1756–1763). Binder (1846, 209–20) mentions batches of coin minted in 1758/59 at 26.167 to 29 *Gulden* per Mark. We apply 8.661 grams of silver, assuming 27 *Gulden* per Mark of silver. We interpolate intrinsic content of *Gulden* in 1750–1754 and 1756/57 with exponential trend and assume it remained stable from 1758 to 1763. In 1764, Württemberg, like other parts of southern Germany, returned to the *24-Gulden-Fuß* (Binder, 1846, 215).

The *24-Gulden-Fuß* prevailed until 1837, when Württemberg joined the *Süddeutsche Münzverein*. Evidence for the continued use of the *24-Gulden-Fuß* as money of account can be found in handbooks containing information on local coins for businessmen; see, e. g., Nelkenbrecher (1793, 300)

and Nelkenbrecher (1820, 363). The *Süddeutsche Münzverein* introduced a division of 24.5 *Gulden* per Mark, that is, 9.545 grams of silver (Gerhard, 2002, 276).

We convert the local volume to litre using the conversion formula from the original publication of grain prices (Titot, 1844, 3), which relates the old local volumes to the ones prevailing in the Kingdom of Württemberg after the Napoleonic Wars. For the latter, we use the values given by Witthöft (1993, 27). To apply the rule, we assume that 1 *Scheffel* equals 8 *Simmer* (for measures prevailing prior to the nineteenth century, see Verdenhalven (1993, 81).

*Barley (1816–1843), oats and rye (1744–1843)*

Nominal prices in *Gulden* and *Kreuzer* per *Heilbronner Malter* from Titot (1844).

Data are available for individual days from four different months, usually covering the first and the second part of the year (January, April, July, and September or October). We use them to compute a calendar year average. In a few cases, deviations appear: 1770: August 22nd instead of a value for September; 1772: March instead of January; 1817: June instead of July. For 1843 Titot provides several data points representing all months, and all were used to obtain a calendar year average. In 1815, 1817 and 1818 observations for September are missing in the rye series. The missing data for these three years are potentially problematic as the second part of the year, when the harvest took place, is not represented. We therefore do not provide calendar year averages for these years.

Before 1816, the series for barley has too many missing values to permit calculation of annual values.

### **SA2.31 Herdecke**

*Currency and volume conversion*

From the late eighteenth century, Herdecke had Prussian currency and Berlin measures; see conversion factors applied to Berlin data. Because Herdecke was not under Prussian rule in 1808–1815 no allowance is made for war-time depreciation of currency, however.

*Barley, oats, rye and wheat (1780–1850)*

We use price data from three sources:

(1) 'Ledger': Original prices for 1780–1830 as given in the local market ledger in *Reichstaler* and changing fractions of *Reichstaler* (*Gute Groschen*, *Stüber* or *Silbergroschen*) per *Berliner Scheffel* from Reinert (1920, 259–65). Reinert provides two prices per year, namely, for market days close to May 15 and November 11 (Saint Martin). We average the two prices for each calendar year. For November 13, 1780 the author gives a rye price of only 4 *Gute Groschen*. This has been corrected by adding a *Reichstaler* (24 *Groschen*).

(2) 'Kopsidis': Annual average prices 1784–1819 in *Reichstaler* per *Berliner Scheffel* from Kopsidis (1994, Appendix Table V.a/8). Kopsidis uses unpublished compilations prepared by the regional administration.

(3) 'Administration': Biannual prices 1817–1850 in *Reichstaler*, *Silbergroschen* and *Pfennig* per *Berliner Scheffel* from reports by the regional administration (*Amtsblätter*; Landesarchiv NRW). We average the two prices for May and October to obtain calendar year prices.

From 1784 to 1824, the level of prices differs between sources, particularly during crises years, such as the Tambora crisis in 1816–1818. To avoid that the choice of the underlying source impacts

on the price level, we use the average of all available sources from 1784 to 1830 (two to three series, depending on sub-period). Specifically, we construct our series as follows:

1780–1783: Based on 'Ledger'.

1784–1816: Average of 'Ledger' and 'Kopsidis'.

1817–1819: Average of 'Ledger', 'Kopsidis' and 'Administration'.

1820–1830: Average of 'Ledger' and 'Administration'.

1831–1850: Based on 'Administration'.

### SA2.32 Herford

#### *Currency and volume conversion*

Currency conversion applies *Graumannscher Fuß* (Gerhard and Kaufhold, 1990, 416). Herford was not under Prussian rule in 1808–1815; therefore, we do not correct for currency depreciation during the war period. Volume conversion applies the rates for *Berliner Scheffel* (Witthöft, 1993, 26).

#### *Barley, oats, rye and wheat (1771–1850)*

Nominal prices are in *Reichstaler* and *Gute Groschen* (until 1821) or *Silbergroschen* (from 1822) per *Berliner Scheffel* from Gerhard and Kaufhold (1990, 56–57, 112–13, 174–75, 227–28).

1771–1774: Data represent calendar year prices based on monthly averages. Value for 1772 rests on only one monthly average but is included to track the crisis of the 1770s.

1776–1816: Calendar year prices extrapolated from *Martini* prices applying the general extrapolation rule (eq. (S1)). This procedure is not possible for *Martini* prices of oats.

1817–1850: Calendar year prices mostly based on monthly averages of minimum and maximum prices.

### SA2.33 Hildesheim

#### *Currency and volume conversion*

According to the local currency system, 1 *Reichstaler* equalled 36 *Mariengroschen* until 1817. We assume that until 1739 Hildesheim followed the same monetary regime as Hanover; cf. Hanover.

From 1740 until 1816, Hildesheim followed a different path of currency depreciation compared to Hanover: We assume that the value of the Leipzig Convention of 1690 given for Hanover by Gerhard and Kaufhold (1990), that is, 19.4844 grams of silver per *Reichstaler*, held until 1762 and that local currency was adjusted to the *Konventionstaler* regime in 1763 (Gerhard, 2002, 270–1).

From 1815, Hildesheim was part of the Kingdom of Hanover. Therefore, from 1817 the intrinsic silver content of *Reichstaler* of Hanover is used; see Hanover.

Volume converted according to Oberschelp (1986, LXII).

#### *Barley, rye, wheat (1568–1863)*

Nominal *Martini* prices in *Mariengroschen* per *Scheffel* covering the years 1567–1817 are from Zeppenfeldt (1830); values until 1661 were accessed through Jacks (2016). Nominal prices in November and December in *Groschen* per *Scheffel* for 1818–1863 are from Oberschelp (1986, 81–97), accessed through Jacks (2016). We treat these data as *Martini* prices. Calendar year prices are obtained by applying the general extrapolation rule from equation (S1).

The source also provides *Martini* prices for oats but these data are not used, because there is no general conversion rule to calendar year prices for this grain.

### SA2.34 Jena

#### *Currency and volume conversion*

Except for a brief period after 1672, Jena belonged to the Duchy of Sachsen-Weimar. From 1840, the *Reichstaler* was divided into 30 *Groschen* with 10 *Pfennig* each (Koppe, 2007, 70). Prices are noted according to this system throughout the whole period for which data are available. Until about 1650, regional mints adhered to the *Reichsmünzordnung* of 1566, which prescribed that 9 *Taler* had to be minted of one *Mark* of Cologne. We assume that Weimar implemented the convention of Zinna (1667; 10.5 *Mark* per *Reichstaler*) in 1668. Since currency depreciation began in 1651 (Koppe, 2007, 64), intrinsic value of *Reichstaler* in 1661–1667 is determined with exponential interpolation.

The Zinna convention was followed only until 1675; intrinsic values of 2/3 *Taler* coins minted in 1676 and 1677 (Koppe, 2007, 65) are used to determine intrinsic value of *Reichstaler* until 1689. We assume that from 1690 the principality adhered to the Convention of Leipzig (1690), according to which 12 *Reichstaler* were to be minted per *Mark* of Cologne (Koppe, 2007, 66). In 1750–1754, Weimar minted debased *Groschen* with a fine silver content of only 0.65 grams of silver (Koppe, 2007, 66–7); intrinsic content of *Reichstaler* is adjusted accordingly. From 1756, the principality began minting large coin according to the *Konventionstaler*-Regime (13.333 *Reichstaler* per *Mark* of Cologne; Koppe, 2007, 68). We assume that Jena had the same rate of currency depreciation as Leipzig during the years 1761–1763 compared to 1760 as a result of the Seven Years' War. Finally, in 1840 Weimar implemented the Dresden convention of 1837 (14 *Reichstaler* per *Mark* of Cologne; Koppe, 2007, 70).

Conversion of *Scheffel* to litre is based on the rate for Berlin.

#### *Rye (1662–1855)*

Nominal price data in *Reichstaler*, *Groschen* and *Pfennig* per Prussian *Scheffel* for the years 1660–1855 from the Beveridge Boxes downloaded from Jacks (2016). Since the data end in 1855, we assume the source was compiled in 1856. Following the Dresden treaty of 1837, Weimar introduced the Prussian currency system in 1840 (Koppe, 2007, 70). Consequently, the use of Prussian units appears plausible.

Comparison of short-term fluctuations of rye prices with prices from neighbouring markets show that data are crop year prices. Hence, the general extrapolation rule (S2) for the conversion of crop year prices is applied.

### SA2.35 Kassel

#### *Currency and volume conversion*

The author of the price data converted historical currency to contemporary currency (1850s, see date of publication of source). We assume that the author correctly converted historical currency to currency prevailing in the 1850s, but do not use data before 1766. This decision is based on the easy availability of information on the currency policy in the Electorate of Hessen-Kassel.

Hessen-Kassel adopted the *Konventions-Kurant-Fuß* in 1766 (Kaiser, 2003, 11). Already in 1819, the territory adopted the *Graumannsche Fuß*; see Gerhard (2002, 202) and Kaiser (2003, 11). In 1841, Hessen-Kassel joined the currency convention of Dresden, which stipulated the currency of Prussia as common standard (Gerhard, 2002, 276).

Volume converted following Witthöft (1993, 255).

*Rye (1766–1855)*

Source is Anonymous (1856). The author gives prices corresponding to the currency system of Prussia (see entry for Berlin), but in the local volume of Kassel (*Kasseler Viertel*).

### SA2.36 Königsberg

*Currency and volume conversion*

1688–1756: Prussian *Gulden (Groschen)* converted to *Reichstaler* applying the relationships: 1 *Reichstaler* = 3 Prussian *Gulden*; 1 *Reichstaler* = 90 Prussian *Groschen* (Naudé et al., 1910, 662; Schrötter, 1903, 247, footnote 1). Silver content of *Reichstaler* derived as follows.

Before 1740 currency conversion follows Berlin but applies adjustment factors to reflect the slightly higher silver contents of minted coins in Eastern Prussia compared to Berlin (which holds for many but not all coins, Schrötter, 1903, 568). E.g., 1724 the mint master of Königsberg had to apply a silver content of 18.9 g per *Taler* while minting coins of a nominal value of 2 *Groschen* (Schrötter, 1903, 400). The Berlin series gives a value of 17.9 g silver per *Taler* for 1724. To reflect the higher silver content of minted coins in Königsberg, we base the adjustment factor (1.056) on the ratio of the values from Königsberg and Berlin. For 1700 a similar factor (1.062) based on a coin with a nominal value of 18 *Groschen* obtains (Schrötter, 1903, 568). We use the average of both factors (1.059) to scale the silver content for Königsberg upward (factor used for period 1688–1724). To reflect the ongoing export of coins with high silver content to Poland reported by Schrötter, the adjustment factor decreases exponentially from 1725 until it reaches 1 in 1740.

From 1740 the silver content is based on the unadjusted Berlin series. This is justified by the scarcity of money since 1743 (Schrötter, 1908, 249) and the King's order to apply the *Graumann'schen Fuß*, i.e. 14 *Taler* per *Mark* Cologne or 16.704 grams of silver per *Taler*, in 1754 (Schrötter, 1908, 252–54; Berlin series: *Graumann Taler* 1750–1857 taking account of currency depreciation in 1759–1764).

1797–1810: Reconversion of data from Jacobs and Richter (1935, 18–21) to original currency using the factor 1 *Reichstaler (courant)* = 3 *Mark* of 1873. The silver content of the *Reichstaler* follows Berlin. Payment was likely done in smaller coins such as *Gute Groschen (Scheidemünze)*, which were subject to debasement in the period 1808–1823 according to Jacobs and Richter. In their conversion, these authors already accounted for the *Aufgeld (Agio)*; an additional payment) which was demanded if payment was not in *Reichstaler*.

Jacobs and Richter also discuss whether payment was actually done in *courant* or *Scheidemünze*; reasons for payment in *courant*: (i) source contains notes stating that payment during bad years must be in *courant*, (ii) payment to 'foreign' trade partners who would accept only *courant* (*Preis-Kurant* is the source). We follow Jacobs and Richter and assume that the *Aufgeld* was necessary. Hence, we do *not* reverse this part of their calculation.

Our replication of their data treatment shows only minor differences for 1808–1812 and thus, we keep their calculations.

1811–1871: Conversion of currency as for Berlin, but applies Königsberg specific adjustment factors from Jacobs and Richter for 1811–1822.

Volume conversion applies the following relationships to *Berliner Scheffel*: 1 *Last* (of Königsberg) = 56.5 *Berliner Scheffel*; 1 *Last* of oats = 51 *Berliner Scheffel* (Naudé et al., 1910, 620).

Conversion of prices per kg from Statistisches Reichsamt (1935) back to volumes as follows: kg per *Scheffel* of Königsberg and kg per *Preußische Scheffel* from Jacobs and Richter (1935, 16) (cf.

Statistisches Reichsamt, 1935, 281); litre per *Scheffel* of Königsberg from Witthöft (1993, 267); litre per *Preußische Scheffel* (as for Berlin) from Witthöft (1993, 26).

*Barley, oats, rye and wheat (1688–1871)*

1688–1730: Average of minimum and maximum prices in Prussian *Gulden* per *Last* from Naudé and Schmoller (1901, 618–9). The type of prices is unspecified. They might be wholesale prices, because the volume is in *Last*, however, this is not certain (hence, no adjustment of price levels to retail prices is made).

1731–1739: gap.

1740–1756: Annual averages of weekly prices in Prussian *Groschen* per *Berliner Scheffel* calculated by Naudé et al. (1910, 664–71) based on *Wöchentlichen Königsbergischen Frag- und Anzeigungsnachrichten*. To fill gaps in 1748, 1749 and 1751 they used information from the *Preiskurant* compiled by the merchant guild of Königsberg. These are wholesale prices. We did not adjust these prices to approximate retail prices due to a lack of support for the choice of the adjustment factor. Assuming a mark-up without empirical backup would be arbitrary. Keeping wholesale prices works against our hypothesis because it increases the spread with other markets and signals disintegrating markets.

1757–1773/96: gap.

1774–1796 (rye only): Annual averages of monthly prices in Prussian *Taler* and Prussian *Groschen* per *Berliner Scheffel* from Kraus (1808, Table VIII).

1797–1810: Prices in *Mark* per 1000 kg from Jacobs and Richter (1935, 52–53) (accessed through GESIS Köln, 2008). Prices in 1792–1796 are not used because Jacobs and Richter extrapolated these data from prices in Berlin (see their note 7).

1811–1871: Calendar year prices in *Guten Groschen* (until 1821; except 1818) or *Silbergroschen* (1818 and from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1811–1859 are from Geheimes Staatsarchiv Berlin (a); those for 1818, 1824, 1860–1864 from Königlich Preussisches Statistisches Bureau (1867, 117, 121, 126, 130); and data for 1865–1871 from Königlich Preussisches Statistisches Bureau (1866–1872). Visual inspection of overlapping data for 1811–1826 from Jacobs and Richter and Prussian sources shows that the observations for 1819 are not well in line but the correlation of series from both sources is still satisfactory (from 0.86 for wheat to 0.94 for rye). Removing 1819 increases these correlations for all cereals (e.g., for wheat to about 0.91).

## SA2.37 Landshut

*Currency and volume conversion*

Currency conversion until 1857 follows Munich; for the period 1858–1871 see Gerhard (2002, 278). *Scheffel* of Landshut prior 1813 are converted to litre using the relationship to the *Scheffel* of Munich given by Seuffert (1857, 138); for the litre equivalent of the latter see Munich. We also use a different volume for oats. *Scheffel* of data for 1815–1871 are converted according to Witthöft (1993, 76).

*Barley, oats, rye and wheat (1584–1700, 1815–1871)*

1584–1855: Calendar year prices in *Gulden* and *Kreuzer* per *Scheffel* of Landshut (1815–1855 *Scheffel* of Bavaria) from Seuffert (1857, 138, 282–85).



1856–1868: Weekly prices in *Gulden* and *Kreuzer* per *Scheffel* of Bavaria from *Ansbacher Morgenblatt* 1856–1860 and *Kurier für Niederbayern* 1861–1868. We aggregate data first to monthly averages, then from monthly averages to annual averages. Data are missing from July to December 1866 and we do not compute an annual average for this year.

1869–1871: Monthly prices in *Gulden* and *Kreuzer* per *Scheffel* of Bavaria from *Zeitschrift des Königlich-Bayerischen Statistischen Bureau* 1869–1871.

### SA2.38 Leipzig

#### *Currency and volume conversion*

Currency and volume conversion follows Pfister (2017, Supporting information S1, p. 9, S4). The *Zollpfund* (500 grams of silver) is applied from 1858 (see Berlin). 30 *Taler* were to be minted from the *Zollpfund*, which implies a slightly reduced intrinsic value for *Taler* and *Pfennig*.

#### *Barley and oats (1574/87–1820), rye and wheat (1577/74–1871)*

Crop year prices (August to July) for barley, oats, rye and wheat (1564–1820) in *Denar* per *Scheffel* from Allen (2010), based on Elsas (1940). Calendar year prices were obtained by extrapolation according to (eq. (S2), Table S7; rye and wheat: until 1818). Calendar year prices for rye and wheat in 1819–1860 in *Groschen* per *Scheffel* from Koehler (1967, 366–78).

Calendar year prices for rye and wheat in 1861–1871 in *Mark* per 1000 kg are from GESIS Köln (2008), original in Statistisches Reichsamt (1935, 293–307). Data start in 1845 and relate to information from the stock exchange (until 1865) or from wholesale trade quotes (from 1866). In 1845–1860 the Pearson correlation with prices in grams of silver per litre derived from Koehler is  $r=0.99$  in the case of rye and  $r=0.82$  in the case of wheat. The ratio of the two series was used to scale prices from Statistisches Reichsamt to the correct level in grams of silver per litre.

### SA2.39 Leisnig

#### *Currency and volume conversion*

Currency conversion applies the silver content of the *Pfennig* series developed for Leipzig; see entry for Leipzig. Volume is converted using the rate for Dresden; see Witthöft (1993, 141).

#### *Rye and wheat (1772–1871)*

Calendar year averages based on monthly data from Uebele et al. (2013); original source is the weekly *Intelligenzblatt* of Leipzig (Uebele et al., 2013, 3). Nominal prices are in *Taler* per *Dresdener Scheffel*. We considered only years with information on prices in at least seven months. This leads to missing values in 1771, 1825–1828, 1832 and 1856.

### SA2.40 Lüneburg

#### *Currency and volume conversion*

In 1705, the principality of Lüneburg (ruled from the residence in Celle) was absorbed by the later Kingdom of Hanover. Hence, we apply silver contents as in Hanover (cf. detailed description for Hanover). The Imperial mint ordinance of 1566 was adopted in Lower Saxony in 1572, but it was by and large identical with the currency regime decreed in the convention of Braunschweig in 1555 (Jesse, 1962, 30, 41). Therefore, intrinsic content of *Reichstaler* in 1566/72 is extended backward

until 1555. Additionally, we assume that the silver content for *Guter Groschen* (1817) is valid for the period 1790–1817 (Cf. Gerhard and Kaufhold, 1990, 62, note 14).

Volumes are converted according to Gerhard and Kaufhold (1990, 407).

*Barley (1728–1863), oats (1718–1863), rye (1617–1863) and wheat (1606–1863)*

#### *Characterization of data and sources*

The final price series are constructed from Gerhard and Kaufhold (1990, 58–63, 114–7, 176–8, 229–31; partly accessed through GESIS Köln, 2015b; checked with Gerhard and Kaufhold) and Oberschelp (1986, 82–97).

Before 1750, Gerhard and Kaufhold (1990) take their data from Unger (1752, Appendix XXI). Until 1734, annual values usually rest on only one piece of information. Gerhard and Kaufhold (1990, 61) state that these data represent annual averages. An exception are values for the years 1689/90 and 1695, which represent autumn prices (*ibid.*, note 5).

Until 1735, the data based on Unger contain clusters of three (or more) identical values in consecutive years, which is very unusual in comparison with later years from 1735 resting on monthly observations and with other markets. This may be related to low market liquidity (the pattern is more pronounced for the low-value grains barley and oats) but also to other reasons (e.g., the way how Unger recorded the prices). To avoid insufficient data quality, we include data for each series only after the last cluster of three or more repeated values occurred (details below).

From 1735 (rye and wheat) and 1750 (barley and oats), annual values are averages of a plurality of data points, often 12 and more. From 1790, data are annual averages that were taken directly from the source.

Where possible, gaps in the series are filled using calendar year prices extrapolated based on *Martini* prices from Oberschelp (1986).

#### *Details 1606–1761*

Until 1734 prices were noted in *Schilling* and *denar* or *Pfennig* (Gerhard and Kaufhold, 1990, 61). In 1735–1761 prices were noted in *Gute Groschen* (Gerhard and Kaufhold, 1990, 62).

Barley and oats: Data for 1555–1727 (barley) and 1555–1717 (oats) were not included, because they contain clusters of identical values in three or more consecutive years.

Rye and wheat: The values for 1690 are extrapolated using the autumn prices for 1689/90 and the local relationship for *Martini* prices (details below). Data for 1555–1616 (rye) and 1555–1605 (wheat) were not included, because they contain clusters of identical values in three or more consecutive years. Autumn price of 1695 omitted.

#### *Details 1764–1863*

Prices in *Mariengroschen* and *Pfennig per Lüneburger Himten* from Gerhard and Kaufhold (1990); from 1790 in *Guten Groschen*. *Martini* prices in *Groschen* and *Denar* from Oberschelp (1986). Missing calendar year prices for barley, oats, rye and wheat for the years 1765, 1820–1831 (rye 1816–1831) and 1851–1863 are extrapolated from *Martini* prices according to the results in Tables S3 and S4.

We omitted implausibly low calendar year prices for rye in 1816–1819 given by Gerhard and Kaufhold. According to these values, rye would be cheaper than barley which is usually not the case. Thus, we replaced these prices with calendar year values estimated from *Martini* prices from Oberschelp, which did not show this anomaly. *Martini* prices from Gerhard and Kaufhold for the years 1820–1831 are not included.

## SA2.41 Magdeburg

### *Currency and volume conversion*

Currency conversion follows Berlin (including adjustment for depreciation of Prussian currency in 1808–1821).

Volume conversion assumes 1 *Magdeburger Wispel* = 24 *Magdeburger Scheffel*; 1 *Magdeburger Scheffel* = 6/7 *Berliner Scheffel*, for the latter see Berlin (Naudé and Schmoller, 1901, 516, 549).

*Barley* (1667–1756, 1816–1871), *rye*, *wheat* (1642–1756, 1816–1871) and *oats* (1740–1756, 1816–1871) 1642–1739: Calendar year prices extrapolated from *Martini* prices applying the general extrapolation rule (eq. (S1)). *Martini* prices in *Taler* and *Groschen* per *Magdeburger Wispel* (from 1714 *Berliner Wispel*) from Naudé and Schmoller (1901, 552, 545–8) and Naudé et al. (1910, 615). Prices for 1641–1666 based on an unspecified manuscript; 1667–1739 based on a list drawn up by the municipal authorities in 1747.

1740–1756: Calendar year prices based on Naudé et al. (1910, 601–14). Original source is *Wöchentliche Magdeburgische Frag- und Anzeigungsnachrichten*. Naudé et al. filled gaps in 1747 and 1748 with monthly reports written by the *Magdeburger Kammerpräsident* (head of regional administration). For rye, the annual average for 1755 calculated by Naudé et al. is implausibly high; we have replaced it with a newly calculated average based on monthly data.

1757–1815: gap.

1816–1871: Calendar year prices in *Guten Groschen* (until 1821; except 1818) and *Silbergroschen* (1818 and from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1816–1859 are from Geheimes Staatsarchiv Berlin (a); those for 1818, 1824, 1860–1864 from Königlich Preussisches Statistisches Bureau (1867, 117, 121, 126, 130); and data for 1865–1871 from Königlich Preussisches Statistisches Bureau (1866–1872).

## SA2.42 Mainz

### *Currency and volume conversion*

The currency system is described by Rödel (1985, 408). Until 1696, prices are given in *Gulden*, *Albus* and *Denar* with 30 *Albus* or 240 *Denar* per *Gulden*. From 1697, the *Gulden* is divided into 60 *Kreuzer*. 1 *Reichstaler* equaled 1.5 *Gulden*.

Silver content is assessed based on the Imperial mint ordinance (1566), the Zinna convention (1667) and the Leipzig convention (1690). We assume that local currency was adjusted to the Leipzig regime in 1690 (Gerhard, 2002, 259). To correct for likely currency depreciation in the late 1730s, values in 1737–1762 are based on the intrinsic content of *Denar* in Speyer. Apart from a similar lowering of the intrinsic content of coins in Frankfurt, comparison of nominal and silver prices in Trier suggests the onset of currency depreciation in 1743. We assume Mainz adopted the *Konventionstaler* regime in 1763 and followed the 20-*Gulden-Fuß* (Gerhard, 2002, 270–1). The same currency regime prevailed in the early nineteenth century, when Mainz was part of the Grand Duchy of Hesse (Darmstadt). Intrinsic content of *Gulden* slightly changed with the monetary union among the southern German states (*Süddeutscher Münverein*, 1837, implemented in 1838) and the treaty of Vienna (1857, implemented in 1858; cf. Berlin file and Gerhard 2002, 276, 278).

Until 1798, volume is converted following Witthöft (1993, 303); from 1824, the factor applying to the official measure of the Grand Duchy of Hesse is used (Witthöft, 1993, 21).

*Rye (1636–1798, 1824–1871), barley, oats and wheat (1824–1871)*

1636–1796: Calendar year average prices of rye in local currency per *Mainzer Malter*, based on weekly market prices from Rödel (1985, 408–9). In the years 1698, 1793/94 and 1796, data rest on only few months that do not represent the calendar year; these observations were excluded.

1824–1871: Weekly prices in *Gulden* and *Kreuzer* per *Malter* from *Darmstädter Zeitung* 1824–1871. Data start at the end of March, 1824. We aggregate data first to monthly averages (from April 1824), then from monthly averages to annual averages.

#### **SA2.43 Mannheim**

*Currency and volume conversion*

Mannheim belonged to the Palatinate until 1803, when it became part of Baden. During the late eighteenth century, the Palatinate followed the *Konventionstaler* regime according to which 24 *Gulden* were to be minted from the Mark of Cologne (Gerhard, 2002, 270). In 1837, Baden was a founding member of the *Süddeutsche Münzverein*. This monetary union introduced a division of 24.5 *Gulden* per Mark, that is, 9.545 grams of silver (Gerhard, 2002, 276).

We assume that Borgius (1899) has already converted the measure prevailing before Mannheim became part of Baden (Witthöft, 1993, 308) to the measure introduced in this state around 1810 (Witthöft, 1993, 16). From 1853 prices are given in *Zentner* of 50 kilogram; cf. Witthöft (1993, 16). We converted kilogram to litre using the specific weights from Kopsidis (1996, 543) based on work published in the 1860s.

*Barley, oats, rye and wheat (1791–1852/56)*

Annual prices in *Gulden* and *Kreuzer* from Borgius (1899, 235–6). Until 1852 prices are per *Malter*, from 1853 per *Zentner*.

#### **SA2.44 Minden**

*Currency and volume conversion*

Currency conversion of data from Naudé and Schmoller (1901) and Naudé et al. (1910) for 1638–1747 applies the intrinsic value of the *Reichstaler* developed for Westphalia (see entry for Münster). The *Reichstaler* was divided into 36 *Mariengroschen* consisting of 8 *Pfennig* (Naudé and Schmoller, 1901, 538). Currency conversion for data from 1775 from Gerhard and Kaufhold (1990) applies intrinsic values for Herford (Gerhard and Kaufhold, 1990, 416–17). From 1834 silver content is identical with the one in Berlin.

Volume conversion for data 1638–1647 applies the same rate as for Berlin. Instead of the rates provided for volume conversion in Gerhard and Kaufhold (1990, 408), we also applied the same rates as for Berlin to data from Gerhard and Kaufhold, because all prices are per *Berliner Scheffel*.

*Barley (1651–1871), oats (1640–1871), rye (1641–1871) and wheat (1724–1871)*

November/December prices (treated as *Martini* prices) 1638–1747 in *Taler*, *Mariengroschen* and *Pfennig* per *Berliner Scheffel* from Naudé and Schmoller (1901, 534–8) and Naudé et al. (1910, 602). Calendar year and *Martini* prices 1775–1850 in *Reichstaler* and *Guten Groschen* or *Silbergroschen* (from 1822, *Martini* prices from 1817) per *Berliner Scheffel* from Gerhard and Kaufhold (1990, 64–7, 118–20, 180–2, 232–4). Calendar year prices in 1640–1747, 1805–1807 and 1811–1814 are extrapolated from *Martini* prices according to the results in Table S4.

1851–1871: Calendar year prices in *Silbergroschen* per *Berliner Scheffel* from Prussian sources. Data for 1851–1859 are from Geheimes Staatsarchiv Berlin (a), those for 1860–1864 are annual averages of monthly values from Preußischer Staatsanzeiger (1860–1865): Data for 1865–1871 are from Königlich Preussisches Statistisches Bureau (1866–1872).

#### SA2.45 Munich

##### *Currency and volume conversion*

The currency system is 1 *Gulden* = 60 *Kreuzer* = 240 *Denar* (Elsas, 1936, 116). Currency conversion until 1740 and 1800–1820 follows Pfister (2017, Supporting information S1, p. 11, S4). 1741–1800: The *Konventionstaler* regime that was agreed with Austria in 1754 was revoked in 1755. In 1759 the *Konventionstaler* was set to 2.5 *Gulden* = 150 *Kreuzer* (Kruse, 1771, 270). 1 *Kölner Mark* = 10 *Konventionstaler* (Gerhard, 2002, 213). This implies an intrinsic value of the *Denar* of 0.390 grams of silver. For the period 1741–1758, the values are determined by exponential interpolation. This reflects the failure of monetary cooperation at the Imperial level in 1740 (Gerhard, 2002, 262–5) and the beginning of devaluation around that time in Cologne and Hamburg. In 1766, the *Kreuzer* was stabilized at 144 *Kreuzer* per *Konventionstaler* (Kruse, 1771, 270). From 1800, the rates for grams of silver per *Denar* are from Gerhard (1984, 623–4).

Volume conversion until 1820 follows Pfister (2017); a separate measure applies for oats (Witthöft, 1993, 329).

For conversion of currencies and volumes of prices in 1811/12, 1819 and 1821–1871 from Statistisches Reichsamt (1935) (identical with series in Jacobs and Richter, 1935), the following procedure applies (cf. Hamburg). First prices in *Goldmark* of 1873 per 1000 kg are reconverted to original local currency and units. Second, local currency and units are converted to grams of silver per litre. Thus, we apply 1 *Gulden* = 1.75 *Mark* (1792–1810) and 1 *Gulden* = 1.7143 *Mark* (1811–1871) (Jacobs and Richter, 1935, 21) to obtain prices in *Gulden*. We assume that prices are in *Rechnungsgulden* (like prices from Elsas, 1936 prices in Statistisches Reichsamt are from the urban grain market *Schranne*). We apply the relationship between *Gulden*, *Kreuzer* and *Denar* as given by Elsas (1936, 116) and multiply with the series of grams of silver per *Denar* provided by Pfister (2017).

Volumes are converted by deriving a kg per litre ratio from the kg per *Scheffel* values (different for each grain type) from Jacobs and Richter (1935, 16) and the litre content of *Scheffel* from Witthöft (1993, 329).

##### *Barley (1514–1871), oats (1452–1871), rye (1452–1871) and wheat (1512–1871)*

Crop year prices for oats (1400–1690) and rye (1404–1690) in *Denar* per *Scheffel* from Allen (2010, Munich file; checked with original source) (Allen, 2001; original in Elsas, 1936, 539–45: *Kammerrechnungen*). Calendar year prices are obtained following the results for oats and rye from *Kammerrechnungen* in Table S8. Prices for barley (1514–1690), wheat (1512–1690), and if possible missing values in the series for oats and rye are extrapolated using the calendar year conversion of the crop year series referring to the *Heilig-Geist* hospital (Allen, 2010, Munich file; checked with original source; original Elsas, 1936, 560–5). Cf. results for barley, oats, rye and wheat from *Heilig-Geist* in Tables S8 and S9. All estimations for the conversion to calendar year prices rely on the overlap with the calendar price series described immediately below.

1691–1820: Calendar year prices calculated as arithmetic averages of monthly data in *Denar* per *Scheffel* from Elsas (1936, 677–9, 680–2, 674–7, 671–4). We obtained prices for 1780–1787, which are

not provided by Elsas, in *Gulden* and *Kreuzer* per *Scheffel* for each month from the *Intelligenzblätter* (Churfürstlich Pfalzbaierisches Intelligenz- und Adreß-Comtoir, 1780–1783; 1784–1787). We applied Elsas' method by using the price for average quality (*Vom Mittern*) of the first *Schranne* per month (Elsas, 1936, 350–1). A comparison with the mean of all monthly observations from the *Intelligenzblätter* for the same period shows that Elsas' method is valid: the correlation ranges between 0.9135 (oats) and 0.9846 (rye). The relatively poor fit for oats is due to an outlier for the observation November 1787 which may originate from a printing error.

Data to fill gaps in 1811, 1812 and 1819, and prices for the period 1821–1871 in *Mark* per 1000 kg are from GESIS Köln (2008), original in Statistisches Reichsamt (1935, 293–307). Prices from Elsas for 1691–1820, and from Statistisches Reichsamt for 1811–12, 1819, and 1821–1871 refer to the urban grain market (*Schranne*). The calendar year prices from Statistisches Reichsamt are higher than those based on monthly data from Elsas. (A possible reason could be that the kg per *Scheffel* values Jacobs and Richter applied are different from those that we use to recalculate per *Scheffel* prices prior to conversion to litre.) Both series correlate almost perfectly for the overlapping period 1791–1820. To avoid the shift in the mean price level, we adjusted each series from Statistisches Reichsamt with a commodity-specific factor downwards when splicing it with data from Elsas (downwards adjustment ranges from 12 to 13%).

Crop year prices for both periods July to June and August to July 1690–1817 and *Martini* prices (as November-December averages) 1690–1818 for barley, oats, rye and wheat are calculated on the basis of monthly data if possible.

## SA2.46 Münster

### *Currency and volume conversion*

Currency conversion of *Martini* prices from Gerhard and Kaufhold (1990) until 1763 follows the compilation of information on currency in Westphalia presented below. From 1763–1826 we apply the *Konventionstaler*; from 1827 currency conversion follows Berlin. *Malter* converted following Gerhard and Kaufhold (1990, 409); *Scheffel* as for Berlin.

### *Currency in Westphalia (1562–1763)*

What follows presents the principles followed in converting prices in Westphalian towns to grams of silver based on Bracht and Pfister (2020, 325–30).

Divisions of *Reichstaler*: Bishopric of Münster (Gerhard and Kaufhold, 1990, 71; Schwede, 2004, 436) 1 *Reichstaler* = 28 *Schillinge*; 1 *Schilling* = 12 *Pfennige*. Bishoprics of Osnabrück and Paderborn (Kennepohl, 1938, 25–26; Schwede, 2004, 43) 1 *Reichstaler* = 21 *Schillinge*; 1 *Schilling* = 12 *Pfennige*. Widely used divisions of the *Reichstaler* in North-Western Germany from 1623: 1 *Reichstaler* = 36 *Mariengroschen*; 1 *Reichstaler* = 24 *Gute Groschen*. Prussian currency reform of 1822/23: 1 *Taler* = 30 *Silbergroschen*; 1 *Silbergroschen* = 12 *Pfennige*.

Silver content of *Reichstaler*: The Imperial mint ordinance of 1566 was implemented in Westphalia in 1569 (Kennepohl, 1938, 167); before this year, no certain information for the silver content of the *Taler* exists. Until 1655 we assume silver content according to the Imperial mint ordinance (25.984 grams of silver).

From 1691 to 1740 silver content is set according to the Leipzig convention of 1690 (19.488

grams of silver). Exponential interpolation is used to calculate values in 1655–1690. The starting point of currency depreciation is set to 1656 because contemporaries deplored a flooding of Westphalia with debased *Mariengroschen* following the war between Brandenburg and Poland in 1656/57. Extrapolated values are consistent with the results of examinations of Westphalian coin by the regional mint authorities in 1675 and 1680 (Kennepohl, 1938, 202–4; Schwede, 2004, 177–86, 258–60, 267).

In 1763 most Westphalian territories accepted the *Konventionstaler* regime (17.539 g; Schwede, 2004, 28). We let depreciation start in 1741 and again define values in 1741–1757 by the exponential trend between the silver content of 1690–1740 and from 1763 onwards. 1741 conforms to the initial phase of the Austrian War of Succession (1740–1748) and the beginning of a longer phase of currency depreciation in Cologne (silver content of *Albus* according to Metz, 1990, 366–95).

Massive depreciation of currency during the Seven Years' War (1756–1863) is captured by a short series of exchange rates of local currency against the *Louis d'or* in Paderborn (Schwede, 2004, 442; value in June for 1757, values for January for subsequent years until 1763; we compute pairwise averages of the latter figures to obtain mid-year values). We use changes of the exchange rate against the value in June 1757 and our interpolated value for 1757 to extrapolate the intrinsic content of the *Reichstaler* in 1758–1762.

*Barley, oats, rye and wheat (1570–1871)*

*Martini* prices 1569–1863 (*Kappensaat*; see notes by Gerhard and Kaufhold, 1990, 71–2) in *Reichstaler* and *Schilling* (from 1827 in *Silbergroschen*) per *Malter* of Münster from Gerhard and Kaufhold (1990, 68–72, 121–4, 183–6, 235–8).

Calendar year prices 1570–1815 extrapolated from *Martini* prices applying the local times series relationship (Table S5). Calendar year prices 1816–1871 in *Guten Groschen* (until 1821; except 1818) and *Silbergroschen* (1818 and from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1816–1859 are from Geheimes Staatsarchiv Berlin (a); those for 1818, 1824, 1860–1864 from Königlich Preussisches Statistisches Bureau (1867, 117, 121, 126, 130); and data for 1865–1871 from Königlich Preussisches Statistisches Bureau (1866–1872).

## SA2.47 Nordhausen

*Currency and volume conversion*

To convert local currency to grams of silver for the period 1669–1763, we apply the average rate of grams of silver per *Taler* from three geographically close cities: Göttingen (currency of Hanover), Halle (Berlin/Prussian currency) and Leipzig (Saxony). We use the basic relationship of 24 *Gute Groschen* per *Taler*.

For the years 1764–1770, we follow Gerhard (2002, 270) and apply the *Konventionsfuß* (20 *Gulden* = 10 *Konventionsspeciester* per *Mark* of Cologne). That is, the currency conversion applies the same fine metal content as Leipzig.

Currency conversion from 1816 follows Berlin (including adjustment for depreciation of Prussian currency in 1808–1821).

*Scheffel* of Nordhausen are converted using the local rate given by Witthöft (1993, 349). For the conversion of *Berliner Scheffel* see Berlin.

*Barley, oats, rye and wheat (1669–1770, 1816–1871)*

1669–1770: Monthly prices in *Guten Groschen* per *Scheffel* of Nordhausen for two qualities (good/bad) from Oberschelp (1986, 51–77). To obtain a single calendar year price for each type of grain, we first calculate calendar year averages and then average across the two qualities. We do not calculate a calendar year average for the years 1668 and 1771, because only a few months are available for these years.

1771–1815: gap.

1816–1871: Calendar year prices in *Guten Groschen* (until 1821) or *Silbergroschen* (from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1816–1859 are from Geheimes Staatsarchiv Berlin (a); the gap in 1824 is closed with annual averages of monthly values from Geheimes Staatsarchiv Berlin (b). Data for 1860–1864 are annual averages of monthly values from *Preußischer Staatsanzeiger* (1860–1865); data for 1865–1871 are from Königlich Preussisches Statistisches Bureau (1866–1872).

## SA2.48 Nuremberg

*Currency and volume conversion*

Original prices until 1671 are in *Rechengeld* (money of account). Silver content was assessed in three steps. We replicated Bauernfeind's conversion to gold and converted the result to silver equivalents via a gold silver ratio. Details: First, we converted to *Rheinischer Gulden* (a gold currency) using the rates of *Denar* or *Kreuzer* per *Rheinischer Goldgulden* according to Bauernfeind (1993, 390–9). Missing observations in these rates are interpolated with the last known value. For the following years and sub-periods no value is given at all: 1430, 1446–47, 1449, 1453, 1461, 1474–1515, 1517–18, 1520, 1526, 1529, 1531, 1534.

Second, we converted *Rheinische Gulden* to grams of gold according to Bauernfeind (1993, 60; based on Metz, 1990, 345–63).

Third, we converted gold prices to grams of silver based on the silver/gold price ratio in Cologne from Metz (1990, 366–95).

The intrinsic value of *Kreuzer* in grams of silver from 1672 until 1699 is determined as follows. The value for 1671 is from Bauernfeind (1993, 397–9, Table A.4). Revised silver values for 1672 until 1699 are determined by exponential interpolation based on the value for 1671 and Gömmel's value for 1700 (Gömmel, 1985, 252–4). For 1700–1857, we use the series for grams of silver per *Kreuzer* and *Gulden* (from 1812) given by Gerhard (1984, 623–4) and Gömmel (1985, 252–4). For the silver equivalent of Bavarian currency from 1858, see Gerhard (2002, 278).

Volume conversion for prices until 1811 applies the ratio given by Bauernfeind (1993, 72, 511); litre rate for *Scheffel* for data in 1812–1871 from Witthöft (1993, 76).

*Barley and oats (1815–1860, 1869–1871)*

1815–1855: Calendar year prices from Seuffert (1857, 284–5).

1856–1860: Weekly prices in *Gulden* and *Kreuzer* per *Scheffel* of Bavaria from *Ansbacher Morgenblatt* 1856–1860. We aggregate data first to monthly averages, then from monthly averages to annual averages.

1869–1871: Monthly prices in *Gulden* and *Kreuzer* per *Scheffel* of Bavaria from *Zeitschrift des Königlich-Bayerischen Statistischen Bureaus* 1869–1871.



*Rye and wheat (1490/1498–1860, 1869–1871)*

1490–1671: Calendar year prices are calculated as arithmetic mean of monthly prices in *Denar per Nürnberger Sümmer*. Data have been kindly provided by Walter Bauernfeind and are from Bauernfeind et al. (2001, 286–7) (personal communication with Walter Bauernfeind). Monthly grain prices are derived from official grain price estimates from the retail market, which were used to fix the bread weight (a process called *Raitung*) and therefore represent retail prices (Bauernfeind et al., 2001, 285–6). Until 1671 these data rest on Bauernfeind (1993). Additionally, they have been corrected for a change from the Julian to the Gregorian calendar introduced in 1700 (Bauernfeind et al., 2001, 287, note 15). As in Bauernfeind (1993), prices from September 1504 until June 1514 are reduced by the tax of 32 *Denar per Nürnberger Sümmer*; the same holds for February 1576 until December 1579 with 126 *Denar* (Bauernfeind, 1993, 78, 220 note 376, 241).

1672–1811: Mean of monthly data from Bauernfeind et al. (2001).

1812–1855: Calendar year prices based on arithmetic mean of monthly prices. Rye prices in *Gulden* and *Kreuzer per Scheffel* from Seuffert (1857, 200–9). Wheat prices in *Denar per Nürnberger Sümmer* from Bauernfeind et al. (2001), who also rely on Seuffert.

1856–1860, 1869–1871: See barley and oats.

## **SA2.49 Osnabrück**

*Currency and volume conversion*

Currency conversion follows Münster until the beginning of the nineteenth century. The currency of the kingdom of Hanover, which was introduced in Osnabrück in 1818, followed the *Konventionstaler* regime that was in force in Osnabrück from 1763. In 1834, Prussian currency was adopted; see entry for Berlin. *Osnabrücker Malter* converted following Witthöft (1993, 372).

*Barley, rye (1615–1861) and wheat (1625–1861)*

Calendar year prices for entire period extrapolated from *Martini* prices applying the general extrapolation rule (eq. (S1)). Original data are in *Reichstaler* and *Schilling (Groschen)* per *Osnabrücker Malter* from Gerhard and Kaufhold (1990, 73–7, 125–8, 187–90, 239–41). Data are of the *Korntaxe* type and we treat them as *Martini* prices (cf. Gerhard and Kaufhold, 1990, 76). Data for barley, oats, rye 1601–1614 are omitted because the absence of interannual variation for various years casts doubt on prices being market prices. Given the lack of an extrapolation rule, oats prices were not converted to calendar year prices.

## **SA2.50 Paderborn**

*Currency and volume conversion*

Currency conversion follows Münster until 1813 and Berlin from 1814, but without adjustment for war-time depreciation. *Paderborner Scheffel* converted following Witthöft (1993, 375); *Berliner Scheffel* as for Berlin.

*Barley, oats (1677–1871), rye and wheat (1641–1871)*

Calendar year prices 1677–1810 (barley), 1677–1808 (oats), 1641–1808 (rye), and 1641–1802 (wheat) extrapolated from *Martini* prices. Extrapolation applies local time series relationships (Tables S5 and S6). Data from 1811 (barley), 1809 (oats, rye) and 1803 (wheat) until 1871 are calendar year

prices from different sources: Until 1850 from Gerhard and Kaufhold (1990, 79–82, 130–2, 192–4, 244–5) in *Reichstaler* and *Mariengroschen* or *Gute Groschen* (from 1814; Gerhard and Kaufhold, 1990, 81) or *Silbergroschen* (since 1822) per *Paderborner Scheffel*; exception wheat: 1803–1810 and 1814–1821 in *Gute Groschen* but 1811–1813 in *Mariengroschen*.

We omit earlier data for calendar years starting from 1780 for barley, oats and rye. The main reason is that the calendar year prices are almost identical with *Martini* prices in these earlier years but both series show the usual disagreement in later years. Furthermore, a visual comparison of rye prices with those in Münster shows that the *Martini* prices of Paderborn and Münster move together well, and the *Martini* price of Münster shows the usual difference with respect to calendar year prices. These issues casts doubt on the quality of the early observations of annual averages for Paderborn.

We extend calendar year averages beyond 1850 with further data in *Silbergroschen* per *Berliner Scheffel* from different sources: 1851–1859 from Geheimes Staatsarchiv Berlin (a); 1860–1864 annual averages of monthly values from Preußischer Staatsanzeiger (1860–1865); 1865–1871 from Königlich Preussisches Statistisches Bureau (1866–1872).

*Martini* prices are called *Domkapitularische Fruchttaxe* in Paderborn and were sampled by contemporaries during the time period between *Martini* and Easter (also referred to as winter prices by Gerhard and Kaufhold) to obtain a mean price which was used for monetizing peasant dues (Gerhard and Kaufhold, 1990, 81). *Martini* prices 1676–1833 (barley and oats) and 1640–1833 (rye and wheat) in *Reichstaler* and *Silbergroschen* per *Paderborner Scheffel* from Gerhard and Kaufhold (1990, 78–80, 129–31, 191–4, 242–4).

### SA2.51 Parchim

*Currency and volume conversion*

see Boizenburg.

*Barley, oats, rye and wheat (1799–1870)*

Grossherzogliches Statistisches Bureau (1873, 46–97) presents monthly prices in *Schilling* per *Rostocker Scheffel*. We aggregate this information to calendar year averages. Some gaps are filled with information for annual average prices (Grossherzogliches Statistisches Bureau, 1873, 26–9): prices for oats in 1799 and 1833, wheat prices in 1830.

### SA2.52 Quedlinburg

*Currency and volume conversion*

We assume that Quedlinburg followed the monetary policies of Brandenburg-Prussia from 1750 (Rittmann, 1975, 365). Hence, intrinsic value of *Taler* follows Berlin (including adjustment for depreciation of Prussian currency in 1808–1821).

*Barley, oats, rye and wheat (1750–1855)*

There are two overlapping sets of biannual prices in *Taler* per *Wispel*. Calendar year prices until 1830 are calculated as averages of prices in January and November from Schulze (1965, 268–70) and Schulze (1967, 327–9) (price 1). Calendar year prices 1831–1855 are extrapolated from a second series (price 2), which is calculated as the mean of the minimum and maximum prices from Schulze (1967, 325–6). The relationships 1800–1830 for extrapolation are as follows (dependent

variable: price 1; explanatory variable: price 2): Barley:  $\alpha = 0.0579^{**}$ ,  $\beta_1 = 0.8218^{***}$ ,  $R^2 = 0.89$ . Oats:  $\alpha = 0.0602^{***}$ ,  $\beta_1 = 0.7205^{***}$ ,  $R^2 = 0.80$ . Rye:  $\alpha = 0.0221$ ,  $\beta_1 = 0.9761^{***}$ ,  $R^2 = 0.92$ . Wheat:  $\alpha = 0.04591$ ,  $\beta_1 = 0.8977^{***}$ ,  $R^2 = 0.91$ .

### SA2.53 Regensburg

#### *Currency and volume conversion*

Currency system and silver equivalent of *Kreuzer* from Kruse (1771, 310–1), Witthöft (1993, 22) and Gerhard (2002, 213, 278). To convert local measures to litre equivalents, we apply 585.5 litre per *Regensburger Schaff* until August 1811; see Verdenhalven (1993, 49), for the same value see Chelius (1830, 323). From September 1811, we apply the rate given for *Bayerischer Scheffel* by Witthöft (1993, 76).

#### *Barley and oats (1786–1871)*

1786–1820: Data are transcriptions from the ledger of the official grain market by Nürnberger (2016). Calendar year prices are calculated as average of daily observations in *Gulden* and *Kreuzer* per local *Schaff* covering the entire calendar year with mostly one observation per month. For a few months missing observations were replaced with values from a very close day of a preceding or following month. E.g., the monthly value for April 1803 refers to March 30, 1803. The average for 1791 rests only on observations for January until May. Data for 1792–1802 are missing.

1821–1855: Calendar year prices in *Gulden* and *Kreuzer* per *Bayerischer Scheffel* from Seuffert (1857, 284–5).

1856–1868: Weekly prices in *Gulden* and *Kreuzer* per *Scheffel* of Bavaria from *Ansbacher Morgenblatt* 1856–1860 and *Königlich-Bayerisches Kreis-Amtsblatt der Oberpfalz und von Regensburg* 1861–1868. We aggregate data first to monthly averages, then from monthly averages to annual averages.

1869–1871: Monthly prices in *Gulden* and *Kreuzer* per *Scheffel* of Bavaria from *Zeitschrift des Königlich-Bayerischen Statistischen Bureaus* 1869–1871.

#### *Rye and wheat (1786–1871)*

1786–1814: As for barley and oats; see above.

1815–1830: Calendar year prices calculated as mean of monthly averages in *Gulden* and *Kreuzer* per *Bayerischer Scheffel* from Seuffert (1857, 161–4). Data from Nürnberger and Seuffert in 1815–1820 are consistent. On average, the difference between the rye prices given by the two sources during this period is only 0.28 percent.

1831–1871: See barley and oats.

### SA2.54 Rendsburg

#### *Currency and volume conversion*

During the later 17th century and until 1766, the currency regime of Holstein closely followed the one of Hamburg (Waschinski, 1959, I, 43–6). Hence, from 1669 to 1788 silver content of *Schilling* is taken from Hamburg. From 1776 the Danish government embarked on a monetary policy that departed from the earlier adherence to the *Lübische Mark* (Waschinski, 1959, I, 49–60). 9.25 *Speziestaler* of 1788 were to be minted from the Mark of Cologne (Waschinski, 1959, I, 49–50). One *Speziestaler* contained 60 *Schilling*. We adjust the intrinsic weight of *Schilling* from 1789. Deviation from the

value for Hamburg in this year is 0.8 percent. There was a strong devaluation of currency during the Napoleonic Wars, including default in 1813 Waschinski (1959, I, 53–4). This is not reflected in the silver content of *Schilling*. The intrinsic value of *Schilling* remained unchanged until the German-Danish War in 1864.

Waschinski (1959) provides prices per *Tonne* of 100 kilogram (kg). We converted kg to litre using the specific weights from Kopsidis (1996, 543) based on work published in the 1860s.

*Barley and wheat (1701–1734)*

Documentation of rye price applies.

*Rye (1701–1734, 1763–1853)*

1701–1734: Market prices (*marktgängige Preise*) in *Mark* and *Schilling* per *Tonne* of 100 kg from Waschinski (1959, II, 185–6). Comparison of short-run fluctuation with prices in Hamburg shows that these data are *Martini* prices, which is line with additional qualitative information in the source. Hence, calendar year prices were calculated applying the general extrapolation rule (eq. (S1)).

1763–1823: Data in local currency per *Tonne* of 100 kg from Waschinski (1959, II, 253–4) refer to prices obtained at auctions of St. Marien grain held at Candlemas (February 2). To investigate the nature of these prices in more detail, we calculated calendar year prices based on the assumption that the series consists of *Martini* prices. The correlation of short-run fluctuations (growth rates) with Hamburg and Lüneburg for the period 1788–1824 are worse with the *Martini* price assumption. In addition, the percentage difference of these February auction prices and the calendar year average prices based on monthly market prices in 1824–1833 (see below) is only -0.3%. Thus, we conclude that February prices are acceptable proxies for calendar year prices.

1824–1853: Based on monthly market prices from Waschinski (1959, II, 254–5).

## **SA2.55 Rostock**

*Currency and volume conversion (1771–1870)*

The authors of the compilation of grain prices that we use have converted prices in historical currency to currency prevailing at the time of publication, which was at par with the Prussian *Taler* (Grossherzogliches Statistisches Bureau, 1873, 4). Hence, intrinsic content of *Taler* as given for Berlin applies.

Litre equivalent of *Rostocker Scheffel* follows Grossherzogliches Statistisches Bureau (1873, 4).

*Barley, oats, rye and wheat (1771–1870)*

Grossherzogliches Statistisches Bureau (1873, 46–97) presents monthly prices in *Schilling* per *Rostocker Scheffel*. We aggregate this information to calendar year averages. Prices are missing from Mai 1813 to November 1814. Hence, no annual prices are computed for 1813 and 1814.

*Rye (1410–1530)*

Prices in grams of silver per litre from Pfister (2017, Supporting information S4). For the documentation, see Pfister (2017, Supporting information S1, p. 13); source is Hauschild (1973).

## SA2.56 Schweinfurt

### *Currency and volume conversion*

Local currency system following Enderlein (1862, 13); silver content of *Pfennig* is series developed for Würzburg by Metz (1990, 436–43). For years from 1764, implied intrinsic silver content of *Pfennig* derived from Enderlein is identical with the value given by Metz for Würzburg. Enderlein (1862, 13) also provides the ratio for converting local volume unit to the *Scheffel* prevailing in nineteenth-century Bavaria. Litre equivalent of latter from Witthöft (1993, 76).

### *Barley, oats, rye and wheat (1725–1782)*

Prices in local currency per *Malter* from Fabri (1794, 437–40). The nature of the data is not documented; we assume they refer to calendar year prices.

## SA2.57 Schwerin

### *Currency and volume conversion*

see Boizenburg.

### *Barley, oats, rye and wheat (1771–1870)*

Grossherzogliches Statistisches Bureau (1873, 46–97) presents monthly prices in *Schilling* per *Rostocker Scheffel*. We aggregate this information to calendar year averages. Annual values for 1813 are based on monthly data for January to April and December.

## SA2.58 Spandau

### *Currency and volume conversion*

Originally, Spandau had the right to mint its own coin, but from 1369 it belonged to the minting district of Berlin (Dilschmann, 1785, 85). Consequently, we use the intrinsic value of the *Reichstaler* for Berlin.

Although Dilschmann (1785) describes urban institutions in great detail, he does not mention a local measure. Hence, the conversion factor of *Scheffel* for Berlin is used.

### *Barley (1623–1783), rye (1622–1783) and wheat (1700–1783)*

Nominal price data from Dilschmann (1785, 92–4). The nature of the data is not documented. A comparison of short-term fluctuations of rye prices with prices from neighbouring Berlin shows that data are *Martini* prices. Hence, general extrapolation rule (S1) for the conversion of *Martini* prices is applied to obtain calendar year prices.

Data for oats are available but due to the missing extrapolation rule for oats they are not included in the analysis.

## SA2.59 Speyer

### *Currency and volume conversion*

Silver content of *Denar* or *Pfennig* based on Metz (1990, 433–5) (until 1799), Elsas (1940, 18) (1800–1820), Gerhard (1984, 623–4) and Gerhard (2002, 278). Conversion of volumes based on Witthöft (1993, 17, 458). We converted *Zentner* (assumed to be equivalent to 50 kilogram) to litre using the specific weights from Kopsidis (1996, 543) based on work published in the 1860s.

*Barley (1519–1871), oats (1530–1871), rye (1530–1871) and wheat (1572–1815, 1856–1871)*

1519–1820: Crop year prices (August to July) in *Denar* per *Malter* from Elsas (1940, 550–4). Calendar year prices were extrapolated using the general relationship in eq. (S2) (parameters in Table S7).

1821–1855: Calendar year prices in *Gulden* and *Kreuzer* per *Scheffel*, 100 litre (from 1826) and *Zentner* (from 1852) from Seuffert (1857, 323).

1856–1871: Monthly prices in *Gulden* and *Kreuzer* per *Zentner* from *Königlich-bayerisches Kreis-Amtsblatt der Pfalz* 1856–1868 and *Zeitschrift des Königlich-Bayerischen Statistischen Bureaus* 1869–1871.

## **SA2.60 Stettin**

*Currency and volume conversion*

Currency and volume conversion follows Berlin.

*Barley, oats and wheat (1740–1756, 1811–1871)*

Calendar year prices for 1740–1756 are aggregated from monthly prices in *Reichstaler* and *Gute Groschen* per *Scheffel* as reported by Naudé et al. (1910, 648–63). Original data are weekly prices published in the *Wochentlich Stettinischen Frage- und Anzeigungsnachrichten*.

1757–1810: gap.

Calendar year prices for 1811–1871 in *Guten Groschen* (until 1821; except 1818) or *Silbergroschen* (1818 and from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1811–1859 are from Geheimes Staatsarchiv Berlin (a); those for 1818, 1824 and 1860–1864 from Königlich Preussisches Statistisches Bureau (1867, 117, 121, 126, 130); and data for 1865–1871 from Königlich Preussisches Statistisches Bureau (1866–1872).

*Rye (1740–1756, 1765–1787, 1811–1871)*

Sources as for barley, oats and wheat; see above. In addition, Skalweit (1931, 66) reports the rye price in Berlin in *Reichstaler* and *Groschen* per *Scheffel* together with the difference of the rye price in several cities relative to Berlin in 1765–1787, among them Stettin. See notes on Frankfurt/Oder for a discussion of this source. We use this information to calculate the implied rye price in Stettin. For seven years in 1765–1777 the average difference between this series and values computed on the basis of monthly prices is only 0.7 percent.

## **SA2.61 Strasbourg**

*Currency and volume conversion*

Conversion according to Allen (2001, 439); original source is Hanauer (1876–1878, I: 496–8, II: 16).

*Barley, oats, rye (1313/15–1681) and wheat (1342–1681)*

Prices are from Allen (2010) (Strasbourg file; Allen, 2001, 439); original in *Francs* per hectolitre from Hanauer (1876–1878, II: 91–101). Hanauer presents prices both in historical currency and in Francs of 4.5 grams of silver. Conversion is based on an extensive study of local currency conditions (Hanauer, 1876–1878, I). From 1391, Hanauer's principal source is the ledger of the public grain market (*mercuriale*). Information on prices in earlier years and to fill gaps in data for the fifteenth century are from the account books of several ecclesiastical institutions.

Originally a free Imperial city, Strasbourg was taken by the French crown in 1681. Hence, we use data only until 1681.

### SA2.62 Trier

#### *Currency and volume conversion*

Currency conversion of *Albus* until 1796 as carried out by Irsigler (1988, 172–3); we use his prices in grams of silver. Volume conversion until 1796 follows Irsigler (1988, 190). Volume and currency conversion of data from 1816 follows Berlin.

#### *Barley, oats (1550–1871), rye (1567–1871) and wheat (1665–1871)*

Prices until 1796 in grams of silver per *Malter* from Irsigler (1988, 185–9). Spelt series (1550–1646) is not used because there is no overlap with wheat series so that extrapolation of missing values is impossible.

1797–1815: gap.

1816–1871: Calendar year prices in *Guten Groschen* (until 1821) or *Silbergroschen* (from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1816–1859 are from Geheimes Staatsarchiv Berlin (a); the gap in 1824 is closed with annual averages of monthly values from Geheimes Staatsarchiv Berlin (b). Data for 1860–1864 are annual averages of monthly values from *Preußischer Staatsanzeiger* (1860–1865); data for 1865–1871 are from Königlich Preussisches Statistisches Bureau (1866–1872).

### SA2.63 Überlingen

#### *Currency and volume conversion*

Currency conversion follows the series for Augsburg (Pfister, 2017) except for the values in 1757–1760, which were replaced by linear interpolation based on the values in 1756 and 1761. This is because nominal values suggest that quotes were made in good currency.

Volume conversion follows Göttmann (1991, 485).

#### *Barley (1723–1811), oats (1663–1811) and rye (1661–1811)*

Crop year prices (August to July) in *Gulden* per *Überlinger Malter* from Göttmann (1991, 478–9). Calendar year prices were obtained by extrapolation following eq. (S2) using the commodity-specific parameters in Table S7.

### SA2.64 Vreden

#### *Currency and volume conversion*

In local currency, one *Reichstaler* equalled 50 *Stüber* (Terhalle, 1981, 12). The intrinsic value of *Reichstaler* follows Münster. Data from 1819 are in Prussian currency; see entry for Berlin. Because Vreden was not under Prussian rule during the Napoleonic Wars, we do not correct for currency depreciation in Prussia prior to 1822. Transition from 24 *Gute Groschen* to 30 *Silbergroschen* per *Taler* took place only in 1823.

For data until 1818, volume conversion follows Terhalle (1981, 9), from 1819 Witthöft (1993, 26).

*Barley (1824–1871), rye (1657–1871) and wheat (1844–1871)*

Nominal *Martini* prices from Terhalle (1981, 41–77). Until 1818, prices are in *Stüber* per *Vredener Scheffel*, from 1819 in Prussian *Taler*, *Groschen* and *Pfennig* per *Berliner Scheffel*. Calendar year prices are extrapolated by applying the general extrapolation rule in equation (S1).

### **SA2.65 Wetzlar**

*Currency and volume conversion*

Currency and volume conversion follows Berlin.

*Barley, oats, rye and wheat (1784–1871)*

Calendar year prices 1784–1815 in *Reichstaler* per *Berliner Scheffel* from Kopsidis (1994, Appendix Table V.a/8). Calendar year prices 1816–1871 in *Guten Groschen* (until 1821) or *Silbergroschen* (from 1822) per *Berliner Scheffel* from Prussian sources. Data for 1816–1859 are from Geheimes Staatsarchiv Berlin (a); the gap in 1824 is closed with annual averages of monthly values from Geheimes Staatsarchiv Berlin (b). Data for 1860–1864 are annual averages of monthly values from *Preußischer Staatsanzeiger* (1860–1865); data for 1865–1871 are from Königlich Preussisches Statistisches Bureau (1866–1872).

### **SA2.66 Wismar**

*Currency and volume conversion*

see Boizenburg.

*Barley, oats, rye and wheat (1771–1870)*

Grossherzogliches Statistisches Bureau (1873, 46–97) presents monthly prices in *Schilling* per *Rostocker Scheffel*. We aggregate this information to calendar year averages. Missing values in 1771 are replaced with information for annual average prices (Grossherzogliches Statistisches Bureau, 1873, 26–9).

### **SA2.67 Wittenberg**

*Currency and volume conversion*

Currency conversion follows Leipzig; volume converted according to Witthöft (1993, 513).

*Barley, oats, rye (1630–1764) and wheat (1656–1764)*

Source is Anonymous (1765). The publication has no text; there is no information on the original source and on the procedure followed in constructing annual averages. The comparison with neighbouring markets (Berlin, Dresden, Halle, Leipzig and Magdeburg) suggests that values refer to calendar years.

For barley, the source lists two series indicating different qualities. One series is called ‘small barley’ and the other one ‘big barley’. We use the average of both series. In years for which only one value is available, we use the latter corrected for the average percentage difference to the average of both series (about 5.5%).



## SA2.68 Würzburg

### *Currency and volume conversion*

Prices from Elsas (1936) and Christoforatu (2010) until 1799 are in *Rechengeld* (money of account). For the conversion we applied 168 *Denar* per *Fränkischer Gulden* (cf. discussion by Metz, 1990, 167–68, 309). *Denar* (or *Pfennig*) are converted to grams of silver following Metz (1990, 436–43).

Currency conversion of prices in 1815–1857 applies the silver equivalent of *Denar* developed for Munich; see entry for Munich. One *Gulden* equals 240 *Denar*. For the silver equivalent of Bavarian currency from 1858, see Gerhard (2002, 278).

Conversion of volumes until 1799 based on Elsas (1936, 157) (cf. Christoforatu, 2010, 294 and Verdenhalven, 1993, 30 for very similar rates). Following Elsas, a different volume applies to oats. Bavarian *Scheffel* (data for 1815–1855) converted according to Witthöft (1993, 76).

### *Barley (1816–1871)*

1816–1855: Calendar year prices in *Gulden* and *Kreuzer* per *Scheffel* from Seuffert (1857, 284).

1856–1868: Weekly prices in *Gulden* and *Kreuzer* per *Scheffel* of Bavaria from *Ansbacher Morgenblatt* 1856–1860 and *Würzburger Stadt- und Landbote* 1861–1868. We aggregate data first to monthly averages, then from monthly averages to annual averages.

1869–1871: Monthly prices in *Gulden* and *Kreuzer* per *Scheffel* of Bavaria from *Zeitschrift des Königlich-Bayerischen Statistischen Bureaus* 1869–1871.

### *Oats (1464–1871)*

Crop year prices (August to July) 1462–1799 in *Denar* per *Malter* from Elsas (1936, 634–40). Conversion to calendar year prices applies eq. (S2) using the parameters from Table S7.

1800–1814: gap.

1815–1871: See barley.

### *Rye (1481–1871) and wheat (1502–1871)*

1490–1655: Crop year prices (August to July) 1463/1500–1799 in *Denar* per *Malter* from Elsas (1936, 634–40). Calendar year prices for the period until 1655 are obtained by applying the local time series relationship for rye and wheat in Table S9 (Elsas' prices). The relationship rests on calendar year averages based on monthly data from Christoforatu (2010) (see below).

1656–1777: Prices for rye and wheat rely on arithmetic averages of monthly data in *Fränkischer Gulden* per *Malter* from Christoforatu (2010, 262–93). The gap in 1685–1700 is filled by extrapolation based on crop year prices from Elsas as above.

1778–1799: Calendar year prices extrapolated from crop year prices from Elsas as above.

1800–1814: gap.

1815–1871: See barley.

## SA2.69 Xanten

### *Currency and volume conversion*

Basic currency system: 1 *Taler* = 26 *solidi*. 1 *solidus* (= *Schilling*) = 12 *Pfennig* (= *denar*) (Beissel, 1889, 75, 91). Intrinsic silver content for *Schilling* from Metz (1990, 416–9). At the beginning, rates of intrinsic content are given for partly overlapping periods; the more recent rate is chosen. In case of gaps the earlier value was continued until a new value is recorded. From 1771 the value of Abel

(1978, 302; cited by Metz, 1990, 419–20, 425) is recorded. This is consistent with contemporary devaluation in Aachen and the intrinsic value of *solidus* in ca. 1827 given by Beissel (1889, 100).

Until about 1510 prices are given either in *albus*, *solidus* or a multitude of other coins, the latter becoming frequent from 1436. Main groups of other coins have been converted to silver equivalents using the exchange rates to *Schilling* given by Beissel (1889, 75–100). These include *Stüwer/Stuwer*, *flems.* (=0.8 *Stüwer*), *albus* of Köln (see Köln for silver content), *Krummstert*, *flor. ren. curr.* (unambiguous rates only from 1480s), *flor. horn.*

From 1511–1585 prices are in *Albus*. Silver content is assessed using the rate of *Albus* per *denar* from Beissel (1889, 83–4). A value given for a particular year or period is continued until a new value is recorded. From 1586 values are in *Taler*; from 1826 Prussian currency in *Graumannscher Fuß*; see Berlin.

Volume conversion until 1799 follows Beissel (1889, 448); from 1800 as for Berlin: 1 *Berliner Malter* = 4 *Berliner Scheffel* (Beissel, 1889, 116).

Prices from Kopsidis (1994) are converted as for Berlin.

#### *Barley, rye and wheat (1371–1819)*

Until 1799 nominal prices from Beissel (1889, 118–33) refer to Xanten; from then on to Goch, a small town about 25 km west of Xanten. We do *not* extend data from Xanten with Goch (as Beussel did) but with data from Kopsidis (1994) that still relate to Xanten until 1819. The reason is that the fit of prices for Xanten and Goch is relatively weak. The correlations of rye prices from Beussel (until 1799 Xanten; from 1800 Goch) and rye from Kopsidis (Xanten) for different periods are: 0.9584 (1784–1799), 0.5696 (1800–1819).

Data from Beissel until 1799 are prices set by ecclesiastical authorities based on observed market prices during the winter period (Beissel, 1889, 114–16). Hence, data are not calendar year prices but comparable to *Martini* prices due to the time period and the strong influence of the last harvest outcome. Hence, general extrapolation rule (S1) for the conversion of *Martini* prices is applied to obtain calendar year prices.

Until 1549 prices are in diverse local currency per *Xantener Stiftsmalter*; 1550–1585 in *Albus* per *Xantener Stadtmalter*; 1586–1799 in local *Taler* per *Xantener Stadtmalter* (rye and barley 1550–1799 from Jacks (2016; checked with Beissel).

Prices for 1800–1819 from Kopsidis (1994, table Va/6) (accessed through GESIS Köln, 2015a) are in *Reichstaler* per *Berliner Scheffel*. Due to the strong correlation with data from Beissel until 1799, we treat these data as *Martini* prices.

Data for oats are available but not used, because there is no robust extrapolation rule for oats.

## **SA2.70 Zwickau**

### *Currency and volume conversion*

Currency conversion applies the silver content of the *Pfennig* series developed for Leipzig; see entry for Leipzig. Volume is converted using the rate for Dresden; see Witthöft (1993, 141).

### *Rye and wheat (1764–1824)*

Calendar year averages based on monthly data from Uebele et al. (2013); original source is the weekly *Intelligenzblatt* of Leipzig (Uebele et al., 2013, 3). Nominal prices are in *Taler* per *Dresdener Scheffel*. Data for 1806 are missing.

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