The Bread of Toledo:
Prices, Political Economy, and Living Standards, 1535-1800*

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Abstract

We study the market for common white bread in the city of Toledo. We assemble a new 266-year-long series of bread prices, obtained from the cash purchases and wholesale bread-for-wheat contracts of two large institutions. Combining our data with existing bread price series, wheat prices, agricultural yield data, we find that Castilian bread markets displayed a remarkable degree of integration over a broad region, and argue that urban supply management systems were effective at smoothing the high volatility of harvest yields. We demonstrate that existing bread prices for Madrid, commonly used in international comparisons of living standards, are not representative of the broader Castilian context. Since bread accounts for about 1/3 of family budgets, our results suggests that current estimates of pre-1750 Castilian living standards are too low; at the same time, the decline in Spanish welfare ratios in the second half of the eighteenth century was likely steeper than thought so far.

JEL classification: N34, N54, Q11

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I. Introduction

Accounting for roughly half of calories consumed and one-third of family budgets, bread is an inescapable element of any analysis of nutrition and living standards in early modern Europe. The supply of bread was likewise a main focus of urban policies, occasionally spilling onto the national scene when harvest failures sparked subsistence riots. Bread markets were never unshackled; layers of politicians, bureaucrats, and officers interacted on a variety of levels with farmers, porters, millers, merchants, bakers, and consumers. As the miller and the baker tended to their own interest, the institutions that governed supply wielded edicts, prerogatives, and enforcement actions to try to keep as many people as possible on the right side of the line that separated subsistence from hunger. Bread markets and their regulatory frameworks underpinned the fortunes of cities, enabling their growth or sentencing them to stagnation and decline. Yet, while wheat markets have been studied extensively across early modern Europe, direct observation and analysis of bread markets is much less frequent, owing to both scarcer and more complex sources. This is particularly true for Spain, where the existing quantitative evidence before 1800 is quite fragmentary.

We study the market for common bread in Toledo, a city whose rise and decline between the sixteenth and the nineteenth centuries paralleled those of Imperial Spain. Our central contribution is a new series of bread prices between 1535 and 1800, featuring two key advantages. First, it spans the longest unbroken period for any such data in the Spanish context, reaching from the beginning of the early modern era to the eve of the Napoleonic conquests, which fundamentally altered supply and fiscal regimes. Second, and most importantly, the underlying transactions positively identify the quality of bread in question. All our observations correspond to common white bread baked from *trechel* summer wheat (*T. aestivus*), called *pan*

de Toledo. It sat between the premium *candeal* bread and the brown bread consumed by the very poor in terms of quality; city regulations refer almost exclusively to it when specifying weights and sale prices; and enforcement actions likewise focus on this particular type of bread.[1] The institutions that generated the records we exploit served it to their rank and file workers and used it to pay the in-kind portions of their salaries. *Pan de Toledo* was the main staple in the diets of most city dwellers, and hence a central commodity of interest when studying living standards, especially from a "respectability" perspective (Allen 2013).

We extract bread prices from two different transaction types: direct cash purchases in the city's bakeries, and large bread-for-wheat contracts. For a short period, we also observe the entire production accounts and cost structure of a bread oven. The overlap between these types of transactions allows us to internally validate our price quotations. To establish external validity, we compare them with shorter series from other towns across south-central Castile. The tight correspondence between our price series and those from Extremadura, Guadalajara, and Murcia point to a well integrated regional market, while providing an additional layer of confidence in our data.

The bread-for-wheat transaction data reveal a large break in the cost structure of bakers in 1619, likely tied to the introduction of a requirement to supply nearby Madrid with a quota of grain or bread. Features like these highlight the importance of incorporating the fiscal and regulatory environment into any analysis, and caution against estimating bread prices as a function of inputs alone. In particular, our bread prices in Toledo between 1535 and 1618 are

[1] Montemayor (1995, 169–70) also notes that *trechel* is by far the most cited wheat variety in Toeldan documentation. Out of 84 enforcement actions related to bread carried out between September and December 1600 by the *fieles ejecutores* (city officials in charge of enforcing weights and measures), 75 were for violations to the weight or pricing of *pan de Toledo*. AMT, Caja 1152, 1600.

around 30% lower than those estimated by Allen (2001), suggesting that the gap in welfare ratios between Castile and other European locales may be substantially overstated for this period.

Wheat and bread markets were heavily regulated throughout early modern Europe. Castilian cities intervened in wheat markets through their public storehouses called *pósitos* or *alhóndigas*. A large number of these were founded in the late fifteenth and early sixteenth century, and were given the key power to acquire grain at a nationally regulated price (*tasa*).[2] *Pósitos* bought wheat during harvest season from as far as necessary, selling it throughout the year at prices set with the ostensible goal of smoothing the very high volatility characteristic of early modern grain markets. At the same time, bread prices were set by city authorities through acts called *posturas*, which largely followed rules based on the fluctuation of wheat prices.[3] The literature casts doubt on the actual effectiveness of storehouses in reducing the volatility of wheat and bread prices, a process our data allow us to quantify. We find that wheat price dynamics were consistent with a one-year storage cycle, and that the volatility in wheat prices was substantially lower than that in farm yields as a result. We also find that bread prices closely tracked the behavior of wheat ones, confirming that intervention efforts were focused on grain rather than on bread markets. The short-lived operation of a bread oven by Tavera's hospital, one of our source institutions, further validates these findings. While turning to in-house production in principle allowed the hospital to avoid the implicit fiscal burden associated with procuring bread through the market, not having access to wheat from the public storehouse meant its overall cost was often much higher than that of commercial bakeries.

[2] On the origin and operation of *pósitos*, see Castro (1987, 96–107).
[3] López Losa and Piquero Zaráuz (2018, 19); De Vries (2019, 26).

Comparative analyses of living standards typically use Madrid as a reference point for Spain. Madrid, however, is an anomalous case. Unable to feed itself relying on its surrounding countryside alone, it wielded a royal prerogative to force cities within a given radius to contribute specified quotas of bread and wheat, while operating an intricate network of agents and storehouses to import grain from even further afield.[4] As a result the relationship between prices in Madrid and those in the rest of Castile was variable and non-monotonic. We show how Madrid's bread prices were about 30% more expensive than Toledo's for at least the hundred years between 1650 and 1750. When constructing measures intended to be representative of a broad swath of Castile for this period, using Madrid bread prices will result in a noticeable underestimation of living standards.

Our final exercise is to quantify the affordability of bread for the working classes. Using a newly assembled series of construction wages from Toledo, we show how, between 1535 and 1750, the amount of bread in a respectability basket for a typical family of four could be purchased with, on average, 45% of the annual earnings of an adult male laborer. That is, even before considering the income from female labor, which was common and relatively well-remunerated, the respectability amount of standard quality bread would have been within reach for most families in all but the bleakest years. Such relative abundance broke down after 1750, when a secular deterioration in real wages eventually more than doubled the share of earnings needed to purchase the respectability amount of bread, likely pushing it out of reach for the working classes.

With this study we contribute to the large literature on wheat and bread markets and their associated regulatory structures in the early modern period, of which de Vries (2019) is the most

[4] Bernardos Sanz (2003) is a thorough study on the supply networks to the north of Madrid.

recent comprehensive work. Strictly on the Spanish side, our work builds on Castro (1987), Bernardos Sanz (1997; 2003; 2008), and Andrés Ucendo and Lanza García (2012), among others. Our data and results also contribute to the literature on comparative living standards pioneered by Allen (2001); we show that the bread prices used in this literature are too high, and not representative of the broader Castilian environment.[5] Relatedly, our results also add to the debate on the timing of the Little Divergence, supporting López Losa and Piquero Zaráuz's (2020) finding that Spanish living standard trends did not begin to systematically diverge from the Northern European pattern until 1750 at the earliest.

II. Data and series construction

Our main data consist of bread purchase transactions from the Hospital of San Juan Bautista in Toledo, better known as Tavera's Hospital, which started operations in 1553. We consulted every surviving book of the *botillería*, the hospital's purchasing department.[6] We also combed through several large binders and boxes of uncatalogued documents, recording the information contained in payment orders and bread purchasing contracts.[7] To extend our series backwards to 1535-1546 we also consulted the records of the Hospital del Nuncio, an asylum for the mentally ill operated by the Cathedral Chapter of Toledo.[8]

In each year of its existence, Tavera's hospital procured bread in one or more of three distinct ways. Between 1554 and 1650, it entered into wheat-for-bread contracts with local bakeries. The observations from Hospital del Nuncio also follow this modality. Starting in 1651,

[5] López Losa and Piquero Zaráuz (2020) also argue that the white bread prices used by the comparative literature are too high. Their reasoning is that the working classes would have consumed mostly brown bread. While neither official, regulatory, or institutional sources in Toledo make any mention of brown bread, we show that even a basket containing exclusively common white bread would be substantially cheaper than assumed in the literature.
[6] HSJB, Botillería, various years.
[7] HSJB, Vitrina XVI, Libramientos y Diversos, various years.
[8] ABCT, Obra y Fábrica, Hospital del Nuncio, 1535-1546.

Tavera's hospital increasingly purchased bread in exchange for cash, while also continuing to use wheat-for bread contracts on most years. And, at least between 1664 and 1667, it operated its own bread oven.

One important feature of our data is the positive identification of the quality of the bread being consumed. All contracts and purchases from which we collect data are for *pan de Toledo*, the name given to common white bread baked from flour milled from soft *trechel* summer wheat. Purchases of higher quality *candeal* bread, obtained from hard *durum* wheat, were specifically indicated as such. *Candeal* bread was only occasionally served to the higher authorities of Tavera's hospital, and its purchases were too irregular to allow for the construction of a consistent price series. The hospital never purchased the lower quality brown bread (variously designated in New Castile as *pan de pueblo* or *pan de cabezuela*), which was made with lower quality flour containing a large proportion of bran, and of which there is little evidence of widespread consumption in the Toledo area.[9] Similarly, there is no evidence of rye being used in the production of bread, a practice that in Spain was only common in some Northern regions. *Pan de Toledo* was clearly the most widely consumed bread within the city of Toledo itself.

Bread-for-wheat contracts

Many of the income streams and obligations of large early modern institutions were denominated in kind. Tavera's hospital paid salaries in all of wheat, barley, wood, coal, bread, wine, and mutton, in addition to cash. Bread was also central in the food rations served in the refectory. On the flip side, a large portion of the hospital's endowment consisted of wheat and

[9] As further evidence that the composition of *pan the Toledo* was solely white flour, in section IV we show how the hospital's bakery sold the milling by-products of bran and *acemite*, a mix of bran and lower quality flour, for extra income, and never used them to bake bread. For a discussion of the different types of bread sold in early modern Castile see López Losa and Piquero Zarauz (2020, 74).

barley rents, which were also collected in kind. The size of these operations was considerable. As early as 1568, the hospital procured over 62,000 pounds of bread to cover its needs, and still averaged an annual consumption of 45,000 pounds per year at the end of the eighteenth century.

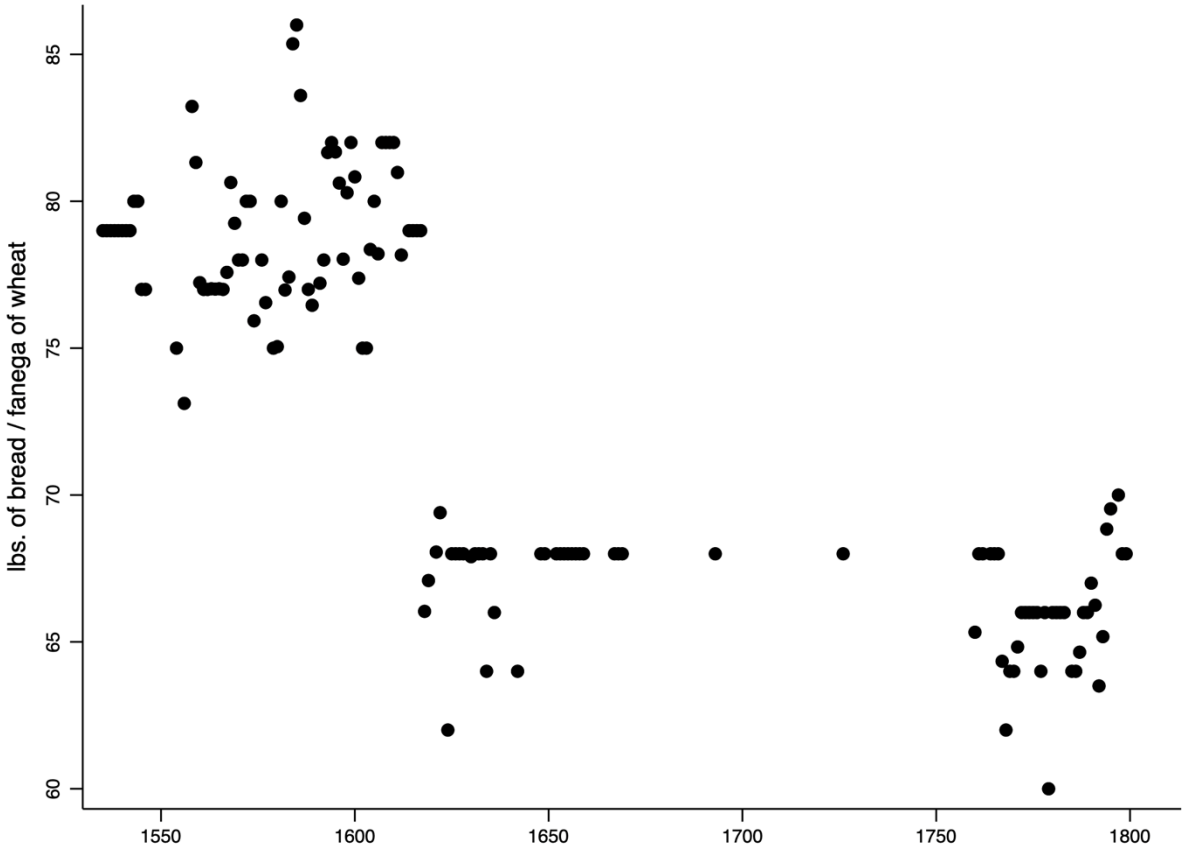
Institutions like Tavera's hospital faced a "currency" matching problem. They had to discharge as many obligations as possible using the same goods they collected their rents in before converting the rest into other goods or cash. Bread-for-wheat transactions were a key instrument in addressing this need. From a financial efficiency perspective, Tavera could use some of its surplus wheat rents to directly procure the bread needed to operate its refectory and pay the bread component of salaries in a single transaction, rather than having to first sell the wheat for cash and then buy the bread. Because wheat is the main input in the production of bread there was no double-coincidence problem, and bakeries were happy to accept it as payment.

The typical bread-for-wheat transaction was straightforward: the hospital handed over a certain number of *fanegas* of wheat, and received a specified amount of bread (usually expressed as a number of standardized two-pound loaves) in exchange.[10] Dividing the number of pounds of bread received by the number of fanegas delivered, we obtain the bread-wheat ratio implied in each transaction.[11]The bread-wheat ratio bakers negotiated with their large customers had to cover all the costs associated with the bread-making process, including the milling, sifting, kneading, baking, and delivery of the final product (though the bakers could recover some money by selling the milling by-products). It also had to allow for the baker's profit, and cover

[10] The *fanega* was a measure of capacity. A *fanega* of wheat weighted 44.1225 kilograms. The Castilian pound was equivalent to 0.460 kg, almost identical to the English pound.
[11] Our data consist of the average bread-wheat ratio in all surviving transactions in a given year, weighted by the quantity of bread in each transaction.

any fiscal obligations. As a result, the bread-wheat ratio was always lower than the total amount of bread that could be baked with the wheat delivered (a magnitude known as the "extraction rate"). A *fanega* of wheat could yield between 85 and 90 pounds of common bread, with a test conducted in Madrid in 1767 pegging it at 87.13 pounds.[12] The bread-wheat ratio in Toledo averaged 79 pounds per *fanega* up to 1618, falling to an average of 68 pounds per *fanega* thereafter. Figure 1 plots the bread-wheat ratio for the 122 distinct years in which we observed bread-for-wheat contracts.

Figure 1: Bread-wheat ratio



Source: 1535-38: ABCT, Obra y Fábrica, Hospital del Nuncio;1539-46: ABCT, Obra y Fábrica, Catedral; 1554-1800: HSJB, Botillería and HSJB, Vitrina XVI, Libramientos.

[12] López Losa and Piquero Zarauz (2020, 74).

The year 1619 marks an obvious break in the behavior of the bread-wheat ratio. The early average of 79 pounds of bread per *fanega* of wheat implied that bakeries retained about 9% of the wheat they received to cover their costs and profit. In 1619 the retained percentage jumps to 22%, and remains stable through the next two centuries. Such a sharp and persistent change points to an institutional cause, rather than to natural fluctuations in non-wheat costs or profits. Neither the literature nor the minutes of Toledo's city hall offer an explicit reason for such a jump. In searching for its origins, we consider three candidate events that happened in close temporal proximity to this break. First, in 1617 the Crown resumed coining large amounts of copper money in order to fund the 30 Years' War. The cities' vociferous protestations in the Cortes resulted in a compromise: in exchange for a new contribution of 18 million ducats over ten years, the king would refrain from issuing copper coinage for the next 20 years (a promise he would not keep). Toledo cast the decisive vote, and was rewarded with a royal confirmation of its right to charge levies on essential products.[13] Some of these could have been applied to the bread production chain, resulting in bakeries retaining more wheat to cover their fiscal obligations.[14] Second, also in 1619, a royal edict lifted the legal price ceiling on wheat –the *tasa*– when sold directly by farmers. Because it was easy to find a farmer to serve as a stand-in in any transaction, this effectively removed most price controls on wheat.[15] While such a policy could well have resulted in an increase in the price of wheat, and hence in the price of bread, wheat prices remained stable.[16] It is also hard to see why a wheat price liberalization should have resulted in higher salaries for bakers or profit margins for bakeries. The final potential culprit is the *pan de*

[13] The negotiation in the Cortes is described in Santiago Fernández (2000, 80). The role of Toledo in casting the decisive vote and obtaining new privileges is documented by Rodríguez de Gracia (1996, 74).
[14] While bread itself was not directly taxed at the point of sale, there were indirect taxes on the transport of wheat and on fuel, as well as levies on wheat and bread brought in from outside the city (Rodríguez de Gracia 1996, 71).
[15] See Andrés Ucendo and Lanza García (2012, 76–78).
[16] Our wheat series show an average wheat price of 570 mrs. per fanega between 1617 and 1626, with no break in 1619. The analysis in García Sanz (1991, xxxviii) coincides with our observations.

registro, the obligation of towns within a certain radius of Madrid to supply the capital with a set quantity of bread, first introduced in 1584. A major expansion in 1598 saw a large number of towns under Toledo's jurisdiction progressively included in the quota; by 1630, the radius had reached 20 leagues –111 kilometres– from Madrid, a full 36 kilometres beyond Toledo. While the city of Toledo itself was exempt from a *pan de registro* quota, the neighboring villages from which it sourced a large proportion of its bread bore its full brunt. Bakeries were responsible for providing the requisite bread, or an equivalent amount of wheat, to be transported to Madrid.[17] In order to meet their obligations, they raised the price charged to retail customers, and increased the proportion of wheat retained in bread-for-wheat contracts. In section III we provide further evidence in favor of this latter explanation.

Cash purchases

Starting in 1651 (after a lone instance in 1632), the records of Tavera's hospital contain an increasing number of cash purchases of bread. These were contracted with a variety of bakers in the city of Toledo, its suburbs, and neighboring towns. Bargas, a village some 14 km away, was a major source of bread for both the hospital and the city at large. The prices are typically reported as a quantity of maravedis per standardized two-pound loaf. In total, we collect cash purchase data for 70 distinct years, 21 of which also feature bread-for-wheat transactions.

Cash purchases of bread could not exceed the price regulated by the city council in its *posturas*. Such prices often followed a mechanistic formula based on the price of wheat, though it was not rare for them to deviate from it if bread became scarce. While the books containing the minutes of the public commission tasked with setting prices have not survived, the few

[17] For discussions of *pan de registro*, its timeline, and its mode of implementation see Bernardos Sanz (1997, 72–74; 2003, 57–66; 2008, 544), Andrés Ucendo and Lanza García (2012, 69–70).

references to *posturas* we have found in the minutes of the city council broadly agree with the cash prices paid by Tavera. Observance of these prices was enforced by city officials called *fieles ejecutores*, and fines were routinely imposed on noncompliant bakeries.[18] The operation of this system strongly suggests that the cash prices we record are very close, if not identical, to those that common citizens would have paid for their bread in city bakeries.

Bread price estimates

Since we only observe cash purchases of bread in 70 out of the 266 years in our period, we must rely on the bread-wheat ratio to estimate the cost of bread in the remaining years. We compute a baseline estimate as

$$p_{bread} = \frac{p_{wheat}}{BWR} \quad (1)$$

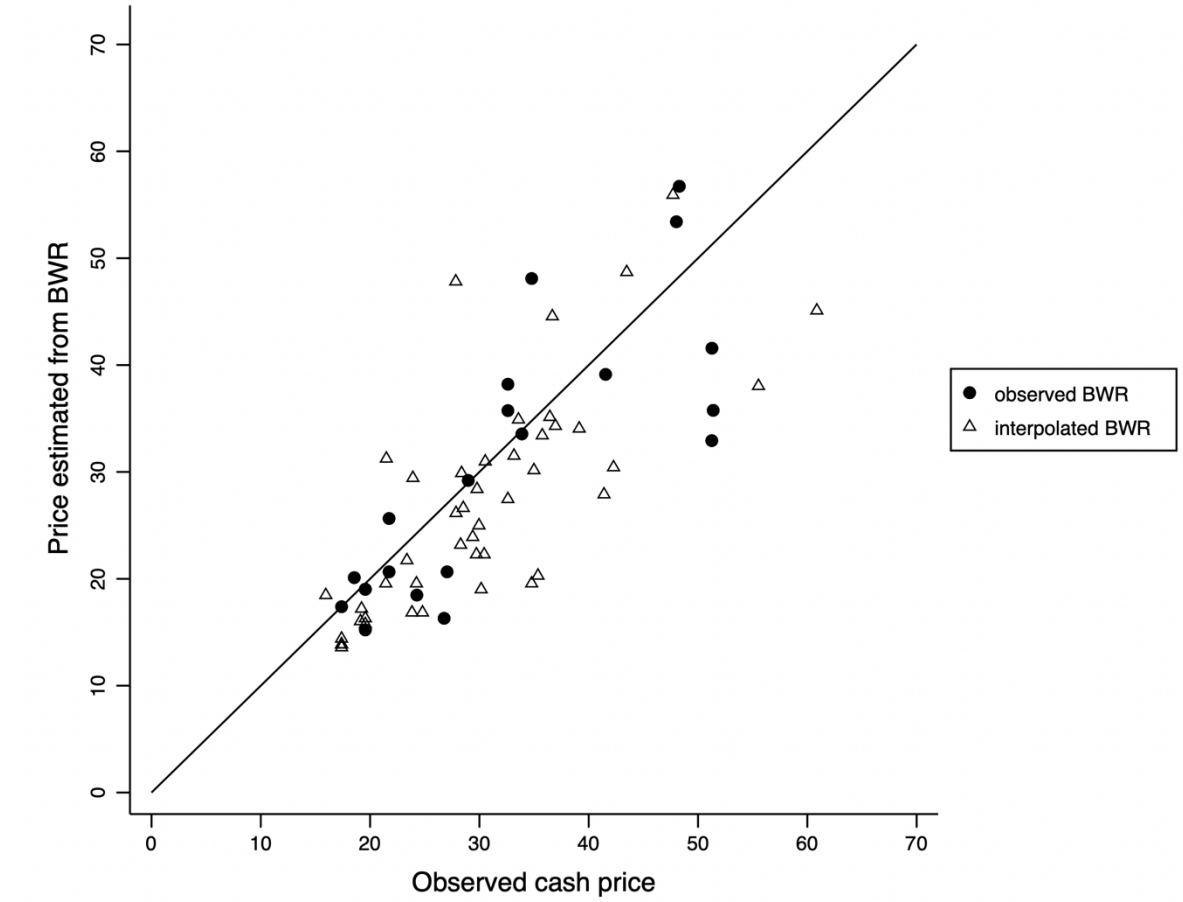
where p_{bread} is the price of a pound of bread, p_{wheat} is the price of a *fanega* of wheat, and BWR denotes the number of pounds of bread delivered by the baker for each *fanega* of wheat received, as stipulated in the supply contracts. For the 74 years in which we do not observe either a cash or a bread-for-wheat contract, but for which we do have a wheat price, we use an interpolated value for the bread-wheat ratio and apply the above formula as well. As illustrated in Figure 1, these are mostly short stretches, except for a long gap between 1727 and 1759. The latter was bookended by periods in which a ratio of 68 pounds per fanega prevailed for several years, so inputting the same value seems reasonable.

[18] Combing through the minutes of 1660, for example, we found a *postura* setting the price of bread at 16 maravedis per pound, exactly matching the cash price Tavera's hospital paid that year. AMT, Acuerdos, 30 de julio de 1660, Sesión Ordinaria. Records of fines imposed from 1512 on are available in AMT, Cajas 1151 and 1152, Condenaciones de Pan Cocido.

Calculating the baseline estimates in equation (1) requires a wheat price series. We collect wheat purchase and sale prices from Tavera's *botillería* books and from the Cathedral Chapter records for 69 distinct years. To complete the remaining observations we use Hamilton's (1934) New Castile data until 1650; for the 1651-1800 period we use Lopez Losa's (2013) reconstruction of Hamilton's (1947) prices. The result is an almost continuous series, with just 9 missing observations.

How accurate is our use of the bread-wheat ratio to estimate bread prices? In 67 distinct years we observe both a cash price and either observe or interpolate a bread-wheat ratio. Figure 2 plots the relationship between cash prices and BWR-based estimates for those years, indicating whether the BWR was observed in an actual contract or interpolated.

Figure 2: Observed vs. estimated bread prices (mrs. / kg.)



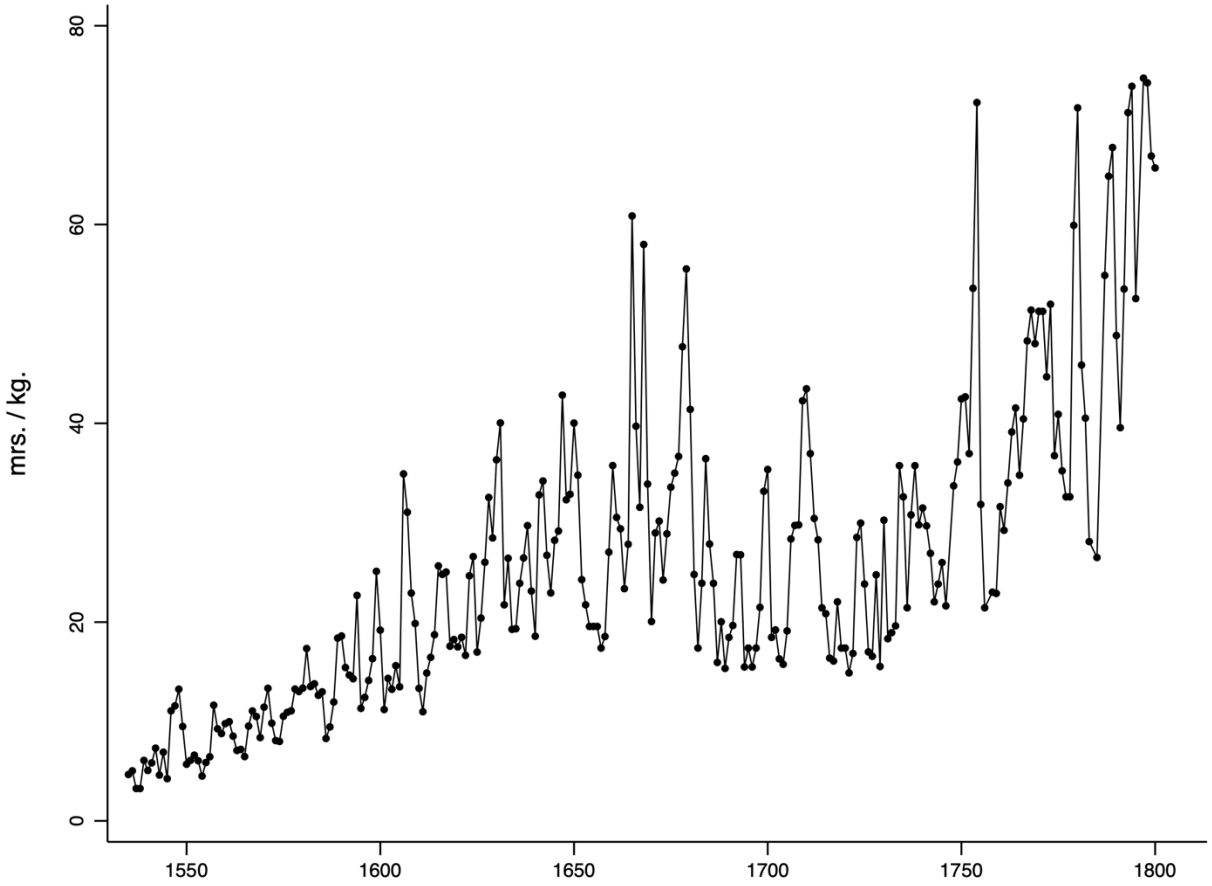
Source: see the text.

If our estimates based on the BWR were a true reflection of cash prices, we would expect the plotted observations to fall along the 45-degree line. The chart shows that cash prices tended to be higher than those implied by the BWR. On average, in years in which Tavera's hospital used both cash and bread-for-wheat contracts, it paid 4.3% more when relying on the former than on the latter. In years in which it only bought bread in cash (and hence we had to rely on an interpolated bread-wheat ratio), it paid 9% more on average than if it had entered into a bread-for-wheat contract. The likely reason for the higher cash prices is that, in order to fulfill those transactions, bakers had to purchase wheat on the open market and have it delivered to be milled, incurring transaction and transportation costs in the process. In a wheat-for-bread contract, the

buyer was responsible for sourcing the wheat and delivering it to the mill, as attested by the multiple payments for carting wheat in Tavera's records. The baker could hence offer a better (implied) price in bread-for-wheat contracts than in a cash sale.

Our goal is to build a series that reflects the price of bread paid by a consumer, to which Tavera's cash purchases provide a reasonable approximation. In the 70 years for which they are available, we use them as recorded in the account books and payment orders to compute an annual weighted average price. When only bread-for-wheat contracts are available, we augment their implied prices by the average differences with cash prices reported above. That is, in the years in which we only observe a bread-wheat ratio, we augment the price implied by it by 4.3%; if only an interpolated ratio is available, we augment its implied price by 9%. This augmentation procedure biases our estimates against finding relatively low bread prices, on which some of the conclusions of this paper rest. Our data file reports both the baseline estimate and the augmented series, which we label our main estimate and use for all our remaining exercises. In order to standardize measures and facilitate comparisons, we also convert all bread and wheat quantities to kilograms from this point forward.

Figure 3: Bread price, main estimate



Source: see the text.

Figure 3 plots our main series of nominal bread prices in Toledo between 1535 and 1800. The effects of the price revolution between 1550 and 1650 are readily apparent, as is the inflation of the second half of the eighteenth century. The volatility of the series is standard for pre-modern agricultural prices throughout Europe, following directly from the high variability in harvest yields and the relatively low integration of wheat markets across long distances.[19]

[19] Dobado-González et al. (2012) show that international wheat markets started to become integrated in the late 18th century, but that central Castile lagged behind in this process. Montemayor (1995, 66–67) illustrates how Toledo was effectively cut off from international weak markets the seventeenth century. The city attempted to import *trigo de la mar* (literally "wheat from the sea") through the port of Cartagena in 1605. The wheat was purchased, but owing to the exceedingly high cost of overland transport it ended up being resold in Murcia.

III. Comparison with existing series

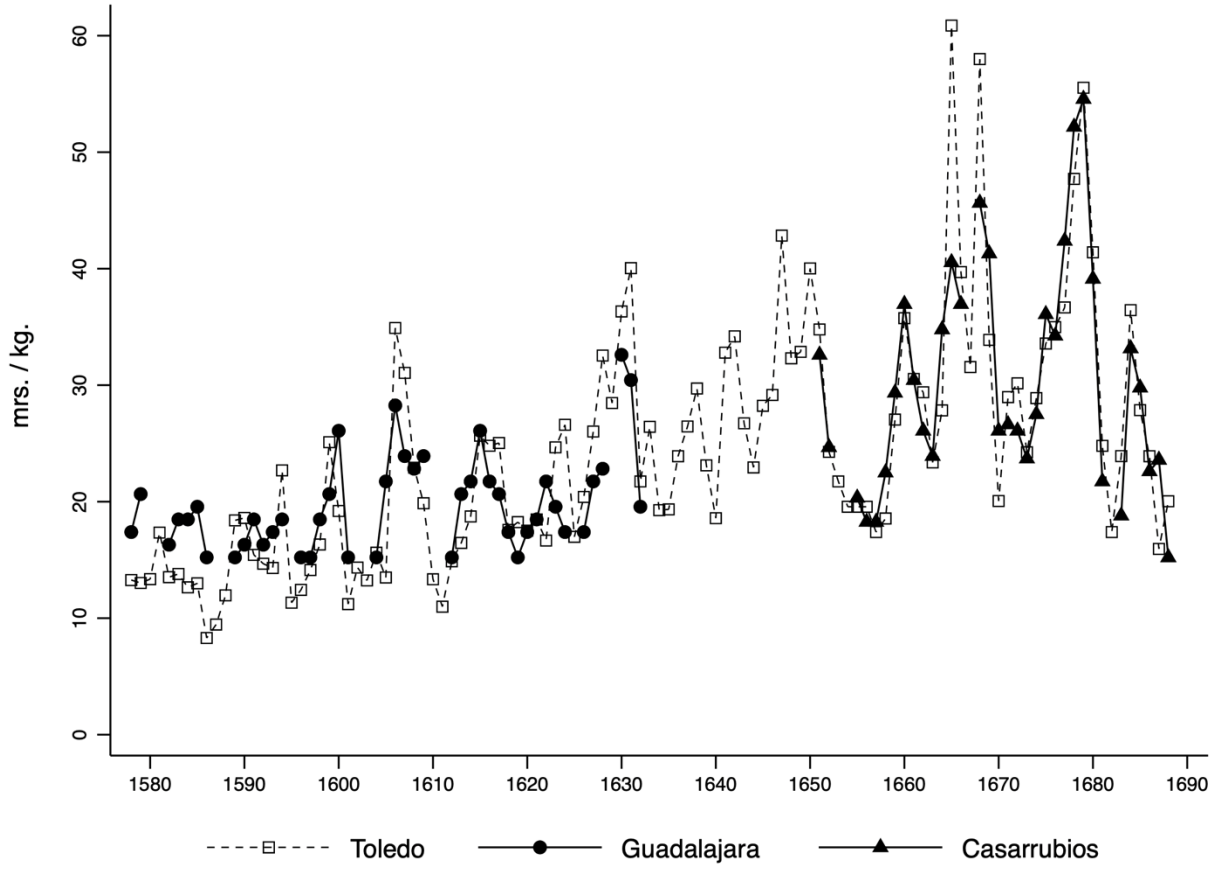
a. New Castilian markets

We now place our price series in context and test its validity by comparing it to five other known data sources from central and southern Castile spanning portions of our period of analysis. Some of these sources report regulated bread prices, while others, including our own series, consist of transaction data.

We begin with the two sources closest to Toledo. Hamilton (1947) compiled bread prices from 1651 to 1688 using data from the purchasing records of the Monastery of the Holy Cross in Casarrubios del Monte, a town some 45 km from both Toledo and Madrid.[20] Mejía Asensio (2003) collected a series of regulated prices for Guadalajara, located 55 km from Madrid (in the opposite direction from Toledo), between 1578 and 1632. Just as Toledo, both towns suffered from the centripetal force exerted by Madrid, and were likewise affected by the obligation to contribute a quota under the *pan de registro* system.

[20] The identification of Hamilton's bread prices as proceeding from Casarrubios is due to López Losa (2013).

Figure 4: Bread prices in Toledo, Guadalajara, and Casarrubios

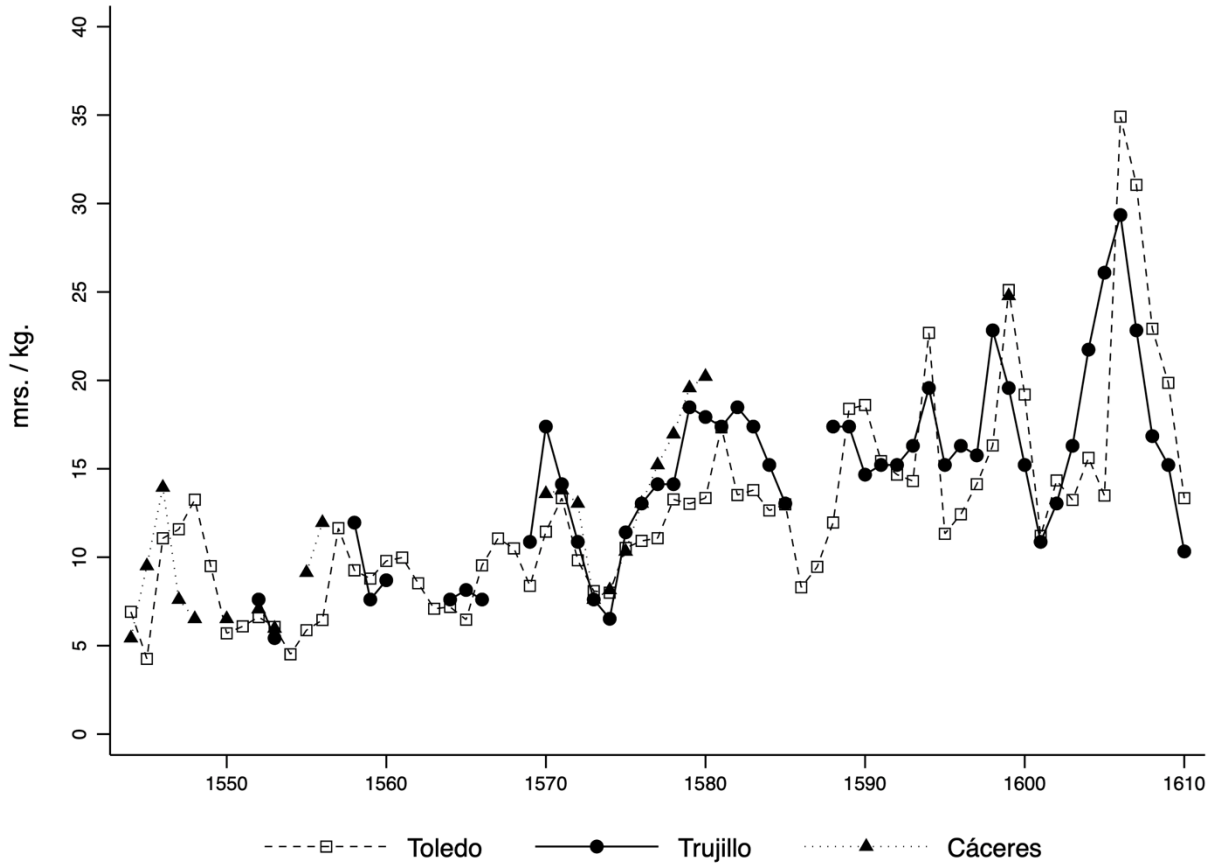


Source: for Guadalajara, Mejía Asensio (2003, 890–94); for Casarrubios, Hamilton (1947, 234–37); for Toledo, see the text.

Figure 4 shows that both the Guadalajara and the Casarrubios series track our Toledo estimates very closely. There is no appreciable break in the relationship in 1619, suggesting that whatever institutional change affected the bread-wheat ratio in Toledo had the same impact on the Guadalajara and Casarrubios markets. Since all three cities were included in the *pan de registro* regime, but were otherwise not subject to any other common jurisdiction, it is quite likely that the quota system was the reason behind the 1619 jump in the bread-wheat ratio.

We next examine two somewhat more distant markets in the Extremadura region. Pereira Iglesias et al. (1987) compile a 1552-1610 series of regulated bread prices for Trujillo, some 200 km west of Toledo. Though small today, in 1591 Trujillo's territorial jurisdiction had half the inhabitants of Toledo according to the *millones* census. The town enjoyed a brief period of considerable wealth in the second half of the sixteenth century when several residents, among whom conquistador Francisco Pizarro, became rich in the New World, and either they or their descendants returned with veritable fortunes. The hinterland was mostly dedicated to husbandry; wheat was generally sourced from central Castile, including areas that overlapped with Toledo's supply catchment. Pereira Iglesias (1981) also compiles a series of regulated bread prices for the city of Cáceres, some 45 km further west from Trujillo, and with roughly the same urban population at the time. The Cáceres series spans the years 1544-1580, with a gap in 1557-1569 and a lone observation in 1599.

Figure 5: Bread prices in Trujillo, Cáceres, and Toledo



Source: For Trujillo, Pereira Iglesias et al. (1987, 168); for Cáceres, Pereira Iglesias (1981, 216–17); for Toledo, see the text.

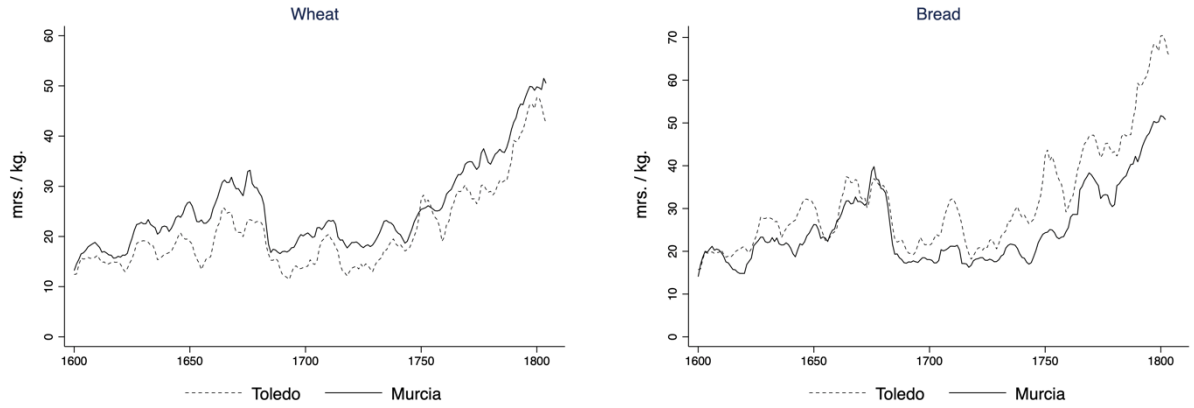
Figure 5 shows that bread prices in Toledo, Trujillo, and Cáceres also moved in lockstep, pointing to closely integrated markets well beyond the area immediately next to Toledo and Madrid. The mechanism of price transmission was likely their sourcing of wheat from a common region. Together with the series plotted in Figure 4, these results provide a strong measure of external validity for our data and methodology.[21]

Our final comparator is Murcia, 400 km south-east of Toledo and one-third its size at the 1591 census. Murcia normally relied on local wheat, as well as on imports from central Castile

[21] Of note, the entire time period for which the Extremadura data is available falls before 1619, the year in which the Toledo bread-wheat ratio experienced a discrete jump. That is, Figure 5 covers a single price determination regime.

for its bread. Owing to its vicinity to the Mediterranean, however, it could also import wheat from as far as Sicily in times of scarcity. This *trigo de la mar* was more expensive and more subject to spoilage than Castilian supplies, but it provided valuable insurance when local harvests proved insufficient. The available series of regulated prices for Murcia refer to brown bread, which saved on flour by adding bran and other milling byproducts, and was commensurately cheaper than white bread. We assemble bread and wheat price series relying on data from Gil-Guirado (2013), and fill gaps with data from Caro López (1985; 1987).

Figure 6: Wheat and bread prices in Murcia and Toledo (9-year MA)



Source: see the text.

The left-hand panel in Figure 6 plots 9-year moving averages of wheat prices in Murcia and Toledo, while the right-hand panel does the same for bread prices. Price volatility was lower in Murcia, perhaps reflecting its exposure to the foreign wheat market, but also possibly the larger flexibility afforded by brown bread, which could be baked with higher proportions of bran or water to keep its cost low if flour became too expensive. Between 1600 and 1800 wheat was on average 17% cheaper in Toledo than in Murcia, while Toledo's white bread was 26% more expensive than Murcia's brown quality. While the nature of the data allows for few definitive statements, the Murcia wheat and bread markets seem less tightly integrated with Toledo's than those in central and western New Castile.

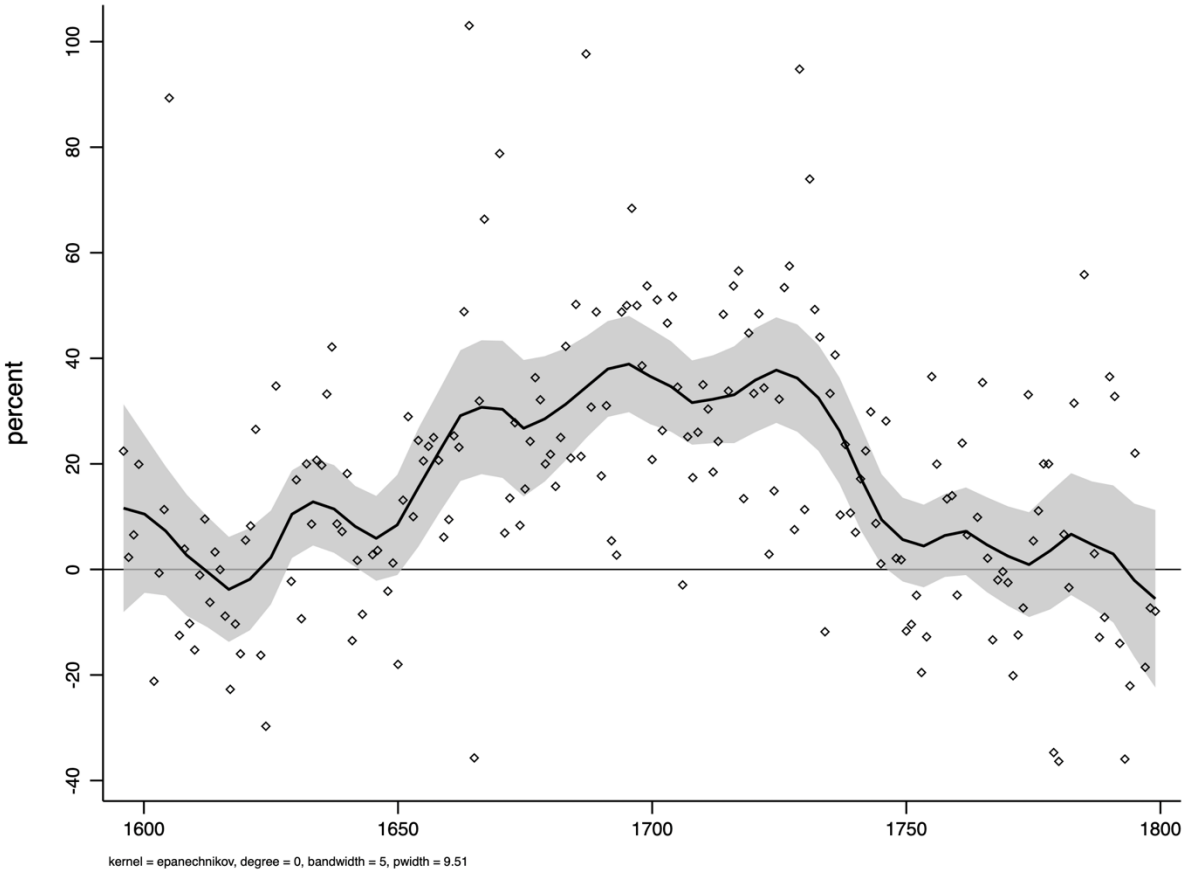
b. Madrid

Most international comparisons of early modern economic variables rely at least partially on data from Madrid, the city that Philip II chose as his permanent capital in 1561. Yet Madrid is in many ways a complete outlier relative to the rest of Castile. As its population grew to support the ever-increasing demands of the royal court, it consumed much more than its surrounding territory could produce. This was especially true for grain and bread, markets in which it acted as giant magnet, absorbing a substantial share of the production of an area that expanded to well over 100 km in radius in the course of the 17th century.[22] The Madrid *pósito,* charged with ensuring a consistent and affordable supply of bread for the capital, grew far beyond the standard parameters of a public storehouse, operating a complex system of quotas, transportation networks, and royal granaries spread out over the territory.[23]

A 200-year-long series of Madrid bread prices can be assembled by combining the data from Andrés Ucendo and Lanza García (2014) for 1596-1700, and from López Losa and Piquero Zarauz (2020) for 1701-1800. Both these contributions rely on the purchasing records of the Colegio de Santa Isabel, a boarding school for upper-class girls and orphans of royal servants. The records themselves do not specify the quality of bread purchased. López Losa and Piquero Zarauz (2020 fn. 26) report them as pertaining to high quality *candeal* bread, while Andrés Ucendo and Lanza García (2014, 615) write that the prices are similar to those paid by the inhabitants of Madrid at local bakeries.

[22] Ringrose (1973; 1983) has studied in detail the economic impact of the rise of Madrid, with specific emphasis on its effects on Toledo.
[23] The first classic treatment on the Madrid bread supply and the role of the *pósito* is Castro (1987). The issue has been revisited by Bernardos Sanz (1997; 2003; 2008), Llopis Agelán and Jerez Méndez (2001), and Andrés Ucendo and Lanza García (2012), among others.

Figure 7: Bread price differential between Madrid and Toledo



Note: local polynomial smoother. The shaded area is a 95% confidence interval.
Source: see the text.

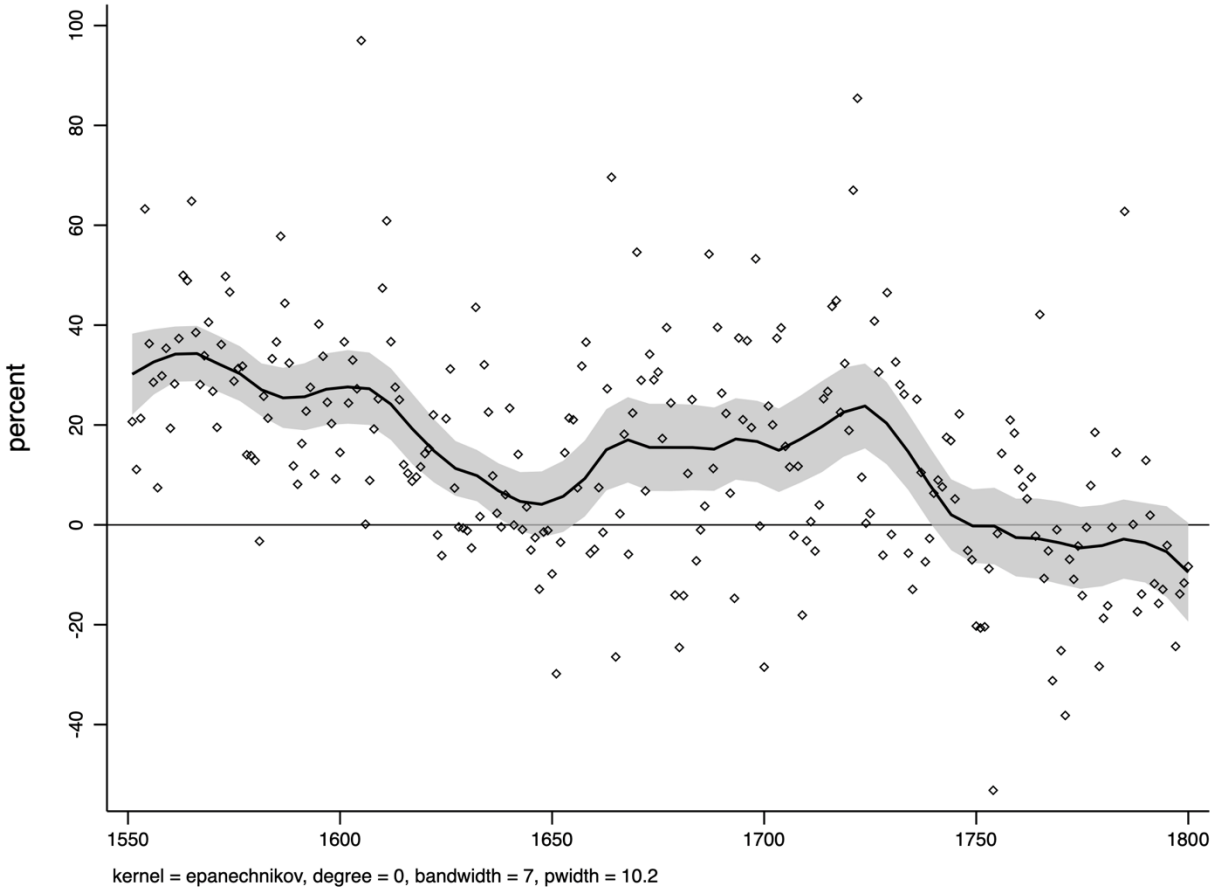
Figure 7 plots a local polynomial smoother of the difference between the Madrid bread price quotes from Santa Isabel and our Toledo main estimate. Without knowing for certain the quality of bread to which the Madrid prices refer to –and, indeed, whether the Madrid data belong to different qualities of bread in different periods– any analysis must proceed with caution. The chart is still striking: the Madrid and Toledo series are very similar in 1600-1650 and in 1750-1800, but Madrid prices are over 30% higher than Toledo's in 1650-1750.

Another bread price series for early modern Spain is Allen's (2001) estimate, which he computed with the purpose of constructing comparable measures of living standards across several European cities. To overcome the dearth of early modern bread prices across Europe,

Allen proposed a "retrocasting" approach that leveraged more readily available wheat price and wage series. He first obtained whatever bread prices were available, together with wheat and labour costs, for eight cities. Next, he regressed the bread prices on the other two variables and a set of city dummies for the periods in which all of them overlapped. Finally, he used the estimated parameters, together with wheat price and wage data, to estimate bread prices for the period in which they were not available. Allen's Spanish series is labeled "Madrid", the city from which he obtained the calibration data for 1751-1800. The wheat price and wage data to "predict" earlier bread prices came from Hamilton (1934; 1947), who in turn sourced them from a variety of institutions from Madrid, Casarrubios, and Toledo. Allen's series is therefore a hybrid estimate that conflates data from a broad region that includes both Madrid, Toledo, and the territory between them in different periods.

The retrocasting approach is based on the assumption that the structural relationship between the wheat, labor, and bread series does not change in the entire period of analysis. The 1619 break in the bread-wheat ratio points to a major violation of this assumption. Other changes in breadmaking technology, the fiscal regime, transaction costs, and transportation costs may have further affected wheat and bread markets in ways inconsistent with Allen's methodology.

Figure 8: Difference between Allen's estimates and our main series



Note: local polynomial smoother. The shaded area is a 95% confidence interval.
Source: Allen (2001) and authors' calculations.

Figure 8 plots the percentage difference over time between our bread price estimates and Allen's. For the 1750-1800, the period on which Allen calibrated his methodology and which contains his only actually observed bread prices, the two series broadly agree, with the confidence interval always including zero. As we move back in time, Allen's estimates become significantly higher than ours. Between 1619 and 1750, Allen's series is on average 13.2% higher than our main estimate; between 1550 and 1618, the gap grows to 28.7%. These differences are already biased downwards due to our augmenting of prices obtained using the bread-wheat ratio. If we rely on our baseline estimates instead, the average differences increase to 18.2% and 35%

respectively.[24] Although the 1650-1750 difference may reflect actually higher prices in Madrid, as suggested by the Santa Isabel data, the large pre-1619 gap is certainly the result of the retrocasting model being unable to incorporate the structural change in the Toledo bread market associated with the drop in the bread-wheat ratio. With bread accounting for up to one third of family budgets, such large discrepancies suggest caution when computing living standards using estimates obtained through this method.

IV. Market procurement vs. own production

Scholars have often claimed that early modern bread prices are hard to come by because the large institutions from which archival data are sourced often baked their own bread.[25] As we amply document, a city like Toledo was more than capable to supply two of its largest organizations, and undoubtedly many others, exclusively through market-mediated transactions. There is, in fact, no evidence that either Tavera's hospital or the Cathedral Chapter (or any other hospital of the more than a dozen we have studied so far, for that matter) operated a bread oven in the sixteenth century. But the siren song of vertical integration was not completely irresistible. While combing through uncatalogued papers, we discovered that Tavera's hospital did in fact experiment with operating its own bread oven between 1664 and 1667. Eight *cuadernos de panadería* record the cost associated with every step of the bread production process in minute detail, on a day-by-day basis.[26] These included the quantity of wheat received; the cost of having it milled; the income received from selling the milling byproducts; the purchase of firewood, cleaning supplies and other consumables; the replacement of tools; and the number of two-pound

[24] López Losa and Piquero Zarauz's (1997; 2003; 2008) also conclude that Allen's estimates are too high, though on the basis of replacing quotations of common bread for brown bread prices.
[25] For example: "Typically, large institutions baked their own bread, so their accounts do not record its price." (Allen 2001, 418).
[26] HSJB, Vitrina 16, Carpetas A20, B, C, D.

bread loaves delivered to the storehouse. The one missing element is the labor cost. No hospital salaries were ascribed to the oven nor recorded in its accounts; its operation was probably entrusted to one of the several hospital employees associated with the kitchen or the storehouse.

Table 1: Tavera's bread oven profitability

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	fgs.	lbs.	lbs. / fg.	mrs. / lb.	mrs./lb.	mrs./lb.	mrs.	mrs./lb.
Year	Wheat received	Pounds of bread baked	Extraction rate	Wheat cost	Milling and baking costs	Income from byproducts	Total cost (ex. labour)	Market price
1664	276.00	21,576	78.17	19.14	2.55	1.80	19.89	12.81
1665	239.17	21,490	89.85	15.70	1.07	1.16	15.61	28.00
1666	313.33	22,851	72.92	15.54	2.58	0.90	17.22	18.27
1667	329.42	28,871	87.64	10.80	2.13	1.47	11.46	14.52

Note: One fanega = 44.1125 kg. One pound = 0.460 kg.
Source: see the text.

Table 1 provides some key statistics about Tavera's bread oven during its roughly four years of operation. Column (1) reports the quantity of wheat the hospital destined to the oven each year, while column (2) reports the amount of bread delivered to the storehouse. The oven supplied between 21,000 and 29,000 pounds of bread per year, approximately one-half to two-thirds of the hospital's consumption. The extraction rate, reported in column (3), ranged from 73 to almost 90 pounds of bread per *fanega* of wheat, handily exceeding the bread-wheat ratio of 68 that prevailed in the market at the time. It is easy to see why the hospital might have wanted to try vertical integration; it stood to obtain as much as 25% more bread in exchange for the same amount of wheat.

Alas, the plan would not work out as envisioned. Column (4) reports the (opportunity) cost of wheat per pound of bread, obtained by multiplying the total quantity of wheat by its

market price, and dividing it by the number of pounds of bread baked. Column (5) reports the sum of all other production costs per pound of bread, while column (6) shows the amounts recovered by selling the process byproducts. These consisted of bran and *acemite*, a coarse mix of bran and lower quality flour used for making brown bread. The last two columns compare Tavera's final cost per pound (excluding labor) with our main market price estimate. In 1664, the first year of operation of its oven, Tavera's cost was 55% higher than the cash prices charged by bakers. This was the result of a spike in wheat prices. Bakers had access to subsidized wheat from the public storehouse, which would almost certainly have been selling stored grain to cushion the price increase. Private institutions like Tavera could not benefit from these subsidies other than by buying bread in the market.[27] The hospital's bread production, therefore, ended up being substantially more expensive than its market purchases.[28] In 1665 the tables were turned, and the hospital's oven substantially outperformed the market, saving almost 45% per pound of bread. In 1666 and 1667 the Tavera's unit production costs maintained a slight advantage over the market price. Without knowing its labour input, however, it is not possible to establish whether the savings, if any remained after subtracting the opportunity cost of labor, were worth the trouble. What is certain is that the hospital shut down its oven in late 1667 and returned to sourcing all of its bread from local bakeries.

In a remarkably similar experience, the Cathedral Chapter of Burgos, a city in Northern Castile, also tried to escape from the vagaries of the open market by opening its own bread oven in 1755. Just as Tavera, Burgos' Cathedral shuttered its oven three years later, having been

[27] Toledo's public storehouse, the *alhóndiga*, sold its wheat at prices set by the city's bread commission. Individuals were given access first, followed by bakers. Institutions came last in the priority order, which would have likely shut them out from subsidized purchases in times of scarcity (Castro 1987, 95–108).
[28] Since Tavera's hospital received wheat as rent payment, baking its own bread did not comport a financial outlay for wheat. It did, nonetheless carry an opportunity cost. In 1664 the hospital would have been better off by selling its wheat on the market and buying its bread from the bakers of the city.

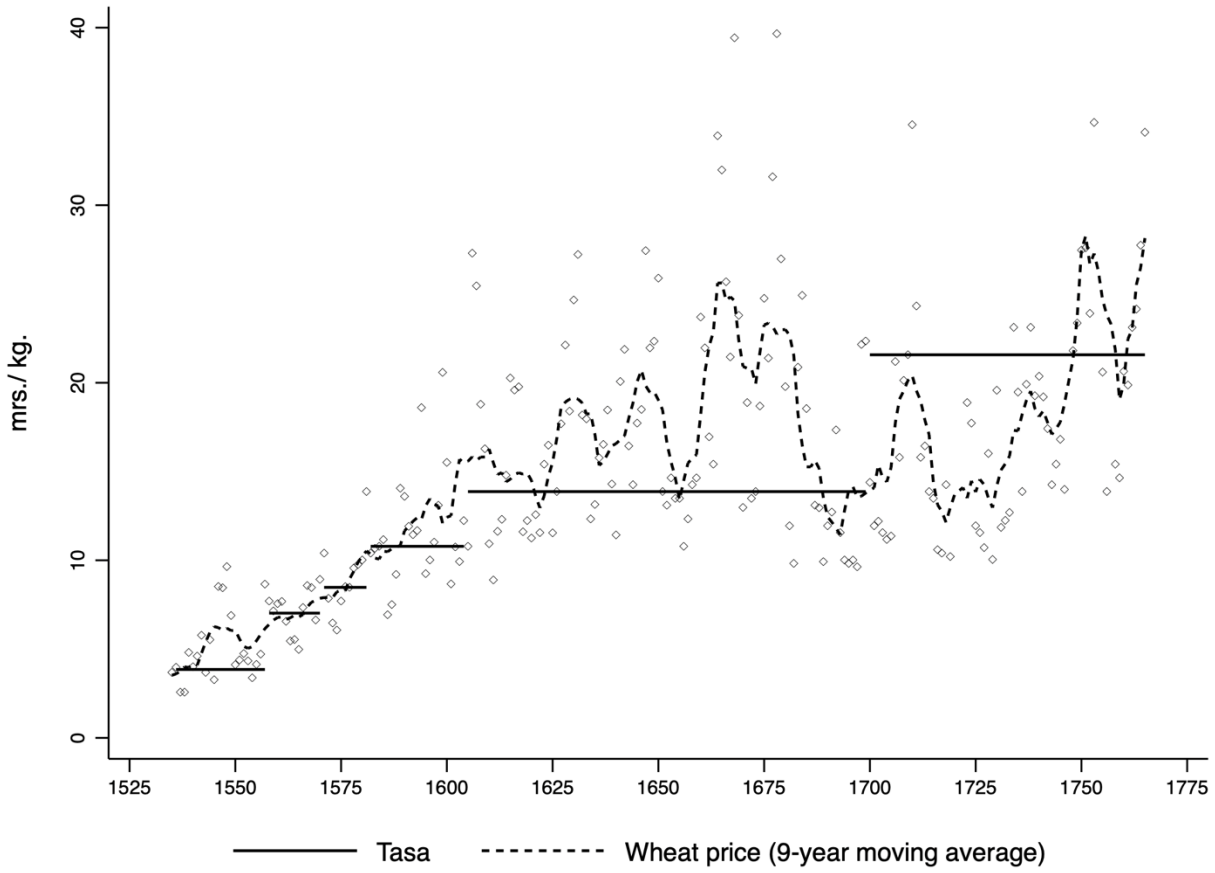
unable to consolidate a workable system of wheat supply and bread production, or even retain the services of competent bakers.[29] These failures, by two large and otherwise administratively sophisticated and capable institutions, suggest that the combination of efficient bread markets and effective price-smoothing public institutions meant there was little advantage for non-specialized players to engage in own production.

V. Political economy

Exerting control over the supply and pricing of bread was a foremost preoccupation of urban authorities in early modern Europe (de Vries 2019). In Castile two levels of regulation coexisted and, indeed, worked together: the kingdom-wide price ceiling for wheat –the *tasa del trigo*–, and local systems that attempted to limit price fluctuations and keep bread affordable for the masses using a combination of market and non-market mechanisms. In this section we characterize their operation and use our data to assess their effectiveness.

[29] See Sanz de la Higuera (2013) for a detailed description and analysis of the venture.

Figure 9: Tasa and the price of wheat



Source: for *tasa* values, Castro (1987, 70–79); for wheat prices, see the text.

The solid line in Figure 9 shows the evolution of the *tasa* over time. The markers plot annual wheat prices, with the dashed line representing a 9-year moving average. It is readily apparent that the *tasa* followed, rather than led, market prices for wheat. As mentioned in section II, from 1619 on farmers were exempted from the *tasa* in private transactions, which allowed others to circumvent the limit as well. The regulated price still had one critical function: public storehouses could force farmers and merchants to sell their wheat for the *tasa*, a derivative of the medieval power of purveyance (*tanteo*), which they exercised often. This placed a limit on hoarding and speculation, as merchants who held on to supplies in times of scarcity waiting for prices to increase could find themselves forced to sell to the public storehouse at the much lower

tasa.[30] In practice, this power depended of the ability of the local *pósito* to enforce the regulation. All of the Madrid, Casarrubios, and Toledo storehouses were able to do so regularly in the sixteenth and seventeenth centuries.[31] While the records of the bread commission of Toledo, which was responsible for managing the *alhóndiga*, are disorganized and very incomplete, at least two account books survive, covering the periods 1562-63 and 1578-85. In years when market prices exceeded the *tasa*, most purchases were recorded as being paid *"a la premática"*, that is, at the price established by royal edict. In the ten months between October 1562 and July 1563, the *alhóndiga* purchased well over 170,000 *fanegas* of wheat, equivalent 7,500 metric tons. Such enormous quantities are indicative of the considerable market power of public institutions, which helped smooth the price fluctuations faced by city dwellers.[32]

In addition to sourcing wheat at *tasa* prices when possible, cities supplemented local supplies by importing wheat from faraway locales.[33] These actions were part of a zero-sum game on the national level, as the highly correlated productivity shocks meant that most cities would be chasing scarce supplies at exactly the same time, with only coastal locations having some respite as a result of their access to imported wheat. Conversely, in times of abundance, cities limited the entrance of wheat from other jurisdictions into the local market as they sought to unload excess stores from prior years before they spoiled. To that effect levies were charged on grain entering the city (in Toledo this was called the *derecho de la calahorra*), access was barred

[30] For a discussion of the function of the *tasa* as a purchase option by the *pósitos* and its effects on the incentives faced by wheat merchants and speculators, see Llopis Agelán and Jerez Méndez (2001, 43).
[31] Castro (1987, 85–86) details how the Madrid *pósito* regularly exercised its prerogative to buy wheat at the *tasa*, especially in years in which market prices significantly exceeded it. *Corregidores*, the representatives of the king in the cities, would enforce the power of purveyance and back it with police power. In Casarrubios, the account books of the *pósito* routinely and explicitly record purchases of wheat from as far as Old Castile at *tasa* prices – e.g. AMCM, libro 15, fol. 153v.
[32] AMT, Libros Manuscritos, 427 and 428.
[33] In different years, Toledo sourced wheat from as far away as Palencia in Northern Castile and Alicante on the Mediterranean. AMT, Libros Manuscritos 428; AMT, Caja 1803, "Pan, S. XVII-XVIII".

to merchants bringing wheat from beyond the city's jurisdiction, and public storehouses imposed on reluctant bakers to accept nearly spoiled wheat leftover from the previous harvest.[34]

Despite these various mechanisms for intervening in wheat markets, scholars have remained skeptical about their actual effectiveness. Dijkman (2021) suggests that Dutch city officials largely concerned themselves with limiting speculation and fraud (certainly a central preoccupation in Castile as well), only turning to active supply management when the threat of famine loomed. In her landmark treatment on the Madrid bread market, Concepción de Castro writes that Castilian *pósitos* "were unable to eliminate the consequences of low productivity and climate fluctuations. It would have been necessary to have good systems of grain preservation or enough resources to fully subsidize any crises. No more was achieved than smoothing the ups and downs, and at a considerable cost" (Castro 1987, 106–7).[35]

Our data allow us to gauge the mechanisms and success of regulatory institutions in mitigating bread price fluctuations by exploring the relationship between harvest yields, wheat prices, and bread prices. Llopis Agelán et al. (2020) collect harvest yield data from eight agricultural estates across Extremadura, Andalucía, and Old Castile between 1668 and 1808, reported as seed harvested per seed sown. We convert our wheat and bread price series to grams of silver per kilogram in order to obtain stationary series and estimate the relationship

$$\log p_t = \alpha + \beta_0 \log k_t + \beta_1 \log k_{t-1} + \beta_2 \log k_{t-2} + \gamma_1 \log p_{t-1} + \gamma_2 \log p_{t-2} + \varepsilon_t \quad (2)$$

[34] AMT, Caja 1803, "Pan, S. XVII-XVIII". The *Puerta del Cambrón*, the city gate through which all wheat was carted into the city, was "closed to foreigners" in times of abundance. The *derecho de la Calahorra*, consisting of 1 maravedi and one loaf per load of bread, was also assessed on all baked bread entering the city, though it was waived in times of scarcity. See also Castro (1987, 96).

[35] The nuanced thrust the last sentence is somewhat lost in translation. Castro writes *"no se logra más que suavizar los altibajos*", which suggests a minor mitigation of market volatility.

where p_t is the price of wheat in period t, k_t is the agricultural yield in period t, and $\varepsilon_t$is an uncorrelated, normally distributed error term.

Let's consider a benchmark case with no storage or market intervention. The first coefficient of interest is β_0, which captures the elasticity of wheat prices with respect to yields in a given year. In the absence of storage, after each harvest farmers would keep the seed they needed to plant for the next year and inelastically offer the rest on the market. That is, supply would be perfectly inelastic, varying one-for-one with yields. As a result the observed price movements exactly identify the demand curve. We can therefore interpret β_0 as the inverse of the elasticity of demand. The other coefficients of interest are γ_1 and γ_2. In the absence of storage or intervention there would be no mechanism for the prices from the previous period to influence those of the current one; we should therefore expect these coefficients to be zero.

If storage becomes possible and is used to smooth price fluctuations, we should expect the coefficient on the first lag of wheat prices, γ_1, to become positive, as fluctuations are reduced and prices in one period become positively correlated with prices in the next. Next, the coefficient on yields, β_0, should fall below the inverse of the elasticity of demand, as supply fluctuations are cushioned by countervailing variations in grain stocks. Finally, since in the large open granaries used in Castilian storehouses wheat was only storable for one year, the coefficient on the second lag of wheat prices, γ_2, should continue to be zero.[36]

[36] Wheat can be stored for decades in airtight containers, but this technology was only workable at a relatively small scale in the early modern period. *Pósitos* stored large amounts of wheat in indoors but otherwise ventilated granaries. Wheat would begin to rot or become significantly damaged by granary weevils if stored longer than one year (Castro 1987, 96; Montemayor 1995, 68).

Table 2: Harvest yields and the price of wheat, 1668-1800

	Coef.	Std. Err.	P>|t|
log yield			
--.	-.447	.077	0.000
L1.	-.070	.068	0.307
L2.	.065	.086	0.452
log pwheat			
L1.	.783	.101	0.000
L2.	.041	.090	0.651
Constant	.697	.219	0.000
N = 131	ADF(log pwheat) = – 4.642		
F (5, 125) = 37.89	ADF(log yield) = – 11.293		

Note: All variables in logs. Dependent variable is the price of wheat in grams of silver per kilogram. Independent variables are harvest yields in seed harvested per seed sown, lagged values of yields, and lagged values of the price of wheat. Newey-West standard errors are reported. The unit-root null hypothesis is rejected at the 1% significance level for both vairables.

The regression coefficients in Table 2 depart significantly from the no-storage case. Estimates of early modern elasticity of demand for wheat range between -.7 and -.8, meaning that its inverse ranges from -1.25 to -1.4.[37] Our estimate of β_0, the same-year elasticity of wheat prices to yields, is -.447, less than half the expected value for the benchmark no-storage or intervention case. At the same time, the estimated coefficient on first lag of wheat prices, γ_1, is .783. These values are strongly consistent with an effective operation of storehouses with the ability to store wheat for one year and a goal of smoothing prices.

We next explore the transmission of wheat market dynamics to bread prices by regressing the latter on wheat prices and two lags of each variable. The results are reported in Table 3.[38]

[37] For a survey on the literature on the elasticity of demand for wheat in the early modern period see Barquín (2005).
[38] A potential additional control is the wage, as labor was an input in the manufacturing of bread. Even when expressed in silver prices, wages were not stationary between 1668 and 1800, owing to the stagnation of nominal wages during the inflation of the eighteenth century. We estimate a model in first differences, finding no significant

Table 3: Bread and wheat prices, 1668-1800

	Coef.	Std. Err.	P>|t|
log pwheat			
--.	.761	.058	0.000
L1.	.048	.107	0.651
L2.	.044	.089	0.624
log pbread			
L1.	.199	.107	0.066
L2.	-.089	.086	0.303
Constant	.377	.051	0.000
N = 133	ADF(log pbread) = – 4.331		
F (5,127) = 433.65	ADF(log pwheat)= – 4.642		

Note: All variables in logs. Dependent variable is the the price of bread in grams of silver per kilogram. Independent variables are the price of wheat in grams of silver per kilogram, lagged values of bread prices, and lagged values of wheat prices. Newey-West standard errors are reported. The unit-root null hypothesis is rejected at the 1% significance level for both vairables.

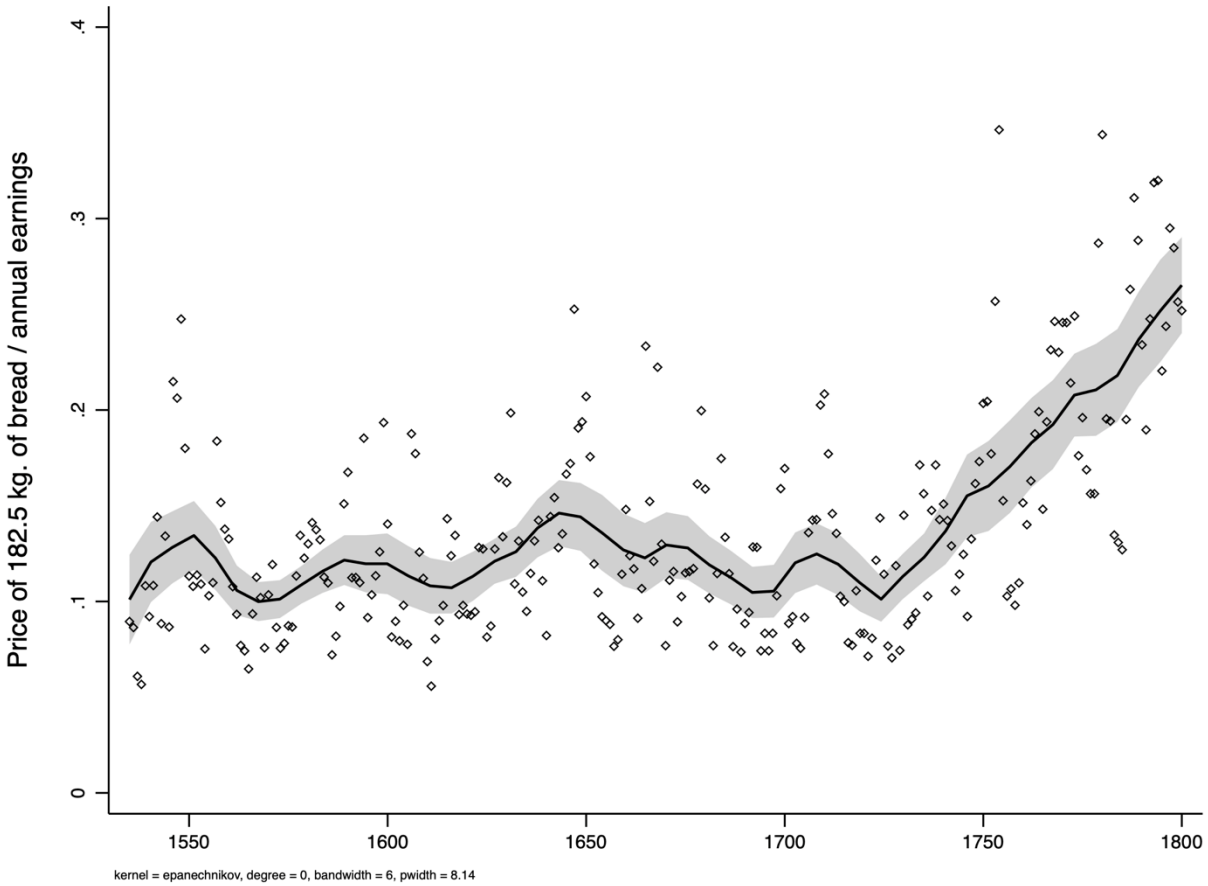
The contemporary elasticity of bread prices with respect to wheat prices is .761, considerably higher than the .447 estimate for the elasticity of wheat prices with respect to farm yields. No lags are significant at the 5% level. The first lag of the price of bread is significant at the 10% level, with an elasticity of .199, possibly reflecting weak persistence in price-setting practices. These estimates suggest a strong transmission of wheat prices to bread prices, with little evidence of smoothing dynamics. Together with the regression in Table 2, these results suggest that public policy did indeed focus mostly on the supply of wheat rather than on bread markets, and that it was successful in moderating the very high volatility in wheat prices that would otherwise have resulted from the natural swings in agricultural productivity.

effects of wages on the price of bread, while the coefficients on the other variables are unchanged. The regression, not reported here, is available in our replication file.

VI. Living standards

To explore what bread market dynamics meant for living standards, we use our series of daily wages for construction laborers (*peones de albañil*) from sixteen different construction sites in the city (Drelichman and González Agudo 2024). These wages are typically taken in the comparative literature as indicative of the earning potential of the lower classes. Following García Zúñiga and López Losa (2021, 705) and our own observations we use a working year of 280 days to compute the annual earnings of day laborers, while taking the amount of bread in a respectability basket to be half a kilo per day (Allen 2015, 6).

Figure 10: Cost of bread in a respectability basket as proportion of annual earnings



Note: local polynomial smoother. The shaded area is a 95% confidence interval
Source: see the text.

Figure 10 plots the cost of 182.5 kg of bread as a proportion of the annual earnings of a laborer in Toledo, calculated as above. Prior to 1750 the cost of bread in a respectability basket stayed under 15% of laborer earnings on average, and did not exceed 25% even during the worst price spikes. Under the standard assumption of a typical family of four in which the two children consume half the amount of food as the adults, during this period a Toledan mason would have always been able to procure the "respectability" quantity of bread in the family basket for about 45% of his income on average.[39] If one were to add the income from female labor, which was ubiquitous and remunerated at a substantial proportion of male earnings, the picture that emerges is one in which Toledan working-class families could comfortably afford the respectability basket in most years.[40]

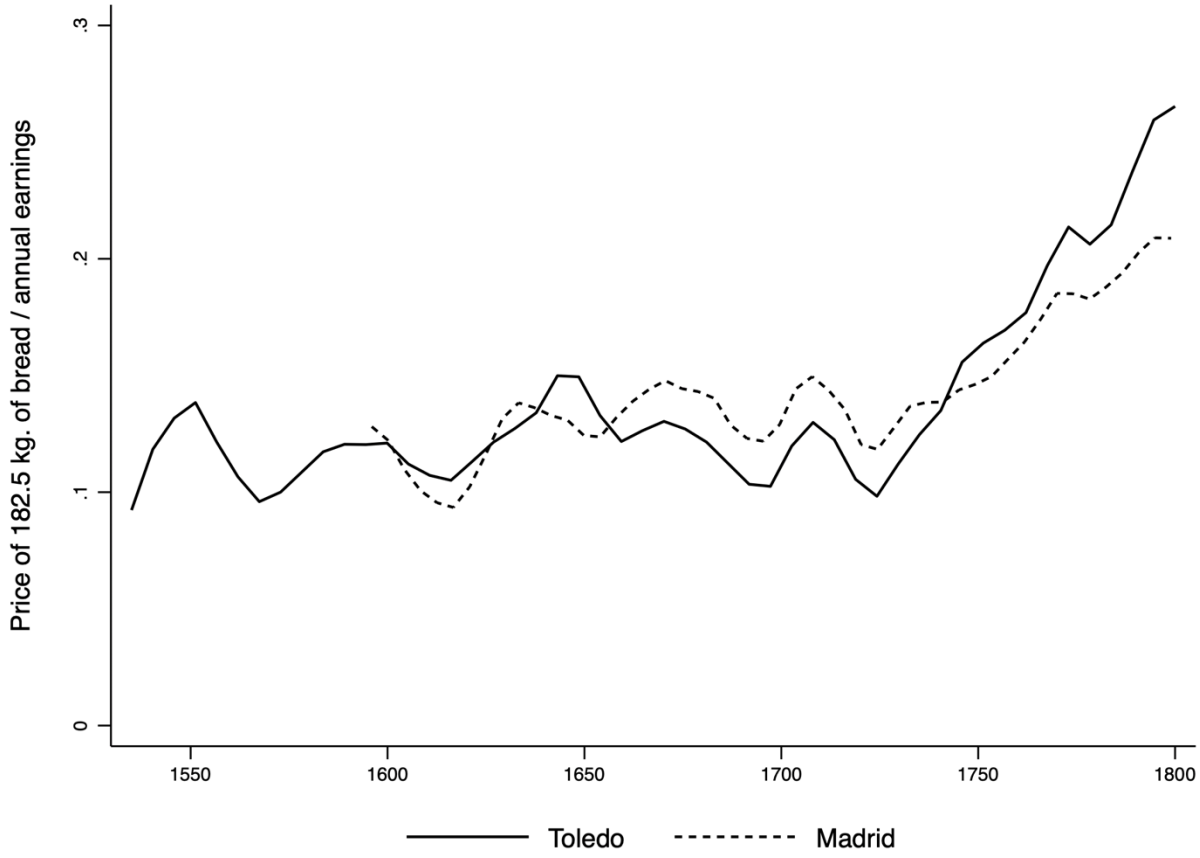
The change in the pattern, with the cost bread as a proportion of income more than doubling between 1750 and 1800, is striking. Productivity was not a major issue. Agricultural yields did not increase in volatility, and the eighteenth century registered somewhat fewer failed harvests than the preceding one. The proximate culprit was the resurgent inflation of the 18th century, coupled with a secular stagnation in nominal wages that López Losa and Piquero Zarauz (2020) identify as the true onset of the Little Divergence in Spain. Unlike what happened during the inflationary process of the sixteenth century, in the eighteenth wages failed to keep pace with rising prices, leading to a sharp decline in living standards. Public institutions were powerless to soften the blow. Both the *tasa* and the *pan de registro* system were formally abolished with the

[39] A kilo of bread contains 2,450 calories, roughly meeting the daily requirements of an average adult exerting moderate effort (Allen 2001, 421; Humphries 2013, 702). It would have therefore been possible for a laborer to meet his family's entire caloric requirements from bread alone while spending under 90% of his income on average. González Agudo (2019) also concludes that construction wages were sufficient to provide 2700 calories per member of the typical family.

[40] Drelichman and González Agudo (2020) find that, between 1550 and 1650, female nurses in Toledo were paid over 80% of the earnings of male nurses on average. For female labor force participation in the eighteenth century, see Sarasúa (2019).

introduction of a set of liberal reforms in 1765, but they had in practice been ignored for decades before legislation caught up to their demise. Even if they had been in full force, it is dubious they would have been able to make much of a dent in the face of such strong macroeconomic trends.

Figure 11: Cost of bread relative to earnings in Toledo and Madrid



Note: local polynomial smoother.
Source: Madrid wages from López Losa and Piquero Zarauz (2020, supplementary data, column BJ). Madrid bread prices as in Figure 7. Toledo prices and wages as in Figure 10.

It is instructive to compare the cost of bread as a proportion of the laborer earnings in Toledo and Madrid. Figure 11 shows how the series broadly agree until 1650, with Madrid becoming about 25% more expensive for the following century (consistent with our earlier finding regarding the divergence of bread prices). This is reversed after 1750, when the cost of bread in a respectability basket rises to just over 20% of annual earnings in Madrid, while in Toledo it exceeds 26%. If the Madrid bread series indeed refers to *candeal* bread, as indicated by

López Losa and Piquero Zarauz, the gap would be even wider. These results suggest further caution about using Madrid data in international comparisons of living standards. *Caeteris paribus*, replacing Madrid's wages and bread prices with Toledo's would result in a noticeable increase in the relative welfare ratios of "Spain" relative to Northern Europe in the seventeenth and early eighteenth centuries, together with a deeper divergence after 1750.

VII. Conclusion

In this study we have conducted a comprehensive analysis of the prices, dynamics, and regulatory institutions surrounding bread markets in the city of Toledo between 1535 and 1800. We assemble the longest bread price series for early modern Spain, sourcing it from granular transaction data, and adjusting it to reflect the cost of common white bread to urban consumers. We show that our estimates have a high degree of external validity, closely matching shorter bread price series from five other Castilian locations.

We combine our data with agricultural yields and wheat prices to analyze econometrically the dynamics of urban bread markets, finding support for the view that public institutions were able to soften the volatility of harvests through countercyclical storage and subsidized supply practices. The short-lived experience of the bread oven of Tavera's hospital further suggest that the public storehouse system had advantageous insurance properties that even large institutions with access to their own wheat supplies could not replicate.

We also show that Madrid bread prices are not representative of the broader Castilian context, registering over 30% higher than those in Toledo and other Castilian towns for over a century. Similarly, we demonstrate that the pre-1619 bread prices most commonly used in the comparative literature have been overestimated by a similar amount. In combination, these two findings suggest that current estimates of Castilian urban living standards up to 1750 are

generally too low, and that, conversely, their decline after 1750 is likely steeper than estimated so far.

Primary sources and abbreviations

ABCT	Archivo y Biblioteca Capitulares de Toledo
AMCM	Archivo Municipal de Casarrubios del Monte
AMT	Archivo Municipal de Toledo
HSJB	Archivo Ducal de Medinaceli, Hospital de San Juan Bautista (Tavera)

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