THE MAKING OF A NATIONAL CURRENCY. SPATIAL TRANSACTION COSTS AND MONEY MARKET INTEGRATION IN SPAIN (1825-1874)

Abstract

This article analyses the integration of the Spanish money market in the 19th century. We use a Band-TAR model of prices in Madrid of bills of exchange on 9 Spanish cities to measure convergence and efficiency in the market between 1825 and 1875. While price gaps between cities were significantly reduced during the period, no progress took place in efficiency. We suggest that increasing convergence was associated to the reduction in transaction costs, which started before the railways through improvements in roads and postal services. By contrast, increases in efficiency were prevented by a very restrictive regulation of arbitrage.

JEL Classification: E02, E42, F02, F15, F31, F36, K00, L10, N13, N73, R40

Keywords: Money Market Integration, Spanish National Currency, Specie-Point Mechanism, Bills of Exchange, Money Market Convergence, Money Market Efficiency, transaction costs, Real Bills Doctrine, Legal Systems, Financial Development

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The making of a national currency. Spatial transaction costs and money market integration in Spain (1825-1874)

Pilar Nogues-Marco1, Alfonso Herranz-Loncán2 and Nektarios Aslanidis3

ABSTRACT

This article analyses the integration of the Spanish money market in the 19th century. We use a Band-TAR model of prices in Madrid of bills of exchange on 9 Spanish cities to measure convergence and efficiency in the market between 1825 and 1875. While price gaps between cities were significantly reduced during the period, no progress took place in efficiency. We suggest that increasing convergence was associated to the reduction in transaction costs, which started before the railways through improvements in roads and postal services. By contrast, increases in efficiency were prevented by a very restrictive regulation of arbitrage.

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1. INTRODUCTION

Economic integration and the removal of institutional and technological barriers to economic relations is one of the main prerequisites of economic progress (Smith, 1776; Balassa, 1961; North and Thomas, 1973). 19th century European industrialization was largely rooted on long-term processes of domestic market integration, and those countries in which integration was delayed fell behind the leading economies. Among the many dimensions of market integration, the integration of the money market performed a crucial role in igniting industrialization by facilitating the consolidation of efficient national systems of payment (Colwell, 1860; Bagehot, 1873; Levine, 1997). Bagehot (1873, I.10&I.12) pointed out the key role of a well-integrated national money market for the development of England: “The money sent up from the accumulating districts is employed in discounting the bills of the industrial districts. Deposits are made with the bankers and bill brokers in Lombard Street by the bankers of such counties as Somersetshire and Hampshire, and those bill brokers and bankers employ them in the discount of bills from Yorkshire and Lancashire. Lombard Street is thus a perpetual agent between the two great divisions of England,—between the rapidly-growing districts, where almost any amount of money can be well and easily employed, and the stationary and the declining districts, where there is more money than can be used (...). This efficient and instantly-ready organisation gives us an enormous advantage in competition with less advanced countries—less advanced, that is, in this particular respect of credit. In a new trade English capital is instantly at the disposal of persons capable of understanding the new opportunities and of making good use of them. In countries where there is little money to lend, and where that little is lent tardily and reluctantly, enterprising traders are long kept back, because they cannot at once borrow the capital, without which skill and knowledge are useless”.

A well integrated national money system is therefore a substantial component of financial development and economic growth (King and Levine, 1993; Neusser and Kugler, 1998; Rousseau and Wachtel, 1998). Under insufficient money market integration, the scarcity of means of payment for interregional transfers increases transaction costs in the economy. Together with other factors such as high transport costs or chronic political turmoil, a fragmented payment system may represent a serious constraint for the development of national markets, specialization and structural change.

Historically, the main push to monetary integration came from the nationalization of payment systems, which accompanied the construction of liberal nation-states during the 19th and early 20th centuries in many countries (Helleiner, 2003). Some of the main elements of national payment systems were the establishment of nationwide issuing banks, based on paper currencies circulating within the whole national territory, and the expansion of branch banking, together with an intra-national par transfer system. These allowed an almost perfect integration of the money market and the reduction of the costs of moving money across national territories practically to zero. By contrast, before their nationalization, European monetary systems were defined at a city level. Interregional money transfers were based on commercial finance, i.e. on bills of exchange trade between cities (Flandreau et al., 2009). Thus, any factors constraining the development of commercial finance would reduce the degree of monetary integration and provoke situations of shortage of interregional means of payment, substantially increasing, as a consequence, domestic transaction costs in the economy.

This paper aims at analyzing the integration of the Spanish money market before the nationalization of the country’s monetary system. In Spain, the Bank of Spain only obtained the national monopoly of banknote issuing in 1874, created a network of
provincial branches mainly between 1874 and 1886, established a system of free money transfers between deposits held in different branches in 1883, and introduced national banknotes valid in the whole national territory in 1884 (Castañeda, 2001a; Martín-Aceña et al., 2013). Prior to those changes, Spain had a diversity of provincial issuing banks and the circulation of each bank’s notes was restricted to the bank’s location and the surrounding area (Tortella, 1973; Sudrià and Blasco-Martel, 2016). As a consequence, before the 1880s Spain kept a traditional city-based monetary system where money transfers between cities were based on the use of bills of exchange. This paper studies to what extent the institutional and technological changes that took place in Spain over the 19th century allowed a better operation of commercial finance and the money market, arguably contributing to the reduction of domestic transaction costs and the increase in liquidity in the economy.

Such analysis is especially relevant for an economy like 19th century Spain, for which insufficient market integration has often been identified as one of the reasons for an extremely slow industrialization process (see, e.g. Fontana, 1983). Indeed, the Spanish economy in the early 19th century has been described as a mosaic of semi-autarkic regional markets. Leaving aside the complex commercial network organized to supply Madrid’s needs, interregional trade is usually assumed to have been very small, especially between the center and the periphery of the country. This would have been the joint outcome of political instability and rugged geography. Whereas the latter made transport too expensive before the arrival of the railways (Gómez Mendoza, 1989; Ringrose, 1972), the succession of civil wars and coups d’état made economic relations rather risky at least until the early 1880s, and would have substantially reduced the government’s ability and available resources to carry out institutional reform. This would have made Spain a case of late market integration, compared with countries such as Britain, the Netherlands or France (Jacks, 2005; Uebele, 2013), and would contribute to explain Spanish sustained economic divergence during the 19th century (Prados de la Escosura, 2017). Integration would have only advanced since the late 19th century, thanks to institutional development, political stability and transport infrastructure construction. As has been recently summarized by Rosés et al. (2010: 845): “Before the mid-19th century, Spanish regions were relatively independent regional economies. (...) Both market liberalization and transport improvements, particularly the completion of Spain’s railway network, induced the creation of a national market for most important commodities during the second half of the 19th century”. In this context, this paper analyses the advances in the domestic integration of the Spanish monetary system before the nationalization of the payment system in 1874, in order to shed some light on the extent to which the money market could have contributed to, or constrained, Spanish economic development during the 19th century.

The degree of integration of city-based money markets can be approached through the analysis of local quotations of bills of exchange. In each city, bills of exchange on other cities were locally traded at a discount or premium, depending on their supply and demand, largely reflecting interregional trade balances, as was often highlighted by 19th century literature (Broussein, 1805; Poy Comes, 1830; Pita Pizarro, 1833; Guillén Suárez, 1846; Castaño, 1862). The price at which bills of exchange payable in one city were traded in another city can be considered as the exchange rate between both cities. Given the metallic definition of currencies, exchange rate variations were limited by the costs of moving specie between cities, which defined a fluctuation band for exchange rates according to the specie-point mechanism. The degree of integration of the money market can be approached through the measurement of price convergence (the width of the
fluctuation bands, determined by the costs of moving gold or silver) and market efficiency (the speed of adjustment of exchange rates to shocks). In this paper, we use daily prices in Madrid of bills of exchange payable in a sample of several Spanish cities between 1825 and 1874. We estimate a band-threshold autoregressive (Band-TAR) model, which measures simultaneously convergence and efficiency. This approach has already been used by several authors to measure money market integration, for either the international gold standard or medieval and early modern monetary systems (e.g. Canjels et al., 2004; Volckart and Wolf, 2006; Esteves et al., 2009; Li, 2015). However, to our knowledge, this is the first time this model has been applied to study the integration of a domestic money market in late modern times.

Our estimation results provide a mixed picture on the evolution of money market integration in 19th century Spain. There was substantial progress in price convergence during the century, which actually started before the construction of the railway network. However, market efficiency tended to decrease in most of the interregional links covered in the analysis. Interestingly enough, these opposing trends of convergence and efficiency in the Spanish money market are consistent with results obtained by Jacks (2005) for the wheat market in Spain and other European peripheral countries, such as Russia and Norway. This author suggests that, while the progress in convergence could be associated to global improvements in commerce, communication and transport, the evolution of market efficiency rather reflects each country’s level of economic development. More specifically, for the case of the Spanish money market we suggest that the early start in price convergence might be largely explained by government investment in the main road network and the organization of a regular and more efficient postal service. By contrast, efficiency did not improve over time, despite the reduction in transport costs, due to a highly restrictive legal framework, explicitly addressed to discourage speculative behavior. This prevented arbitrage opportunities from being fully seized, and slowed down the adjustment of the money market to exogenous shocks. The efficiency of the Spanish money market remained relatively low until the establishment of the Bank of Spain’s transfer system and the complete integration of the system in the early 1880s. These results seem to support the hypothesis that legal systems may have a significant impact on economic development (La Porta et al., 1998), and, more precisely, that cross-country differences in legal systems may help to determine differences in financial development and economic growth (Levine et al., 2000). Thus, our results highlight the potential relevance of Spanish institutional backwardness as a factor retarding economic integration in the country, together with other long-recognized factors such as harsh geography, poverty, political instability and low government resources.

2. DATA

This paper focuses on the process of integration of the Spanish money market before its nationalization and the disappearance of locally-based money in 1874-1884. In order to do this, we have hand-collected a dataset of daily prices (exchange rates) in Madrid, between 1825 and 1874, of bills of exchange payable in the main commercial and financial centers of the country: Barcelona, Bilbao, Cadiz, Corunna, Malaga, Santander, Seville, Valencia and Zaragoza. Map 1 shows the location of these cities, which are at a distance (by road) between 317 and 648 km from Madrid. With the exception of

4 The distance between Madrid and each of those cities, measured through the current road network, is: Barcelona, 624 km; Bilbao, 402 km; Cadiz, 648 km; Corunna, 591 km; Malaga, 531 km; Seville, 528 km; Santander, 437 km; Valencia, 355 km; and Zaragoza, 317 km. Current roads largely follow the 19th century
Zaragoza, which was an inland town with an active domestic commerce, all other cities were among the most important ports of the country and sustained a significant international trade.

We start our analysis in 1825, due to data availability, and end it in the mid-1870s, when the Bank of Spain was granted the note-issuing monopoly in the whole country. Bills of exchange payable in the nine sample cities had daily quotations in Madrid from the early 19th century onwards, which is an indication of their importance in the Spanish money market. Unfortunately, we cannot consider other cities due to scarcity of data. Secondary centers had a lower degree of liquidity and, therefore, their quotations were not published in the financial press or, when they were, the abundance of gaps prevents the compilation of daily series, especially during the first half of the 19th century.

The lack of liquidity that affected most Spanish cities at the beginning of the 19th century had already been pointed out by Francisco Cabarrús (1813: 160), who was the director of the Bank of San Carlos (the early antecedent of the Bank of Spain) in the last years of the 18th century. Incidentally, his words also make clear that Spanish monetary centers were part of a much larger international network of European cities:

road network, although some small differences (around 5% according to the available information) between current and 19th century distances must be allowed for.

5 The general press in Madrid (Correo Mercantil de España y de sus Indias) published bill of exchange quotations, although not on a regular basis, between 1792 and the French invasion of 1808. After the Napoleonic Wars, data of Madrid’s exchange rates with other Spanish cities only reappeared in the local press in the mid-1820s, in the Gaceta de Madrid. From 1854 onwards, although the Gaceta went on publishing daily rates, the Official Bulletin of the Madrid Stock Exchange was the official source that validated exchange rate information.

6 The Gaceta de Madrid only reported exchange rates for 12 cities during the first half of the 19th century, and only 9 of them (those included in our sample) had regular quotations. The other 3 centers were often mentioned without quotation, which would reflect a low degree of liquidity. The Official Bulletin of the Madrid Stock Exchange provided information for 47 centers, but only since 1854, when it was established. To capture the long-term dynamics of the process of market integration, here we focus on the 9 centers for which we have daily quotations from the 1820s.
“My tasks as director of the Bank have brought me to touch some bills whose existence I would never had suspected, and have forced me to follow them back to their origin in order to explain them. If you have money in Zamora, Badajoz, Granada or Cuenca and want to cash it in Madrid, it will be faster, cheaper and less risky to bring it from Leghorn, London or Amsterdam, because there is no alternative between the hindrance and contingencies of the material cash and transport of the money or the need to wait for months until a bill is available. (...) And how many years will pass until you find a bill in Córdoba on Zaragoza, or a bill in León on Murcia? Assess, from these examples, the condition of our trade: the signs follow the commodities and both trades follow the same push.”

Our analysis focuses on the relationships between Madrid and other towns for two reasons. The first is data availability: although there is some published information on bill of exchange prices in other cities, its frequency is much lower than in the case of Madrid, especially during the first half of the 19th century.7 Secondly, Madrid was the administrative and financial center of the country and had therefore a crucial role in the process of integration of the Spanish economy. In addition, its geographical location, right in the center of the country, reinforced its strategic role as the main node of the financial and commercial national networks.

Our data, taken from the Gaceta de Madrid and the Official Bulletin of the Madrid Stock Exchange, are daily prices in Madrid of bills of exchange payable in other towns at 8 days sight. Prices were quoted as the percentage of premium or discount on the bills’ face value. In this paper we use those daily deviations to estimate changes in the degree of market integration in the Spanish money market in the second and third quarters of the 19th century. An integrated market, following Cournot’s well-known definition, is “an entire territory of which the parts are so united by the relations of unrestricted commerce that prices take the same level throughout with ease and rapidity”.8 So, the concept of market integration includes two different dimensions: same prices across territories (price convergence) and non-persistence of asymmetric shocks (market efficiency) (Federico, 2012: 474). We use our database to measure these two dimensions. Our dataset comprises 110,623 observations and allows estimating the convergence and efficiency indicators with the highest possible precision, while avoiding the problem of time aggregation and the subsequent underestimation of market efficiency (Taylor, 2001; Federico, 2012; Brunt and Cannon, 2014). Figure A1 in the appendix plots the complete series.

3. MODEL

Convergence and efficiency are the two essential dimensions of market integration. Price convergence can be defined as a sustained decrease in the price gap between two centers. Price gaps are limited by a band defined by the prevailing transaction costs. As for efficiency, it can be defined as an increase in the speed at which excess price gaps disappear. Therefore, price differentials may be assumed to follow a random walk when they are lower than transaction costs, but to follow an autoregressive process otherwise. This behavior may be captured through threshold autoregressive (TAR)-type models, which allow simultaneously analyzing the convergence and efficiency dimensions of market integration (Jacks, 2006). The TAR framework was initially popularized in the

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7 The Diario de Barcelona reported bills of exchange prices in Barcelona from 1792 onwards, and the Diario Mercantil de Cadiz did the same for Cadiz from 1800 onwards.
literature by Obstfeld and Taylor (1997), who used it to analyze purchasing power parity (PPP), and it has often been applied later on to analyze the money market.

In the case of metallic money, the definition of market integration is based on the concept of specie-point mechanism (Morgenstern, 1959; Officer, 1996; Flandreau, 2004; Nogues-Marco, 2013). Because shipping specie was costly, the “specie points” are defined by the ratio of the bullion prices (gold or silver) in two centers plus/minus the cost of shipping specie between the two cities. These specie-points delimit a band within which the price of bills of exchange could fluctuate without making the dispatch of metal to the other city profitable. In the case of the pair composed by Madrid and another Spanish city:

\[
(1 - \gamma) \frac{p_M}{p_X} \leq e_{MX} \leq (1 + \gamma) \frac{p_M}{p_X}
\]  

(1)

where \(p_M\) represents the official price of gold and/or silver, expressed in units of account (currency), in Madrid; \(p_X\) represents the official price of gold and/or silver in location X (being X= Barcelona, Bilbao, Cadiz, Corunna, Malaga, Santander, Seville, Valencia or Zaragoza); \(p_M/p_X\) is thus the official exchange parity; \(\gamma\) represents the cost of transporting gold or silver between Madrid and X or between X and Madrid (we assume that the cost was the same in both directions); and \(e_{MX}\) is the market exchange rate between Madrid and X (price in Madrid of bills of exchange payable in X or vice versa). When both towns used the same currency, such as in our case, the official exchange rate \(p_M/p_X\) was always 1.

If the market exchange rate remained within the specie-points (defined by transaction costs), there would be no movement of precious metal between Madrid and X. However, if bills of exchange on X became expensive enough in Madrid to bring the exchange rate beyond the upper limit of the fluctuation band, agents would transfer metal from Madrid to X, rather than buying bills on X. Symmetrically, if bills became cheap enough to bring the exchange rate beyond the lower bound, it would be profitable to move metal from X to Madrid. As a consequence of those specie movements, the demand or supply of bills of exchange would decrease and the market exchange rate would go back to the fluctuation band. After a shock that brought the exchange rate out of the bands, the speed of return to the band depended on the efficiency of the market.

To measure the speed of adjustment (efficiency) and transaction costs (convergence) we apply a flexible Band-Threshold Autorregression (Band-TAR) model. The Band-TAR model takes the form:

\[
\Delta x_t = \begin{cases} 
-\lambda (x_{t-1} - \gamma) + \epsilon_{t^{\text{in}}} & \text{if } x_{t-1} > \gamma \\
\epsilon_{t^{\text{in}}} & \text{if } \gamma \geq x_{t-1} \geq -\gamma \\
-\lambda (x_{t-1} + \gamma) + \epsilon_{t^{\text{out}}} & \text{if } -\gamma > x_{t-1} 
\end{cases} \quad 0 < \lambda < 1; \gamma > 0
\]  

(2)

where \(x_t\) is the percentage deviation of the market exchange rate from the official parity (since the official parity is \(p_M/p_X=1\), \(x_t=[e_{t}-1]\times100\)), and \(\Delta\) is the first difference operator. The parameter \(\gamma\) is the threshold that proxies for transaction costs, while \(\lambda\) indicates the speed of adjustment to equilibrium. More specifically, the market exchange rate follows a random walk inside a non-arbitrage band defined by \([ -\gamma, \gamma ]\), within which transaction costs in metal imports/exports prevent arbitrage from correcting the exchange rate disturbances. By contrast, outside the band, arbitrage forces correct any deviations
and the market exchange rate has a tendency to move back to the edge of the band, at a speed that depends on $\lambda$. The model allows for heteroskedasticity across the different regimes, being $\varepsilon_i^{\text{out}} \sim N(0, \sigma_i^{\text{out}}^2)$ and $\varepsilon_i^{\text{in}} \sim N(0, \sigma_i^{\text{in}}^2)$ the disturbances outside and inside the band, respectively.

An appealing feature of Band-TAR models relates to its computationally simple estimation procedure. Let the parameters of interest be the vector $\theta = (\lambda, \sigma_i^{\text{out}}^2, \sigma_i^{\text{in}}^2)'$ and the threshold value $\gamma$. Obstfeld and Taylor (1997) propose an algorithm to estimate the Band-TAR by maximum likelihood (MLE), under the assumption that the errors are Gaussian. Holding $\gamma$ fixed, the Gaussian log-likelihood is given by:

$$
\ln L(\theta | \gamma) = -\sum_i I[|x_{t-1}| \leq \gamma] \frac{1}{2} \left( \ln(2\pi) + \ln(\sigma^{\text{in}}^2) + \frac{(\varepsilon_i^{\text{in}})^2}{\sigma^{\text{in}}^2} \right) - \sum_i I[|x_{t-1}| > \gamma] \frac{1}{2} \left( \ln(2\pi) + \ln(\sigma^{\text{out}}^2) + \frac{(\varepsilon_i^{\text{out}})^2}{\sigma^{\text{out}}^2} \right)
$$

where $I[|x_{t-1}| \leq \gamma]$ and $I[|x_{t-1}| > \gamma]$ are indicator functions which depend on the position of the (so-called) transition variable $x_{t-1}$ being inside or outside the band. In practice, we perform OLS regressions for the sub-samples for which $|x_{t-1}| \leq \gamma$ and $|x_{t-1}| > \gamma$, respectively. Once the estimates of $\theta$ are obtained, in a second stage, the estimator of $\gamma$ is given by:

$$
\hat{\gamma} = \arg \max_{\gamma \in [\gamma_D, \gamma_U]} L(\hat{\theta} | \gamma)
$$

This is the value of $\gamma$ that maximizes Eq. (3), where $[\gamma_D, \gamma_U]$ denotes the empirical support of $|x_{t-1}|$.

As is typical in the threshold literature, the above optimization problem is solved by a grid search. More precisely, the grid search algorithm is implemented as in Obstfeld and Taylor (1997) (see Appendix A). We first find the 5th and 95th percentiles of $|x_{t-1}|$ considering 5% trimming. Then, we implement a grid search with increments of 0.001 over the remaining $T * 0.90$ empirical support of $|x_{t-1}|$. This estimation algorithm results in a very dense grid search using $T * 0.90 * 1000$ equally spaced values of $\gamma$ (for example, for $T=5,000$; it amounts to 4,500,000 grid points), and guarantees that the values of the indicator functions contain enough sample variation for each choice of $\gamma$.

4. ESTIMATION RESULTS

Before proceeding with the main empirical analysis, we note that the Band-TAR can be seen as a special case of a Self-Exciting TAR (SETAR) model. Basically, there are three main differences between the Band-TAR and the SETAR models. Firstly, in the SETAR the autoregressive process outside the band may include more than one lag. Secondly, in this type of models the part inside the band is not restricted to a random walk, but can be a stationary autoregressive process. Thirdly, in a SETAR model the equilibrium lies

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9 For more details on the grid search method and theoretical results in threshold models, see the seminal paper by Tong and Lim (1980) and the essential contributions by Hansen (1996, 2000), among others.
towards the center of the band, while a Band-TAR model is less restrictive, as it allows the equilibrium to be anywhere within the band.

To the best of our knowledge, there is no formal test to compare the Band-TAR and the SETAR models. Nevertheless, in Table 1 we compare the results obtained from the estimation, using our complete sample, of the Band-TAR and two types of SETAR models, one with nine autoregressive lags (as in Canjels et al., 2004) and another one with a single lag. For the transition variable we use the first lag, even though we have experimented with different lags with the results remaining qualitatively very similar. It is important to highlight that the Band-TAR model reduces the number of parameters to estimate from 23 (in the case of the nine lag SETAR) to 4.

<table>
<thead>
<tr>
<th>City</th>
<th>SETAR (2;9,1)</th>
<th>SETAR (2;1,1)</th>
<th>Band-TAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barcelona</td>
<td>186.8</td>
<td>190.7</td>
<td>190.8</td>
</tr>
<tr>
<td>Bilbao</td>
<td>115.8</td>
<td>117.3</td>
<td>117.4</td>
</tr>
<tr>
<td>Cadiz</td>
<td>171.3</td>
<td>176.6</td>
<td>176.0</td>
</tr>
<tr>
<td>Corunna</td>
<td>96.9</td>
<td>99.7</td>
<td>99.9</td>
</tr>
<tr>
<td>Malaga</td>
<td>133.6</td>
<td>143.8</td>
<td>144.0</td>
</tr>
<tr>
<td>Santander</td>
<td>137.6</td>
<td>141.0</td>
<td>141.6</td>
</tr>
<tr>
<td>Seville</td>
<td>135.4</td>
<td>138.1</td>
<td>138.4</td>
</tr>
<tr>
<td>Valencia</td>
<td>137.8</td>
<td>141.0</td>
<td>141.2</td>
</tr>
<tr>
<td>Zaragoza</td>
<td>75.67</td>
<td>77.00</td>
<td>77.03</td>
</tr>
</tbody>
</table>

**Table 1. Band-TAR vs. SETAR models**

<table>
<thead>
<tr>
<th>City</th>
<th>Sum of Squared Errors</th>
<th>Transaction costs estimates (γ)</th>
<th>Sum of autoregressive coef. Inside band</th>
<th>Outside band</th>
<th>Number of parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barcelona</td>
<td>186.8</td>
<td>1.50</td>
<td>0.993</td>
<td>0.934</td>
<td>23</td>
</tr>
<tr>
<td>SETAR (2;1,1)</td>
<td>190.7</td>
<td>1.50</td>
<td>0.992</td>
<td>0.935</td>
<td>7</td>
</tr>
<tr>
<td>Band-TAR</td>
<td>190.8</td>
<td>1.47</td>
<td>1</td>
<td>0.895</td>
<td>4</td>
</tr>
<tr>
<td>Bilbao</td>
<td>115.8</td>
<td>1.13</td>
<td>0.988</td>
<td>0.976</td>
<td>23</td>
</tr>
<tr>
<td>SETAR (2;1,1)</td>
<td>117.3</td>
<td>1.13</td>
<td>0.987</td>
<td>0.964</td>
<td>7</td>
</tr>
<tr>
<td>Band-TAR</td>
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<td>1.04</td>
<td>1</td>
<td>0.779</td>
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</tr>
<tr>
<td>Cadiz</td>
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<td>2.00</td>
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<td>2.00</td>
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<td>1.63</td>
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<tr>
<td>SETAR (2;1,1)</td>
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<td>0.994</td>
<td>0.961</td>
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<tr>
<td>Band-TAR</td>
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<td>1</td>
<td>0.925</td>
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<td>Santander</td>
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<tr>
<td>SETAR (2;1,1)</td>
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<td>Band-TAR</td>
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**Notes:** SETAR (2;9,1) denotes a two-regime SETAR model (inside band vs. outside band) with nine autoregressive lags in both regimes, while for the transition variable we use the first lag. SETAR (2;1,1) is a two-regime SETAR model with a single lag in both regimes. The number of parameters includes the two variances ($\sigma_{\text{in}}^2, \sigma_{\text{out}}^2$). We consider a 5% trimming. Estimation period is 1825-1874.
The table indicates that the improvement in fit achieved by the SETAR model with nine lags is rather small, ranging from 1.8% in Zaragoza to 7.2% in Malaga. Another relevant feature of the results reported in the table is that, inside the band, the sum of the autoregressive coefficients is close to unity, supporting the random walk hypothesis for this regime, in line with the Band-TAR model. By contrast, outside the band the sum of the autoregressive coefficients is generally smaller. In light of these results, and given that previous historical analyses on the topic have mostly used a Band-TAR model with a single lag, which is more intuitive and interpretable in terms of the specie-point mechanism and allows calculating half-life estimates, for our analysis we adopt the Band-TAR model.

Since we are interested in analyzing the evolution of market integration over time, we perform a rolling window estimation of the Band-TAR model for each city. In practice, we experimented with different estimation windows and settled with 5,000 observations (thereafter RW5000) as this estimation window gave us more stable results. Figures 1 and 2 present, for each one of the sample cities, the rolling window estimates of transaction costs and the speed of adjustment of the market. These estimates are generally significant at the standard levels. Since bills of exchange prices are expressed as percentage distance from parity, transaction costs, as captured by the threshold parameter $\gamma$, are given as a percentage of the price. In the case of efficiency, we have transformed the speed of adjustment parameter $\lambda$ into an indicator of the half-life, i.e. the number of days that were necessary to reduce the distance of prices to the equilibrium bands by 50%.\textsuperscript{10} The horizontal axis in each figure indicates the initial and final years of the rolling windows.

\textbf{Figure 1. The evolution of transaction costs ($\gamma$) in the Spanish money market, 1825-1874 (%)}

![Figure 1](image)

$\text{Half-lives are calculated as } \text{Time}_{T/2} = \frac{\ln(0.5)}{\ln(\rho)}, \text{ where } \rho = 1 - \lambda.$
Note: The dotted line reports the results of an OLS regression line of the spread parameter on a constant and a time trend. Time trend is highly significant using bootstrapped standard errors or (normal) standard errors; see the estimation results in Table A1 of the Appendix.
Figure 2. The evolution of speed of adjustment in the Spanish money market, 1825-1874 (half-lives, days)
The rolling window estimation of the threshold parameters $\gamma$ shows a gradual reduction of transaction costs in the Spanish money market during the period under study (Figure 1). Part of this reduction can be attributed to the completion of the telegraph and railway lines connecting Madrid with the other cities, which took place largely in the late 1850s in the case of the telegraph and in the mid-1860s in the case of the railways.\(^\text{11}\) However, in most links the reduction of transaction costs started clearly before the arrival of those new technologies.

The overall average of the estimates across all windows and all nine cities is 1.1%, although individual city averages varied from 0.7% (Corunna) to 1.4% (Cadiz and Seville). These figures are not far from the direct transaction cost data that are available in contemporary sources for the latest years of the period. For instance, railway rates of transport of money and securities between Madrid and the nine cities of the sample ranged from 0.2 to 0.4% of the declared value in 1867 (Compañía de los Ferro-Carriles de Madrid a Zaragoza y Alicante, 1867: 14). Similarly, a study included in the reports of the Spanish Monetary Advisory Board estimated that the total cost of transporting metal from Santander to Madrid amounted to 0.3% in 1877 (Junta Consultiva de Moneda, 1876-80: 274-276). These transport costs should be increased by the fee of the brokerage of the bill trade associated to the movement of metal, which amounted to 0.2% (half paid by the seller and the other half paid by the buyer, see the Decreto Orgánico de la Bolsa de Madrid 08/02/1854, and Castaño, 1862: 108), and the stamp duty, which was 0.05% (Real Decreto 08/08/1851, Castaño, 1862: 95). Additionally, when the operation was conducted by an intermediary (merchant-banker), there was an additional commission fee of ca.

\(^{11}\) All nine cities in the sample were connected by telegraph with Madrid between 1855 and 1858. The railway connection of Madrid with Valencia was completed in 1859, with Barcelona, Bilbao and Zaragoza in 1863, with Cadiz, Malaga, Santander and Seville in 1866, and with Corunna only in 1883.
0.25%. The final cost was between 0.45% and 0.95%, not very different from our estimations of 0.6 to 1.2% for the latest rolling windows estimates (see Figure 1).

These percentages are also in line with the direct estimates of transaction costs for international money flows between the main world financial centers during the Classical Gold Standard, as reported by Officer (1989, table 1), which range from 0.62 to 0.69%. They are also, specially at the end of the period, similar to Canjels et al.’s (2004: 876) figure of ±0.67% for money flows between London and New York in 1879-1913, obtained by applying a similar model to ours. Finally, and not surprisingly, they are much lower than figures estimated for 16th century Spain, for money flows between Seville and Medina del Campo, which were as high as 6% (Bernholz and Kugler, 2011).

While the rolling estimation of the threshold parameters $\gamma$ shows a gradual process of reduction in transaction costs in the Spanish money market, the estimates of the speed of adjustment parameters $\lambda$ (transformed into half-lives) show a different picture. Interestingly, these estimates did not improve over time despite the reduction in transaction costs. Quite the opposite, half-lives tended to increase in all centers except for Corunna, indicating a decrease in market efficiency in the long run (Figure 2). In addition, their level looks higher than the available estimates in the literature for other markets. The average half-life estimate over all rolling windows and across all 9 cities was 14 days, although the individual city averages ranged between 6 days (Bilbao) and 48 days (Zaragoza). With the exception of Bilbao, all other averages are higher than the 6 days half-life for flows between London and New York during the classical gold standard (Canjels et al. 2004: 876), and the difference with the latter figure tended to grow larger over time.

Therefore, to sum up, the results indicate a gradual reduction in transactions costs in the Spanish money market, but no improvement in efficiency. Rather, in most cases, the speed of adjustment of the market tended to decrease over time. Therefore, the Spanish money market provides an interesting case in which price convergence and efficiency did not evolve in the same direction. The next section suggests some potential explanations for these results.

5. DISCUSSION

5.1. The early decrease in transaction costs

Our estimates indicate that, while the latest decreases in transaction costs in the Spanish money market correspond to the railway era, a significant share of those decreases took place before the 1860s, i.e. before the completion of the direct railway connections between Madrid and the cities in the sample. Such early progress seems puzzling in a country without previous cheap transport and communication alternatives (such as waterways). However, a potential explanation for the early progress in price convergence is the gradual improvement in road infrastructure and in the organization of high-speed inland transport that took place before the arrival of the railways. These processes probably had a significant effect on the cost of transport of money, as happened with other high-value commodities, wealthy passengers and information.

Progress in European high-speed transport during the early decades of the 19th century has been analyzed by Kaukiainen (2001). Focusing on the speed of information, he estimates that dispatch times in the 1850s were on average approximately a third of their level around 1820. This means that, on most routes, the decrease in the number of travel days was higher between those two dates than afterwards, with the introduction of the
telegraph. To a large extent, those early gains were the result of the first steamships and other advances in water transport technology and infrastructure. However, Kaukiainen also observes a significant increase in the speed of overland information transmission in several European economies. While, by 1820, only in Britain, northern France and, maybe, the Low Countries and part of Germany was overland transport able to regularly cover more than 100 km in one day, by 1840 this figure had increased to 200 km on many routes outside those areas, such as the roads to and from Danzig, Marseille or Trieste. There seem to have been also significant advances in other, more peripheral, areas, such as Odessa and Constantinople. Such widespread progress would be explained by better quality and higher density road networks, better carriages and improvements in the organization of coach lines (Kaukiainen, 2001: 11-13).

Similar advances took place in Spain before the arrival of the railways and this may explain the early steps in the integration of the money market. Map 2 to 4 show the Spanish road network in 1808, 1840 and 1855. Investment in the network, which was very low until Ferdinand VII’s death (1833), grew substantially thereafter. Between the end of the Napoleonic Wars and 1833 the government only invested 7.2 million reales per year. The length of the road system in 1833 was just 4,564 km, and the network consisted of a system of largely unfinished radial trunk routes centered in Madrid, partly inherited from the 18th century. Investment increased to 8.3 million per year in 1834-1840, 11.5 million in 1841-46 and 45.5 million in 1847-55 and, as a result, by 1855 the network length was 8,324 km (Uriol Salcedo, 1992: 223-25) and the main cities of the country (including the nine centers analyzed in this paper) were already connected with Madrid by good quality roads (see Map 4).  

12 It is very difficult to identify the specific date of completion of each road, due to the paucity of statistical information on the road network before 1856. The main contemporary sources (e.g. Dirección General de Obras Públicas, 1856; Alzola y Minondo, 1979) do not report specific dates. However, specific completion dates are less significant in the case of roads than in the case of railways, because construction took place over much longer periods, during which the economy could gradually benefit from the already completed portions. As a consequence, the positive shock associated to the construction of the main road network was not sudden, but was gradually felt along the second quarter of the 19th century.
Map 2. The Spanish road network, 1808

Map 3. The Spanish road network, 1840
There was also substantial progress in the organization of high-speed inland passenger transport and postal services before the 1850s, which were essential from the perspective of the money market operation. The increasing reliability, safety and speed of Spanish domestic passenger transport were perceived at the time as revolutionary (Madrazo, 1984: 420). Organized stagecoach transport of passengers started in 1816, with regular connections between Barcelona, Valencia and Madrid, and it significantly expanded in the 1820s.\(^{13}\) The frequency of postal services increased accordingly because, from 1820 onwards, many licenses of passenger services included the obligation to transport mail twice a week. Passenger services stagnated during the 1830s due to the Carlist War, but expanded again in the early 1840s, with a fast increase in their frequency and territorial coverage. In many routes, these services included the obligation to distribute mail three times a week. Finally, in 1844, the government decided to restore and reorganize the public postal service, establishing the daily distribution of correspondence in an increasing number of cities (Madrazo, 1984; Bahamonde Magro, 1993).

Following Kaukiainen (2001), we approach the effects of infrastructure and organizational improvements on transaction costs by looking at the speed at which information travelled, for two reasons. First, travel speed is an indication of the quality of infrastructure and transportation services, which largely determine transport costs. Second, in the case of high-value commodity, the speed and regularity of trips could have been as relevant as transport fares to determine transaction costs, through higher safety

\(^{13}\) For instance, the line between Madrid and Irun, in the French border, was opened in 1821, and the connection between Madrid, Seville and Cadiz in 1822; see Madrazo (1991: 137).
and certainty, savings in travel time and the associated costs (wages, insurance, etc.). To illustrate this issue, Figure 3 presents, based on a hand-collected dataset, the evolution of the number of days elapsed between the registered dispatch and reception of the correspondence that the agents of the Bank of Spain (or its antecedent, the Bank of San Fernando) sent to the bank headquarters in Madrid. We show data for agents based in Barcelona, Cadiz, Corunna, Malaga and Santander, which are the cities for which correspondence has been preserved.

**Figure 3. Speed of transmission of information to Madrid (km. per day, 3-month averages)**

The figure shows a sustained increase over time in the speed of information transmission. Such increase was especially high in the 1840s, with two significant boosts at the beginning and at the end of the decade. The synchronization of the evolution of speed among cities until 1850 is impressive, which indicates that improvements in information transmission were the result of national-wide processes, such as road investment and the reorganization of postal services in the 1840s. In the mid-1850s, right before the construction of the railway network, correspondence between these five cities and Madrid was transported at a speed between 150 and 200 km per day, which would be quite a

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14 Structural breaks applied to the five series in the graph (Bai and Perron, 1998 and 2003) find significant breaks in the 1830s and 1840s but not afterwards. The only exception is Cadiz, for which the test detects a break in 1858. The results of the tests are available upon request. On the reduction in travel time between Madrid and other Spanish cities before 1850 see also Madrazo (1991: 155-158).
respectable figure in comparative terms, according to Kaukiainen (2001). In other words, by the mid-19th century the efficiency of Spanish high-speed road transport was not far away from the best continental standards. In the 1860s, the railways allowed an additional increase in the speed of the postal service, which fluctuated around 220 km per day, and approached 300 in the case of Cadiz. A speed of 150 to 200 km per day meant that, by 1850, letters sent from these cities would arrive at the Bank headquarters in 3 to 4 days. This was a very short time, compared with the average 13 days that the mail took in the late 1820s. In other words, changes in the road network and in the postal service had reduced the number of days that the letters took to cross the country by 70%. In that context, the railways would only mean a reduction of one or, in the best circumstances, two additional travel days, which represented a relatively low decrease compared with the gains obtained in the 1840s.

In addition, such speed increase was associated to a significant decrease in speed volatility. This can be seen in Figure 4, which shows the trend and fluctuations of the number of days that correspondence took to arrive from each city to the Bank of Spain headquarters in Madrid. The trend and the cyclical component of each series have been isolated through the application of a Hodrik-Prescott Filter. The decrease in volatility in the 1830s or 1840s (depending on the city) is impressive and reflects the improvement in the system of high-speed inland transport. To sum up, from the 1830s or 1840s onwards, agents in each Spanish city could expect to receive information and high-value commodities from other cities with considerable regularity and at a comparatively high speed.

Figure 4. Long-term trend and fluctuations of the speed of information transmission to Madrid
The decrease in time was accompanied by other essential improvements, such as price reduction and increased safety. According to Madrazo (1991: 167) stagecoach passenger rates decreased by 57% between 1822 and 1854. This was important from the viewpoint of money transport, which usually was not dispatched, but carried by merchants or other agents, including in some cases security guards. And, especially since the 1840s and the deployment of the Civil Guard across rural Spain, banditry activity, which had been endemic some decades ago, was substantially reduced (Madrazo, 1991: 221-238). All these changes involved substantial savings and increasing certainty in Spanish overland transport. Although we cannot demonstrate causality, these improvements are likely to be among the main explanatory forces of the reduction in transaction costs that took place in the money market at the same time.

5.2. The constraints to increasing efficiency in the Spanish money market

The decrease in transaction costs in the Spanish money market was not accompanied by an improvement in efficiency. On the contrary, as seen in Figure 2, in most cases the speed of adjustment of the market tended to decrease in the long run, starting from already relatively low levels, with the exception of the links between Madrid and Corunna, where it remained virtually stagnant. In other words, in the mid-1870s, the adjustment of the Spanish money market to shocks was generally slower than in the 1820s.

The coincidence of price convergence with a decrease in efficiency has also been documented by Jacks (2005) in the context of 19th century wheat market integration in several countries. Jacks observes that market convergence and efficiency followed opposing trends in Spain, Russia and Norway, but not in other European countries, during the 19th and early 20th century. He explains such an apparent paradox by suggesting that progress in convergence can be associated to global improvements in commerce, communication and transport. By contrast, improvements in market efficiency might have been hindered by these countries’ low level of economic development. This interpretation might also be applicable to the case of the money market. The previous subsection described the progress in the Spanish transport system over the 19th century, even before the construction of railways, which seems to be the main explanatory factor for price convergence. By contrast, we suggest that limits to increasing efficiency in the money market were probably related to Spain’s low level of institutional development and, more specifically, to the outdated Spanish legal system, which imposed strict limits to arbitrage. The Spanish regulation restricted arbitrage by establishing that money transactions had to
be the counterpart of trade operations, therefore forbidding the speculative issue of bills of exchange. These constraints prevented agents operating in the market to take full advantage of price differentials in a speedy way. Thus, in line with Levine et al. (2000: 35), we suggest that Spain was a clear-cut case in which the legal and regulatory system seriously affected the ability of the financial system to mobilize money and provide ease exchanges.

During the period under analysis, the operation of the Spanish market of bills of exchange was regulated by the 1829 Code of Commerce. This was intended to provide the first national legal framework for trade activities, replacing the Consulates’ ordinances that had been in force during the early modern period. The need of a national mercantile law had already been included in the 1812 Spanish Constitution (art. 258), but it was not until 1827 that a commission of experts started discussing the contents of the new Code. Some parts of the new text, however, were highly conservative, including the regulation of bills of exchange, which was directly copied from the Bilbao Ordinances (1737), a compilation of the laws and trade practices used by the Bilbao Consulate until then. This meant the preservation of the Ancient Regime Spanish regulation of commercial finance and, more specifically, the strict prohibition of the speculative use of bills, for most of the 19th century (Divar Garteiz-Aurrecoa 2011: 17-18).

Such restrictive regulation was consistent with European contemporary ideas on well-functioning money markets, which assumed that bills of exchange should be “real bills”, i.e. bill drawn to cash real mercantile transactions (Encyclopedia Britannica, 1824: 205-206). By contrast, speculative bills were not backed by commodities as collateral. They were therefore unsecured bills that could disturb the money market and create speculative bubbles. This view was shared by well-known authors such as Adam Smith (1776, book II, ch. II) and Thomas Tooke (1840, vol. 3). The influence of the real bills doctrine went beyond Europe and inspired codes of good practices in the global banking system. According to these, banks should only discount high quality commercial paper backed by real mercantile transactions. This doctrine was influential enough to be reflected in the legislation of the US Federal Reserve Act of 1913 (Sargent and Wallace, 1982: 1234). In this context, however, Spain adopted the strictest and most traditional version of the real bills doctrine, forbidding the speculative issue of bills of exchange and, therefore, introducing a serious restriction to the smooth operation of the money market.

To understand why real-bills legislation restricted arbitrage, let us imagine a shock in the market that drove the quotation in Madrid of bills of exchange payable in Barcelona down to 95 units, far below par (100). Under these circumstances, it might have been profitable to move 95 specie units from Barcelona to Madrid, trade them there against a bill of exchange, cash this in Barcelona and receive 100 units. The arbitrageur would have gained 5 units with the operation. Arbitrage would take place whenever this gain was greater than total transaction costs (including the transport costs of specie, information costs, brokerage, delays, etc.). As a consequence of arbitrage, there would be higher demand in Madrid of bills of exchange payable in Barcelona, whose price would increase and move back to the fluctuation band of the specie-point mechanism. The speed of this adjustment would directly depend on the intensity of arbitrage.

However, if bills could only be issued or accepted as counterpart of commercial transactions, as established in the Spanish Code of Commerce, and speculative bills were forbidden, arbitrageurs’ activity was severely restricted. Following the previous example,

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15 Códigos españoles concordados y anotados (1851) includes the Bilbao Ordinances of 1737 and indicates how each article of the 1737 Ordinances was transferred to the 1829 Code of Commerce.
despite arbitrage opportunities to buy bills in Madrid to cash them in Barcelona, bills could only be traded in Madrid on Barcelona to pay commodities sold to Madrid. Under-arbitrage was therefore imposed by law and, if the restriction was effective enough, the efficiency of the money market and its speed of adjustment to shocks would directly depend on commodity trade volumes.

To make legal restrictions to arbitrage effective, the Spanish Code of Commerce established that only wholesale traders registered in the guild of merchants were protected by commercial law when using bills of exchange. The registry process was also regulated in the 1829 Code of Commerce (Lib. 1, Tit. 1, art. 1 and Lib.1, Tit. 2, art. 21-31). If an individual who was not registered in the guild of merchants wanted to operate with bills of exchange, he had to prove that those operations were the counterpart of trade. Otherwise, in case of non-payment, the unpaid bill would not be submitted to mercantile courts but to ordinary ones (Code of Commerce, 1829, Lib. 2, Tit. 9, art. 434; see also Avecilla, 1849: 209). This meant a significant lower legal protection, because the unpaid bill would be considered not as a commercial contract, but as a simple promise of payment regulated by ordinary laws on loans (Code of Commerce, 1829, Lib. 2, Tit. 9, art. 570). These measures represented an entry barrier intended to reduce arbitrage.

In addition, the legal system also prevented merchants from drawing speculative bills by a set of strict control measures, which were explicitly aimed at discouraging cheating. All operations executed with bills of exchange had to be registered by an authorized broker (Code of Commerce, 1829, Lib. 1, Tit. 3, art. 83). Brokers also had to give both participants (buyer and seller) an invoice of the operation, and mercantile courts had the legal authority to control brokers’ registry books and match the information registered there with merchants’ invoices (Code of Commerce, 1829, Lib. 1, Tit. 1, art. 86, 91, 93, 95 and 97).

Finally, reputation acted as a complementary mechanism to discourage merchants from arbitrating with bills of exchange. The legal definition of merchants included traders who operated for themselves, but also merchant-bankers who had expanded their activity to combine banking services, trade and other activities such as insurance or shipping (Montañes y Machado, 1860: 161). These merchant-bankers were the main agents in the Spanish banking sector at the time. They could operate as individuals or associate in general partnership companies (sociedades colectivas) or limited partnership companies (sociedades comanditarias), and their activity was based on long run solvency and reputation. Because merchants were personally and fully liable, their reputation provided credibility to their banking activities (García-Lopez, 1989) and therefore they were personally interested in trading with bills of exchange according to the law.

Although our knowledge about the agents who participated in the Spanish money market is very limited, the available evidence shows that the number of active merchants and merchant-bankers was rather limited, which intensified the reputational mechanisms. The

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16 The fact that trade activity was reserved to individuals registered in the guild of merchants reflected the Ancient Regime regulation of economic activity (Gondra 1992: 31), under which Mercantile Law was only applied to the trade activity of registered merchants. This contrasts, for instance, with the French Code of Commerce of 1807, which regulated trade operations in general, regardless of the agents involved (Gondra 1992: 28). Spain did not update her regulation until 1885, when a new Code of Commerce was issued to regulate the trade operations made by any individual that engaged in trade activity, without necessarily being a registered merchant (Jorge-Sotelo, 2016: 5). This liberalization of trade activity in 1885 involved the dismantling of the Spanish merchant guild (Menéndez Menéndez, 1986: 51-59), and included the liberalization of the use of bills of exchange, which in the new Code would always be valid and covered by Mercantile Law, regardless of the agents involved (Duque Domínguez, 1986: 151).
brokers’ registry books have been preserved for Barcelona, which allows knowing all registered bill of exchange operations and, therefore, the structure of the money market. Castañeda (2001b: 214-237) analyzes the participants in the Barcelona market of bills of exchange in the years 1817, 1840, 1848 and 1860. Half of the total amount drawn in bills was traded by only 20 individuals in each of those years. Because the number of participants was rather limited, it was possible to monitor their activities or, at least, the activity of the most relevant merchant-bankers.\textsuperscript{17}

To sum up, the legal system compiled in *Bilbao Ordinances* (1737) regulated the use of bills of exchange to discourage arbitrage because contemporaries considered that speculation was a source of instability in the system. We argue that the maintenance of Ancient Regime regulation of commercial finance in the 1829 Code of Commerce was an anachronism that limited the integration of the Spanish money market, constraining its speed of adjustment and its capability to efficiently allocate payments across the national territory in order to promote economic growth.

In order to test this hypothesis, we should analyze if the amount of money traded among cities using bills of exchange fell behind the evolution of GDP or domestic trade. The intuition behind this test would be that the higher the amount of money traded, the higher the liquidity of the system. Higher (lower) liquidity would have stimulated (discouraged) arbitrage, which, in turn, would have enhanced (decreased) market efficiency (Chordia \textit{et al.}, 2008). Unfortunately, information of the amount of money traded is not available for the period under study. In this context, a very indirect indicator of the constraints that the legal system established on the efficiency of the money market is the long-term stagnation in the number of brokers authorized to operate in Madrid and the amount of taxes they paid. According to the statistical summaries of the industrial and commercial tax, the number of brokers increased just from 34 to 40 (an 18% increase) between 1856 and 1879, while in the same period GDP grew by 41%\textsuperscript{18}, and interregional trade might be assumed to have growth even faster, thanks to the improvement in the road network, and, afterwards, to the completion of the main railway links. The growth of domestic trade was reflected in the increase of government revenues from road tolls (from 6.3 to 11.6 million *reales* between 1840 and 1856; see Dirección General de Obras Públicas, 1856: 302-307), and the evolution of the volume of railway freight traffic (ton-miles), which grew by 86 percent between 1865 (when most of the main lines had already been finished) and 1880 (Gómez Mendoza, 1989: 288-289; Herranz-Loncán, 2008: 124). In that context, the stagnation in the number of Madrid brokers, and also in the amount of taxes they paid,\textsuperscript{19} might be a sign the amount of money traded was falling behind the requirement of the economy.

\textsuperscript{17} In the mid-19\textsuperscript{th} century modern forms of banking emerged and coexisted with the traditional banking sector. Credit societies (joint-stock companies) participated in the bill of exchange market together with merchant-bankers. However, their participation was marginal. According to Castañeda (2001b: 232-234), three credit societies operated in the Barcelona market in 1860, accounting for very small proportions of the total amount of transactions. More specifically, the *Compañía General de Crédito en España (Barcelona)* represented 0.69\% of the amount traded that year in the market, the *Crédito Mobiliario Barcelonés* accounted for 0.32\%, and the most important of the three, the *Sociedad Catalana General de Crédito*, represented 6.58\%.

\textsuperscript{18} \textit{Estadística Administrativa de la Contribución Industrial y de Comercio}, years 1856 and 1879; Prados de la Escosura (2017). There is not fiscal tax published for any year before 1856.

\textsuperscript{19} Brokers paid a fixed tax quota as “industrial and commercial” tax, which depended on the city where they operated, and which was supposed to be gradually updated over time to reflect the variation in the average size of brokers’ profits. Although the Spanish fiscal system cannot be assumed to have been updated regularly, the gradual increase in those fixed quotas would be a very indirect indicators of the
The stagnation of liquidity, due to an outdated regulation, might have had negative effects on Spanish economic growth and structural change. Because the use of bills of exchange was restricted to wholesale merchants, emerging industrial sectors remained to a large extent outside the formal circuits of commercial finance. Unlike the British case, in which industrial sales were backed by bills of exchange and manufacturers could transfer commercial credit to a banker who would discount the bill, in Spain, manufacturers’ clients (retail merchants) did not participate in bills of exchange circuits and, as a consequence, an informal system of payments based on credit provided by manufacturers to clients had to be developed as a second best, in order to sustain industrial development outside the boundaries of the financial system (Prat, 2009).

Constraints to the access to means of payment would only be removed when the Bank of Spain obtained the national monopoly of banknotes issuing in 1874. The Bank established a network of provincial branches, mainly between 1874 and 1886, and implemented the system of free transfers between branches, which allowed overcoming the restrictions to integration imposed by the old Ancient Regime legal framework. This gave way to a striking increase in the volume of the Bank’s interregional money transfers, from 2.4 to 10% of GDP between 1884 and 1900 (Castañeda, 2001a: 119; Prados de la Escosura, 2017), which would be a direct indication of the removal of the prevailing constraints to the operation of the payment system.

6. CONCLUDING REMARKS

This paper analyses the process of integration of the Spanish money market during the 19th century. Taking advantage of the late nationalization of the Spanish monetary system and the availability of a rich hand-collected database of daily prices in Madrid of bills of exchange on other Spanish cities, we have applied a Band-TAR model to estimate the evolution of price convergence and efficiency in the Spanish money market between 1825 and 1875. Our estimation results offer a mixed picture of the degree of market integration in Spain. Whereas there was substantial progress in price convergence since the early decades of the century, speed of adjustment to shocks decreased over time in most of the links of the sample.

We suggest several possible explanations for those results. Early price convergence was probably associated to the significant progress that took place in Spanish road infrastructure and the organization of high-speed overland transport before the arrival of the railways. These factors would have allowed a substantial decrease in transaction costs in the money market, down to levels comparable to those prevailing in the links between the most important international financial centers. However, the reduction in transaction costs was not accompanied by an increase in the efficiency of the market. We suggest that legal constraints to arbitrage might help to explain that the market speed of adjustment stagnated or even declined over time. The Spanish legal framework might arise therefore as a potential factor of economic backwardness, pointing at the significant impact that legal structures may have in long term economic growth (La Porta et al., 1998).

As a consequence, the integration of the Spanish money market remained incomplete at least until the 1870s and the consolidation of a perfectly integrated money market had to evolve.
wait until the nationalization of the Spanish monetary system. This took place between 1874 and 1884 through the concession of the note-issuing monopoly to the Bank of Spain, the quick creation of the Bank’s network of branches, the introduction of national banknotes valid in the whole Spanish territory, and the adoption of a system of free transfers between the Bank’s provincial branches (Castañeda, 2001a; Martín-Aceña et al., 2013).

The nationalization of the Spanish monetary system represented the end of a system of money transfers based on sight bills of exchange. The new monetary institutional structure reduced the costs of moving money across the Spanish territory to zero and provoked therefore the full integration of the Spanish money market. This integration was clearly reflected in the London Stock Exchange. In 1877-1887, the centers whose bills were quoted in London were reduced from nine to six (Madrid, Cadiz, Barcelona, Malaga, Seville and Valencia). And, from 1888 onwards, only one Spanish exchange rate was quoted in The Economist, under the label: “Madrid, Barcelona & co.”. With a substantial delay over other Western European countries, this was the end of the traditional city-based monetary system in Spain, which had faced significant institutional constraints to full integration.

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APPENDIX

Figure A1. Prices in Madrid of bills of exchange payable in each city (percentage points of distance from official parity) 20

20 The published data are the quotations reported by brokers at the end of the day. They are sometimes reported as a range, which represented the bid-ask price (Castaño 1862:99). In those cases, we have used the range midpoint (Canjels et. al. 2004: 870). Data plotted in Figure A1 exclude outliers. These correspond to periods of financial crises (especially those of 1848 and 1866), in which the Bank of Spain delayed the conversion of banknotes into specie. Under those circumstances, private bankers and money dealers kept exchanging banknotes for metallic currency, after applying a discount to the face value of the banknote (see Santillán, 1865: T1, 281-283; and Tedde, 1999: 222; and 2015: 18-27, for the 1848 crisis; and Tedde 2015: 304-327, for the 1866 crisis). During these episodes of “pseudo-convertibility”, some bills of exchange circulated with a special clause indicating: “payable in gold or silver, excluding all paper money” (Historical Archive of the Bank of Spain, Cartas de los Comisionados del Reino y Sucursales, file 1125 – Corunna, 1847 and 1848-, and file 1307 –Santander, 1848) and exchange rate quotations were divided in two: nominal exchange rates (in the case of bills payable in notes), whose quotation incorporated the depreciation of banknotes; and metal exchange rates (in the case of bills payable in gold or silver). We have found some anecdotal evidence of provincial bulletins which published both nominal and metal exchange rates with Madrid. For instance, in the case of Bilbao, in December 2nd, 1848, bills payables in notes were quoted at 3.5%, whereas those payables in metal were quoted at 1.5%. The Zaragoza Discount Bank (Caja de Descuentos) indicated in April-June 1848 that: “all changes must be made in notes due to shortage of money”. In April 1848, the commissioner of the Bank of San Fernando in Zaragoza complained that: “it was impossible to find takers for bills of exchange even at a discount of 2.5, and silver is extremely scarce. Having bills today is useless, since silver is impossible to find.” In the same town, in August 1848, the exchange was 4 to 4.5% in the case of notes and 1% in the case of metal (Historical Archive of the Bank of Spain, Cartas de los Comisionados del Reino y Sucursales, file 1079, Bilbao; file 1380, Zaragoza; and file 1125, Cadiz). Unfortunately, Madrid brokers only reported the nominal exchange rate (published in the Gaceta de Madrid and the Official Bulletin of the Madrid Stock Exchange). Because the specie-point mechanism measures transaction costs in convertible specie-systems, and free convertibility is an absolute requirement for the proper estimation of the model, we must exclude those observations. To identify outliers, we proceed as in Stock and Watson (2005), and define as outliers as those observations with absolute median deviations larger than 3 times the interquartile range. Following these authors' recommendations, to carry out the estimation, outliers have been replaced by the median value of the series.
Note: Data for Cadiz were misreported from 13/08/1866 to 19/10/1866 (exchange rates were quoted with premium instead of discount). To certify and correct the quotation, we have calculated the indirect exchange rate in Madrid on Cadiz as the exchange rate in Madrid on London multiplied by the exchange rate in London on Cadiz (data from The Economist).
Table A1. Time-trend coefficient of a regression of the RW estimated $\gamma^{21}$

<table>
<thead>
<tr>
<th>City</th>
<th>Time trend coef.</th>
<th>Bootstrap std.err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barcelona</td>
<td>-0.000086</td>
<td>6.85e-07</td>
</tr>
<tr>
<td>Bilbao</td>
<td>-0.000065</td>
<td>3.90e-07</td>
</tr>
<tr>
<td>Cadiz</td>
<td>-0.000054</td>
<td>1.97e-06</td>
</tr>
<tr>
<td>Corunna</td>
<td>-0.000049</td>
<td>5.81e-07</td>
</tr>
<tr>
<td>Malaga</td>
<td>-0.000156</td>
<td>1.29e-06</td>
</tr>
<tr>
<td>Santander</td>
<td>-0.000134</td>
<td>6.45e-07</td>
</tr>
<tr>
<td>Seville</td>
<td>-0.000114</td>
<td>6.00e-07</td>
</tr>
<tr>
<td>Valencia</td>
<td>-0.000114</td>
<td>6.42e-07</td>
</tr>
<tr>
<td>Zaragoza</td>
<td>-0.000125</td>
<td>8.72e-07</td>
</tr>
</tbody>
</table>

Table A2. Time-trend coefficient of a regression of the RW estimated half-lives

<table>
<thead>
<tr>
<th>City</th>
<th>Time trend coef.</th>
<th>Bootstrap std.err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barcelona</td>
<td>0.000968</td>
<td>0.0000161</td>
</tr>
<tr>
<td>Bilbao</td>
<td>0.0009733</td>
<td>0.0000101</td>
</tr>
<tr>
<td>Cadiz</td>
<td>0.0012944</td>
<td>0.0000579</td>
</tr>
<tr>
<td>Corunna</td>
<td>-0.0000434</td>
<td>0.0000174</td>
</tr>
<tr>
<td>Malaga</td>
<td>0.0057099</td>
<td>0.0000397</td>
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<tr>
<td>Santander</td>
<td>0.0007813</td>
<td>0.0000143</td>
</tr>
<tr>
<td>Seville</td>
<td>0.0014533</td>
<td>0.0000181</td>
</tr>
<tr>
<td>Valencia</td>
<td>0.0017211</td>
<td>0.0000122</td>
</tr>
<tr>
<td>Zaragoza</td>
<td>0.0179965</td>
<td>0.0001028</td>
</tr>
</tbody>
</table>

Regression in Tables A1 and A2 are based on bootstrap standard errors, though a similar conclusion is reached when normal standard errors are employed (results for the latter are provided upon request).