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Differences in silver prices across temporal and spatial dimensions
Silver pricing and determinants of local prices in the 19th-20th century

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Abstract

The paper has a twofold purpose: first to introduce a database of local silver prices and silver production collected from multiple sources, covering multiple countries in the 19th and 20th century. The paper describes the data sources and methods used in the compilation of the dataset in order to support similar research efforts in economic history and to enable the use of the dataset for further analysis. The second goal is to investigate the collected data in relation with the effect of local characteristics on prices and whether the price of this widely traded commodity shows a convergence due to the growing impact of international trade. Based on the data the paper argues that despite a convergence of silver prices in the 16th-17th century, described in the literature, prices were still affected by local environment in the 19th and 20th century and therefore a convergence of prices was not fully reached.
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1 INTRODUCTION

The focus of this paper is to present a dataset of comparable international silver prices for the period of 19th-20th century, to describe the process of its compilation and to conclude basic descriptive analysis on the obtained data. The dataset was created as part of an ongoing research effort, led by Prof. Jörg Baten, at the University of Tübingen Economics Department. As part of a research internship here, the author had the opportunity to work on the discovery of this particular area with the help of Mr. Daniel Steinberg.

With this paper I have various objectives. First to introduce and present the dataset which can be helpful for researchers of economic history. Second to document how the collection of the data for a topic like this goes and to highlight certain methods, calculations, issues and questions which I encountered along the way. At last to present the results from the basic analysis conducted on the data.

To ensure that these goals are met the paper is organised as follows: in the next parts of the introduction the important characteristics of the international silver price and why silver is one of the most important commodities internationally are introduced. This historical introduction, based on the available literature is the basis of the last – analytic – part of the paper. After that the compilation of the dataset in question will be detailed including the sources, the format and the various issues (with an emphasis on the use of exchange rates in calculations) encountered in connection with the data collection. In the last part of the paper a basic analysis based on the literature and the questions it raised are presented.

1.1 WIDER CONTEXT OF THE DATA COLLECTION

As it was mentioned before, the data collection process was part of a bigger ongoing project which aims to collect price information internationally for the most common commodities, such as iron, aluminium, gold etc. The research is aimed to use these datasets to analyse the effects of international trade and globalisation in general on local prices and on the diversity of prices across countries. A dataset like this can answer several important questions considering the impact of openness on local prices and through that the reallocation methods implied by trade activity. It was an important aspect of the data collection to try to have so called “complete” observations in the data – observations where next to the (comparable) price data both local production and GDP / capita data can be supplied.

1.2 INTRODUCTION TO THE PRICE MOVEMENTS OF SILVER

The starting point for the understanding of the global price movements and divergences of silver were Flynn & Giráldez’s work on the question of silver prices and how it affected global markets and the development of international trade\(^1\). In their 1995 piece they have analysed the world market of silver mostly between the beginning of the 16th century and

\(^1\) Flynn and Giráldez, ‘Born with a “Silver Spoon”’; Flynn and Giráldez, ‘Cycles of Silver’. 

[1]
the 17th century. They emphasized the importance of China on the demand side and Spanish America and Japan on the supply side. They have also written about the arbitrage opportunity which arose from the unsatisfied demand in China in the period of the 16th to the 17th century and indicated by the bimetallic ratios2 reported by Chuan (1979, p144) of 1:5.5-7, while the same ratio in that period in Spain was 1:12.5-143. However in their 2002 article they also stated that the bimetallic ratios – following two cycles in 1540-1640 and 1700-1750 when the demand was peaking – converged between the cycles and after them4. This is in line with the findings of Atwell5 who found that around 1640 the bimetallic ratios globally converged. The second cycle however, which started at the beginning of the 18th century had also seen diverging ratios. As reported by von Glahn (1958, p57) then the divergence was giving a 50% premium when selling in China6.

Based on this literature I came to the conclusion that in the period, which I were looking at (beginning of the 18th century to nowadays) I will find mostly converging prices with small differences across countries due to the converging prices and the integration of global trade.

Also based on the work of the mentioned authors the importance of the silver standards must be emphasized. In our case the silver standard means more than one thing: 1) that we are searching for a price of something what have been seen in certain periods and certain locations as something for which the prices were given in, 2) in the case of silver standard countries the exchange rates should not diverge from the intrinsic price of silver.

The first notion – from a point of data collection – means that we need a common denominator or base to compare the prices – as we will see later the using of an established and commonly recognized currency could be a way to establish such a denominator. This also means that the use of currency exchange rates to establish price data (mostly for countries who use the silver standard) is a possible way to go – evidence for such practice was found in Leavens7 (whose article later turned out to be also a valuable data source).

The second notion also supports the use of currency exchange rates. As Hasan argues8 any discrepancy between the exchange rates and the intrinsic value of silver “signals an inefficient market and profitable arbitrage opportunities”9. Therefore it is assumable that – apart from some serious market failures, which happened in the case of the 16th-17th century China (see above) – the exchange rates follow the intrinsic value of silver in these countries.

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2 The rate of gold:silver exchange.
3 Flynn and Giráldez, ‘Born with a “Silver Spoon”’.
4 Flynn and Giráldez, ‘Cycles of Silver’.
6 Flynn and Giráldez, ‘Cycles of Silver’.
7 Leavens, ‘Bullion Prices and the Gold-Silver Ratio 1929-45’.
8 Hasan, ‘Equilibrium and Efficiency of Exchange Rates in a Silver-Based Monetary System—the Cases of India and Iran’.
9 Ibid., 319.
Raising that question we can gain deeper understanding from Mitchner & Voth\(^{10}\). The paper emphasizes the important role of China in the context and describes the common use of the silver standard – even after the end of the 19\(^{th}\) century. The authors highlight that many Asian countries used silver based currencies, China even as long as 1935\(^{11}\), often in the forms of bullions, ingots or foreign money. They used the money not at its nominal price, but at its silver content. They also outlined that the silver standard came under pressure following the 1870s – Diebold gives an overview when the European states switched from the silver standard\(^{12}\) – which caused a gradual demonetization.

Leavens\(^{13}\) and Blagg\(^{14}\) provided an important source for understanding some of the more recent periods and their price movements. First it is important to talk about the London price fixing, which started a few decades after the introduction of the gold standard to most western states. In the summer of 1896 the silver price reached an all-time low, thanks to the oversupply of the precious metal\(^{15}\), thus the most important London brokers of silver agreed to fix the daily price through a negotiation process\(^{16}\). This mainly established an accepted international price as other cities started to follow the London Fix price. Following the introduction of the fixing the other important market event was the decline of price in the years between 1929 and 1936. This eventually led to China’s switch to gold standard and a decree by the Roosevelt administration which – after a new all-time low price in 1932 – fixed the domestic purchase price and obligated mintages to buy the American mined silver\(^{17}\).

Therefore the literature also directed me to prioritize certain countries in my research efforts like China, Mexico, Peru or Japan, and also shifted my focus to specific periods: I thought that after the introduction of the London fixing – apart from government interventions – the prices are most likely to converge to the internationally set price. Also I thought that the greatest differences could be detected before the 18\(^{th}\) century, nevertheless for that period we have no production or GDP data. The switch for gold standard also defines an interesting point as it marks the time when silver in most western countries become a commodity. Therefore the first focus period should be between 1870 and the beginning of the 20\(^{th}\) century (we can assume that it have taken some time for the London fixing to have global effect), while the second most important is a wider period between 1800 and 1870.

\(^{10}\) Mitchener and Voth, ‘Chapter 5 - Trading Silver for Gold: Nineteenth-Century Asian Exports and the Political Economy of Currency Unions’.
\(^{11}\) Ho, ‘Dilemma of the Silver Standard Economies’.
\(^{12}\) Diebold, Husted, and Rush, ‘Real Exchange Rates under the Gold Standard’.
\(^{13}\) Leavens, ‘Bullion Prices and the Gold-Silver Ratio 1929-45’.
\(^{14}\) Blagg, ‘1897 - 1939, A New Era for the London Silver Price’.
\(^{15}\) Mitchener and Voth, ‘Chapter 5 - Trading Silver for Gold: Nineteenth-Century Asian Exports and the Political Economy of Currency Unions’.
\(^{16}\) Blagg, ‘1897 - 1939, A New Era for the London Silver Price’.
\(^{17}\) Leavens, ‘Bullion Prices and the Gold-Silver Ratio 1929-45’.
2 DATA COLLECTION

As it was stated before the main aim of our work was to collect regional prices for different metals over the period of about 300 years from the end of the 17th century to today. The collected price observations then were supplemented with GDP data for the particular year and country and production data from the CLIO-Infra dataset. The idea is to trace certain trends in the dataset, and to be able to discover the impact of certain events detailed in the literature (and in the introduction part of this paper). The addition of GDP and production data was needed for the wider project and in our case also gives an opportunity to see how local prices are impacted by local supply and the development level of the observed countries.

The following subsections will deal with the questions of setting up a format for the dataset, the data collection process itself and the issues and questions arisen through the collection process.

a. FORMAT OF THE DATASET

The data format was set up at the beginning of the collection process. I decided on using a long data format out of the consideration that it can be easily imported to STATA or other statistical packages for further analysis of the data. Therefore the column structure of the dataset is the following (every bullet indicates a separate column):

- Country code
- Country
- City
- Year
- Price
- GDP per capita
- Production Volume
- Comparable price (GBP / gram)
- Comparable price (USD / gram)
- Unit (price)
- Source (price)
- Unit (GDP)

Most of the variables are obvious for a dataset like this, however there are some columns which are important to talk about. First I have not included the city variable in the initial database, but after the first steps in the data collection I had to realize that in certain time periods and at certain places there was a possibility of wildly various prices. Germany is a good example of that: here part of the data is based on the prices reported in Hamburg while another is based on a country wide average. Through the city variable these differences are indicated in the dataset. GDP per capita and Production Volume are included firstly because of reasons detailed above, while the introduction of comparable prices based on common currencies are inevitable for the dataset to provide value for analysis.

GDP per capita data is derived from Mr. Steinberg’s advice from the New Maddison Project Database created by the Maddison Project in 2013. Later population estimates...
data were added from the CLIO-Infra database, which gave opportunity for further analysis in some cases.

2.1 METHODS AND SOURCES, THE PROCESS OF DATA COLLECTION

The data presented in the database is collected from multiple sources, with often differing definitions and units of measurement. As the dataset is later on used to derive calculations and some important insights of the period, I find it important to give an example of data collection, and possible problems arising. I also introduce available sources that can be used for a research topic like this. In this section I show in detail how the sources were used, what problems have arisen and how I handled them during my research.

First I would like to offer some general remarks on this kind of historical data collection. Data collection is obviously the easiest for recent time period and for western countries. There is also a speciality because of the commodity analysed in this paper: silver is a currently traded commodity and investment metal and as such it has an easily accessible international price, which is mostly given accordingly to the London market. Because of the availability of this information it is also assumable that most prices are currently (and in the last few years) set to this level.

Also it should be noted that already compiled databases of historical prices and measures can provide resourceful sources when looking for price data as they often report volumes and traded sums from which average unit prices could be calculated. The same hold for (mostly foreign) trade data, which is a valuable source for the same reasons.

There are some starting points which I would like to recommend for starting similar researches:

- The International Institute of Social History’s datafiles section could provide an excellent source for historical economics data. The datasets are grouped by their country coverage and time coverage can be easily seen from their descriptions. The files are mostly come in an easily processable format.
- It could also prove valuable to search for historical reports published by statistical agencies (or in our case even central banks). While these agencies usually do not provide very long historical series through their general interfaces (such as annual statistical reports) they often provide research papers or historical records going back longer periods.
- Collection of individual data points (which is a more time-consuming task) on international prices is sometimes possible through the use of contemporary travel books. For example Galignani’s Traveller’s Guide whose editions (published around 1820-30) are available in a digital format on Google Books and hold data on exchange rates and prices of various goods (not used in the current dataset).

International Institute of Social History, ‘List of Datafiles of Historical Prices and Wages’.
Much of historical data is existing, however have not yet digitalized. A good example of that is Schmitz’s book\(^{21}\) which contains a wide selection (both in temporal and geographical spectrum) of data, but only digitized in parts (the CLIO-Infra dataset publishes certain parts of it and the current dataset contains data from it on Germany and the United Kingdom). Nevertheless these books are often hard to find and available only at major university libraries.

Going from the general comments to the process of data collection in my project, various sources and the way their data was used will be presented in the following paragraphs. There are some highlighted sources (which includes multiple countries) shown in a detailed way and the rest is grouped and discussed by country.

### 2.1.1 Robert C. Allen datasets

A dataset compiled by Robert C. Allen can be found in the IISCH collection titled “Consumer price indices, nominal / real wages and welfare ratios of building craftsmen and labourers, 1260-1913” by Robert C. Allen\(^{22}\). The dataset provides data for various wages and goods’ prices from various sources and contains data for 17 European cities. Although the wages / prices do not provide direct price points for these periods / cities Allen also included various exchange rates, often in the local currency’s exchange rate against silver. This was due to the fact that silver is mostly used as a common denominator in the period between the 17th and 20th century, as it was claimed before.

Because of that the Allen dataset is the first and most important part of the data collection. To transform the data to the final format we have to use the currency exchange method grounded in the introduction part. As it was stated before the observations have to be made somehow comparable. Based on the introduction and Hasan’s argument\(^{23}\) the problem of comparability can be solved by using a relatively permanent and stable valued currency such as the British Pound (my attention was later brought to the question that using this approach can possibly mean that the differences between the prices are only exchange differences not “real” price differences – this problem will be discussed later).

Therefore the Allen dataset was processed with the following method – I checked whether it had data on silver related exchanges / prices in a particular table and if yes, I proceeded with obtaining the data, connecting it with production date and GDP / capita data and – if it was needed – and I tried to find exchange rate data to bring the prices to a common denominator (the GBP).

I was able to do this for the table of Vienna, Austria (Prices and Wages in Vienna, 1439-1913) where Allen have given the grams of silver per Kreuzer in the Conversion, Sources & Comments table. Then I had to convert these measures to a comparable (GBP/grams) measure, which I did using the following formula (1):

\[^{21}\text{Schmitz, World Non-Ferrous Metal Production and Prices, 1700-1976.}\]
\[^{22}\text{Allen, ‘Consumer Price Indices, Nominal / Real Wages and Welfare Ratios of Building Craftsmen and Labourers, 1260-1913’.}\]
\[^{23}\text{Hasan, ‘Equilibrium and Efficiency of Exchange Rates in a Silver-Based Monetary System—the Cases of India and Iran’}.\]
(1) \[ \frac{1}{\text{price}_t} c_{\text{GuldenKreuzer}} / c_{\text{CrowsGulden}} / e_{\text{GBPCrowns}}_t \]

Where \( \text{price}_t \) is the grams of silver per Kreuzer in \( t \) year, \( c_{\text{GuldenKreuzer}} \) is the conversion rate between Gulden and Kreuzer in 18-19\textsuperscript{th} century Austria (its value is 100), while \( c_{\text{CrowsGulden}} \) is the conversion rate between Crowns and Guldens in the same period (which is 0.5) finally \( e_{\text{GBPCrowns}}_t \) is the exchange rate between Austrian Crowns and British Pounds in year \( t \).

Through a similar process I was able to calculate comparable prices for Madrid. For this procedure two measures from the Allen dataset (Grams of pure silver / pesetas and Pesetas per pound sterling) were obtained and used for the calculation.

Through further investigation into this dataset I was able to obtain data for Gdansk, however these data points were proven to be problematic and therefore cannot be used in the final data. With Gdansk the problem was that I was not able connect the city level price data to a country level GDP or production volume, because of the changing country affiliation of the city.

Denzel in the Handbook of world exchange rates, 1590-1914 reports exchange rates for most of the important trade centres\textsuperscript{24}. After discovering these exchange rates I also reconsidered some of the data supported by Allen, and found that the price data for 1891-1914 from Florence is usable with its support.

2.1.2 United States of America, United Kingdom

I easily found the fixed price of London and New York for the period 1975-2010 on the Silver Institute’s website\textsuperscript{25}, which is a commercial institution focusing on silver as a commodity.

For the UK I found the KITCO historical charts / data, which covers the UK’s London Fix prices from 1792 to 2014\textsuperscript{26}. The price is once again given in USD / ounces, therefore I used the previously collected exchange rates and conversion rates to get a comparable price.

For the US I was able to complement the previous data using the data provided by USGS (1900-2010)\textsuperscript{27} and by Peter H. Lindert (1800-1977)\textsuperscript{28}. For the USGS observations prices were given for units of troy ounce, therefore a conversion have to be used to get comparable prices (1 troy ounce = 31.1033 grams; 1 ounce = 28.3495 grams) and also exchange rates have to be used. For the data reported by Peter H. Lindert pure silver market price in pounds were given, therefore I was able to use these directly. Furthermore for the USGS prices exchange I obtained GBP/USD exchange rates for the period 1791-2014 from the MeasuringWorth database\textsuperscript{29}. This additions meant that for the US at this point I had a

\textsuperscript{24} Denzel, Handbook of World Exchange Rates, 1590-1914.
\textsuperscript{25} The Silver Institute, ‘Historical Prices’.
\textsuperscript{26} Kitco Metals Inc., ‘Historical Silver Data and Charts - London Fix’.
\textsuperscript{28} Lindert, ‘Silver in North America 1649-1977’.
\textsuperscript{29} Officer, ‘Dollar-Pound Exchange Rate From 1791’.
dataset of comparable prices covering the period 1800-2010 and production data for 1834-2012. As a supplement I also collected data from the UNCTAD \(^{30}\) who publishes Handy & Harman data from New York in \(\text{¢}/\text{troy ounce}\) for the period 1970-2014.

2.1.3 France
I found out that the Banque de France published data on silver and gold prices between Paris-London-Hamburg and also exchange rates between these cities \(^{31}\). Using the French language source provided by the Banque de France I was able to calculate comparable price data for Paris and also for Hamburg. The prices were given in the local currency (Francs/Mark) per kilograms, therefore to get the comparable price I had to convert the volume measures to grams and use the exchange rates from the Banque de France dataset. This led to a dataset for the period 1815-1873 for Paris and Hamburg. I also had to clear the role and value of Reichsmark and Mark Lübs bancos to have a stable time-series.

2.1.4 Germany
I was able to access a book by Schmitz \(^{32}\) at the University of Tübingen Institut für Politikwissenschaft, a big part of CLIO-Infra production data builds on the prices and volumes reported in this book, and the book also reports silver price data – along with other metals – for certain countries and periods (mostly between 1900 and 1975 and for Germany, US, UK). First I checked some of the existing data against these number in case of the US/UK which turned out to be quite similar and second I digitalized the data for German average price between 1897-1974. This is a good example of datasets which have not yet been digitalized and despite their high value are still only available physically. Saving these sources and the data contained in them is an important goal of economic history research.

2.1.5 Japan
I was also able to find online sources such as the Japanese Statistical Office’s trade data on Metallic Ore production, based on what the market prices for silver could be calculated\(^{33}\). The Statistics Japan provides production data for metals such as that for every year the gross production and the gross value is reported (in yens and in kilograms). From that the calculation followed the formula (2):

\[
\frac{\text{Gross value}}{\text{Gross quantity}} \times 0.001 \times \frac{\text{ex}_{\text{USDJPY}}}{\text{ex}_{\text{GBPUSD}}}
\]

Where \(\text{Gross value}\) is the value reported by Statistics Japan in thousand yens, \(\text{Gross quantity}\) is the quantity reported by Statistics Japan in kilograms, the 0.001 multiplier was used to convert from kilograms to grams, while the \(\text{ex}_{\text{USDJPY}}\) is the USDJPY


\(^{31}\) Banque de France, ‘Taux de Change et Prix de L’or et de L’argent - Les Tableaux de Series (1800-1873)’.

\(^{32}\) Schmitz, World Non-Ferrous Metal Production and Prices, 1700-1976.

\(^{33}\) Statistics Japan, ‘Quantity and Value of Production of Metallic Ores, Non-Metallic Ores, Coal and Crude Oil (1874-2003)’.
exchange rate in year $t$ \(^{34}\) and the $e_{GBPUSD_t}$ is the GBPUSD exchange rate in year $t$ (this is to ensure comparability). Because of the two currency exchange calculations the stability of the prices points are not the best, but for Japan another dataset have not been found yet.

### 2.1.6 Peru

Another valuable asset was found on Peruvian prices. First I was able to find the book “Between silver and guano: commercial policy and the state in post-independence Peru” by Gootenberg, which among many very interesting stories about the Peruvian economy also reports average prices for the period of 1833-1850 \(^{35}\). Further data on Peruvian prices was found online – however it is unfortunately based on estimations – in S.J. Hunt’s paper \(^{36}\) for the years 1913, 1929, 1939, 1950, 1953, 1954 and 1959.

### 2.1.7 China

After many failed attempts of finding data on China I finally found data from two hidden sources. First from Atwell\(^{37}\) where the data was given in USD / taels (33.9 grams), and then from Hsiao\(^{38}\) where data again was published in haikwan taels (which are different from traditional or Shanghai tael, with a value of 37.53 grams).

### 2.1.8 Mexico

For Mexico I was able to find data on the 17th – beginning of 18th century reported by John J. TePaske (available on Richard L. Garner’s site)\(^{39}\) and on the 1902-1976 period reported by the Mexican INEGI\(^{40}\).

Of course the values were given in Mexican pesos, therefore for the currency conversion I used data from Nugent’s article\(^{41}\) and from a recent report by the INEGI\(^{42}\).

### 2.1.9 Issues and dead ends

I ran into a dead end with Italian price data – I have been working from primary sources, mostly primary exchange rates, for which I collected data from various sources (like contemporary travel books and exchange rate reports). I was only able to collect silver prices for Naples and also exchange rates for the Naples Carlini, between 1798-1857, however production data was not available for the periods in Italy. That is why it was neglected from the final dataset.

### 2.1.10 Summary

This meant that by the end of the day I compiled a database including price data for 13 countries. The dataset contains data points between 1439-2014 for price data, data points

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34 Officer, ‘Exchange Rates Between the United States Dollar and Forty-One Currencies’.
35 Gootenberg, *Between Silver and Guano*.
38 Hsiao, *China’s Foreign Trade Statistics, 1864-1949*.
41 Nugent, ‘Exchange-Rate Movements and Economic Development in the Late Nineteenth Century’.
for GDP / capita between 1800-2010 and production data between 1741-2010. Also for the calculation of comparable prices I compiled currency exchange data for 12 currency pairs. I used 19 data sources for price data and used 11 data sources for currency exchange data. I summarized the data available in the following tables (additions are separated by two-lines and described below):

<table>
<thead>
<tr>
<th>Country (City)</th>
<th>Period</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria (Vienna)</td>
<td>1439-1913</td>
<td>Allen, Vienna(^{43})</td>
</tr>
<tr>
<td>Austria-Hungary</td>
<td>1827-1914</td>
<td>Cvrcek(^{44})</td>
</tr>
<tr>
<td>France (Paris)</td>
<td>1800-1873</td>
<td>Banque de France(^{45})</td>
</tr>
<tr>
<td>Germany (Hamburg)</td>
<td>1816-1873</td>
<td>Banque de France(^{46})</td>
</tr>
<tr>
<td>Germany</td>
<td>1897-1974</td>
<td>Schmitz(^{47})</td>
</tr>
<tr>
<td>Italy (Naples)</td>
<td>1798, 1819, 1824, 1829, 1835</td>
<td>Allen, Naples(^{48})</td>
</tr>
<tr>
<td>Italy (Florence)</td>
<td>1891-1914</td>
<td>Allen, Florence(^{49})</td>
</tr>
<tr>
<td>Japan</td>
<td>1950-2003</td>
<td>Statistics Japan(^{50})</td>
</tr>
<tr>
<td>Mexico (Mexico City)</td>
<td>1559-1821</td>
<td>TePaske(^{51})</td>
</tr>
<tr>
<td>Mexico</td>
<td>1902-1976</td>
<td>INEGI(^{52})</td>
</tr>
<tr>
<td>Peru</td>
<td>1833-1850</td>
<td>Gootenberg(^{53})</td>
</tr>
<tr>
<td>Peru</td>
<td>1913, 1929, 1939, 1950, 1953, 1954, 1959</td>
<td>Hunt(^{54})</td>
</tr>
<tr>
<td>Russia</td>
<td>1791-1796</td>
<td>Blanchard(^{55})</td>
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<tr>
<td>Spain (Madrid)</td>
<td>1800-1914</td>
<td>Allen, Madrid(^{56})</td>
</tr>
<tr>
<td>United Kingdom (London)</td>
<td>1792-2014</td>
<td>KITCO(^{57})</td>
</tr>
<tr>
<td>United Kingdom (London)</td>
<td>1975-2014</td>
<td>Silver Institute(^{58})</td>
</tr>
<tr>
<td>United States</td>
<td>1800-1977</td>
<td>Lindert(^{59})</td>
</tr>
<tr>
<td>United States</td>
<td>1900-2010</td>
<td>USGS(^{60})</td>
</tr>
<tr>
<td>United States (New York)</td>
<td>1970-2014</td>
<td>UNCTAD(^{61})</td>
</tr>
<tr>
<td>United States (COMEX)</td>
<td>1975-2012</td>
<td>Silver Institute(^{62})</td>
</tr>
<tr>
<td>United Kingdom (London)</td>
<td>1929-1945</td>
<td>Atwell(^{63})</td>
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<tr>
<td>United States (New York)</td>
<td>1929-1945</td>
<td>Atwell(^{64})</td>
</tr>
<tr>
<td>India (Bombay)</td>
<td>1929-1945</td>
<td>Atwell(^{65})</td>
</tr>
<tr>
<td>China (Shanghai)</td>
<td>1929-1945</td>
<td>Atwell(^{66})</td>
</tr>
</tbody>
</table>

\(^{43}\) Allen, ‘Consumer Price Indices, Nominal / Real Wages and Welfare Ratios of Building Craftsmen and Labourers, 1260-1913’.

\(^{44}\) Cvrcek, ‘Austro-Hungarian Prices and Wages, 1827-1914’.

\(^{45}\) Banque de France, ‘Taux de Change et Prix de L’or et de L’argent - Les Tableaux de Series (1800-1873)’.

\(^{46}\) Ibid.

\(^{47}\) Schmitz, World Non-Ferrous Metal Production and Prices, 1700-1976.


\(^{49}\) Ibid.

\(^{50}\) Statistics Japan, ‘Quantity and Value of Production of Metallic Ores, Non-Metallic Ores, Coal and Crude Oil (1874-2003)’.

\(^{51}\) TePaske and Garner, ‘Annual Silver Data Colonial Mexico 1559-1821’.

\(^{52}\) Instituto Nacional de Estadística y Geografía, ‘16. Sector Externo’.

\(^{53}\) Gootenberg, Between Silver and Guano.


\(^{55}\) Blanchard, Russia’s ‘Age of Silver’, 339, Table A2.3.

\(^{56}\) Allen, ‘Consumer Price Indices, Nominal / Real Wages and Welfare Ratios of Building Craftsmen and Labourers, 1260-1913’.

\(^{57}\) Kitco Metals Inc., ‘Historical Silver Data and Charts - London Fix’.

\(^{58}\) The Silver Institute, ‘Historical Prices’.

\(^{59}\) Lindert, ‘Silver in North America 1649-1977’.


\(^{62}\) The Silver Institute, ‘Historical Prices’.


\(^{64}\) Ibid.

\(^{65}\) Ibid.

\(^{66}\) Ibid.
### Table 2: Available currency exchange data coverage and sources

<table>
<thead>
<tr>
<th>Currency pair</th>
<th>Period</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>GBP / USD</td>
<td>1791-2014</td>
<td>MeasuringWorth72</td>
</tr>
<tr>
<td>GBP / Crowns (AT)</td>
<td>1827-1914</td>
<td>Cvrcek73</td>
</tr>
<tr>
<td>GBP / Crowns (AT)</td>
<td>1896-1914</td>
<td>Scheiber74</td>
</tr>
<tr>
<td>GBP / Carlini (Naples)</td>
<td>Between 1798-1857, 13 data points</td>
<td>Various sources</td>
</tr>
<tr>
<td>GBP / Francs (FR)</td>
<td>1802-1805, 1815-1873</td>
<td>Banque de France75</td>
</tr>
<tr>
<td>GBP / Marks (DE)</td>
<td>1816-1872</td>
<td>Banque de France76</td>
</tr>
<tr>
<td>GBP / Marks (DE)</td>
<td>1873-1914</td>
<td>Denzel71</td>
</tr>
<tr>
<td>GBP / Pestas (ES)</td>
<td>1821-1914</td>
<td>Allen, Madrid78</td>
</tr>
<tr>
<td>GBP / ITL (IT)</td>
<td>1902-1967, 15 data points</td>
<td>Banco Popolare di Sondrio79</td>
</tr>
<tr>
<td>USD / DEM (DE)</td>
<td>1913-1974</td>
<td>MeasuringWorth80</td>
</tr>
<tr>
<td>USD / Peru</td>
<td>1929, 1948-1959</td>
<td>MeasuringWorth80 &amp; Hayn82</td>
</tr>
<tr>
<td>GBP / ITL (IT), Florence</td>
<td>1891-1914</td>
<td>Denzel83</td>
</tr>
<tr>
<td>USD / JPY</td>
<td>1956-2003</td>
<td>MeasuringWorth84</td>
</tr>
<tr>
<td>GBP / silver roubels (RU)</td>
<td>1791-1803</td>
<td>Denzel85</td>
</tr>
<tr>
<td>USD / Mexican pesos</td>
<td>1877-1897</td>
<td>Nugent86, MeasuringWorth87</td>
</tr>
<tr>
<td>USD / Mexican pesos</td>
<td>1820-2013</td>
<td>INEGI88</td>
</tr>
</tbody>
</table>

### Table 3: Complete data / problems – comparable price, GDP / capita, production data

<table>
<thead>
<tr>
<th>Country (City)</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria (Vienna)</td>
<td>1860-1913</td>
</tr>
<tr>
<td>Spain (Madrid)</td>
<td>1871-1914</td>
</tr>
<tr>
<td>United Kingdom (London)</td>
<td>1854-2010</td>
</tr>
<tr>
<td>United States</td>
<td>1834-2010</td>
</tr>
<tr>
<td>Germany (Hamburg / Avg)</td>
<td>1850-1874</td>
</tr>
<tr>
<td>Italy (Florence)</td>
<td>1891-1914</td>
</tr>
<tr>
<td>Japan</td>
<td>1950-2003</td>
</tr>
<tr>
<td>Mexico</td>
<td>1800, 1820, 1902-1976</td>
</tr>
<tr>
<td>France</td>
<td>No production data before 1898</td>
</tr>
</tbody>
</table>

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67 Hsiao, *China’s Foreign Trade Statistics, 1864-1949*.  
68 Banco Central de Reserva del Perú, ‘Memoria 2004’.  
69 Banco Central de Reserva del Perú, ‘Memoria 1994’.  
70 Banco Central de Reserva del Perú, ‘Memoria 1994’.  
71 Banco Central de Reserva del Perú, ‘Memoria 1994’.  
72 Officer, ‘Dollar-Pound Exchange Rate From 1791’.  
73 Cvrcek, ‘Austro-Hungarian Prices and Wages, 1827-1914’.  
74 Scheiber, ‘The Experience of Exchange Rate Regimes in Southeastern Europe in a Historical and Comparative Perspective’.  
75 Banque de France, ‘Taux de Change et Prix de L’or et de L’argent - Les Tableaux de Series (1800-1873)’.  
76 Ibid.  
80 Officer, ‘Exchange Rates Between the United States Dollar and Forty-One Currencies’.  
81 Ibid.  
84 Officer, ‘Exchange Rates Between the United States Dollar and Forty-One Currencies’.  
86 Nugent, ‘Exchange-Rate Movements and Economic Development in the Late Nineteenth Century’.  
87 Officer, ‘Exchange Rates Between the United States Dollar and Forty-One Currencies’.  

[11]
2.2 **Discussion on the Exchange Rate Method**

Using the exchange rate as an indicator for silver prices, however, has been previously heavily used by other scholars, is a method that raises questions. Its use is more straightforward – even to say it is obvious – when we are calculating prices for silver standard countries. This is the case for some of the countries and periods in our dataset:

- Most of the Scandinavian countries (Denmark, Norway, Sweden, Finland) and Germany, Netherlands used the silver standard up to the 1870s
- Japan, Mexico and India used the standard until the end of the 19th century
- And finally China, Indonesia and the Philippines used the silver standard until the beginning of the 20th century

In the following page I describe the methods of calculation which were used during creating the dataset, to provide a full picture of them. Although I believe that these methods are good for at least to proxy the real prices I would like to let the reader decide whether he/she agrees with them or not. In our dataset I have three cases where exchange rates are playing a role:

1) The case when I calculated the comparable silver price from the local currency’s silver content. This is for sources like Allen and TePaske. The problem here is the possible inaccuracy and inflexibility of the local currency in terms of silver content. In Austria for example the silver content of a Kreuzer was 0.07796 gram / Kreuzer between 1820-1846 as reported by Allen. This could be either a data problem, but it could also resulted from the inflexibility of the Kreuzer (it could have not followed the real prices changes).

2) For sources like Hsiao, where we have a silver standard country, I used the exchange rate from the silver currency to the comparable currency. Here we have a problem with exchange rates – an exchange rate could also contain effects from country

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[12]
3) Lastly if the prices were given in a local currency, the exchange rate from local currency price to comparable price could have been used. There we also have the question whether we actually measure differences in silver prices or just in exchange rates. That is an important question and the author currently could not give a comforting answer for it. The easiest way to handle this problem would be to use something that is country bound and have the same unit of measure than the comparable price. This would mean that we can control for the exchange rate effect. Using GDP data would be a great choice – in our case the only problem is that our GDP data is in 1990 GK$ while our price data is in simple nominal USD.

For every and each of this calculations it must be taken into account that the use of exchange rates in the calculation means that we are including a lot more information into the price than merely the real effects effecting the price of silver. When we use an exchange rate this way it also means that we include all factors which effect the currency exchange rate. However as I have used to denominators (GBP and USD) in our data and also used the same denominators for each of the data points I do believe that the dataset presented here contains comparable information and therefore could be basis of an analysis. Although when doing such an analysis it should be always taken into consideration that the pricing data is connected to the home country of the denominator (either the US or the UK) and therefore political and economic interactions between these countries and the target countries (where the price data from) could impact the prices seen in the dataset.

3 ANALYSIS OF THE DATA

In order to establish a picture about the data I concluded some basic descriptive analysis. This could help establishing the temporal patterns and can highlight certain peaks or low points which will be the target of my further analysis.

a. DESCRIPTIVE ANALYSIS OF THE DATASET
First the summary statistics are calculated, the results are shown below. I ended up with 1081 observations overall, with 470 observations having production data.
Kiss-Dobronyi: Differences in silver prices across temporal and spatial dimensions

Table 4 - Summary statistics of the dataset, own work

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>Obs</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP per capita</td>
<td>1990 Int. GK$</td>
<td>1081</td>
<td>7245.73</td>
<td>7681.758</td>
<td>525</td>
<td>31655</td>
</tr>
<tr>
<td>Production volume</td>
<td>Tonnes</td>
<td>470</td>
<td>104.2518</td>
<td>195.0146</td>
<td>.1</td>
<td>980.4</td>
</tr>
<tr>
<td>Comparable price GBP</td>
<td>GBP / grams</td>
<td>1080</td>
<td>.0497797</td>
<td>.1104037</td>
<td>.0004466</td>
<td>1.468267</td>
</tr>
<tr>
<td>Comparable price USD</td>
<td>USD / grams</td>
<td>1081</td>
<td>.0816977</td>
<td>.1119755</td>
<td>.0018</td>
<td>.74018</td>
</tr>
</tbody>
</table>

Also the data is plotted using Tableau to check for issues, potential problems and trends. Visualizing the dataset can be a powerful tool to define future research questions and to spot data quality problems.

Figure 4 - Silver prices between 1800-1900, own work, for the sources used refer to the II. chapter

The GBP prices and USD prices were also compared on the plots. In the 4th figure we can see that the USD based prices are more convergent. This holds for both periods (1800-1900 and 1900-2014) in the data. This is mainly a scaling effect as it can be seen on the figure. Further investigation of the 4th figure shows a decrease in prices starting from 1870 (about the time of the termination of the European silver standard systems), and also shows that while the
prices are mainly converging there are variations in the data. We can also see a peak just before the decreasing trend (1864).

As for the second period shown on the 5th figure we can see a peak in 1979-80, which can be mainly attributed to the Soviet invasion of Afghanistan and the resulting instability in commodity prices\(^90\). While the upsurge following the 2000’s is unprecedented – in 2010 silver prices were outperforming gold\(^91\).

3.1.1 Analysis of convergence over time
Based on the introduction it was assumed that after the 18th century we should see a convergence of prices as a result of globalization and increasing international trade. To investigate whether this phenomenon is really happening or we just observe some random noise, a period with full country data coverage was selected. The period of 1900-1941 contains data on five countries mainly from different geographical regions: China, Germany, Mexico, the UK and the USA. Over the period only a small and insignificant amount of data is missing. The period where data for two of the countries is missing out of the five is highlighted with yellow colour on Figure 6. From the figure it could be read that the notion of converging prices over that period is not full evident. Nevertheless it cannot be forgotten that we are looking at a period leading up to a war and having a war in its middle period.

\(^90\) ‘Timeline’.
\(^91\) Ibid.
Figure 6 - Convergence of global silver prices 1900-1941, own work, for the sources used refer to the II. chapter

Figure 7 which can be found in the Annex calculates the same values for the period 1900-2010. First it has to be noted that this figure has to be interpreted with great caution as the data sources it is based on, sometimes cover just a part of the period, therefore it could bias the final results. Nevertheless the results from the plot seem to be in parallel with the literature and with historical events. While as it has been claimed previously, it shows the rising prices in 1979-80 and after the 2000’s years, it also shows that the actual deviation between the prices are growing towards the end of the century. This can be in part attributed to the addition of Japan, for which data is available only between 1950-2003 and has lower minimum values. But also without having Japan in the data there is an upsurge in the standard deviation of reported prices.

Therefore, while the data does not provide solid evidence, it still shows us what seems like a rising trend in the question of global silver prices for the 20th century. Therefore it can be assumed that while, as it is detailed in the literature, the beginning of the 18th century did see a convergence of prices due to internationalization this trend is somewhat reversed in the 20th century. It could be assumed that it is mainly due to the decentralization and liberalization of trade and also due to the sharper responses to economic and political events effecting the market (such as in the case of Afghanistan ‘79-80).
3.1.2 Pooled analysis of relations between production, prices and development

Based on the dataset it is also possible to investigate how certain local characteristics affect the price levels and vis-à-vis. Here we can investigate whether the development of the country in question (proxied by the GDP per capita) had any effects on prices and also are able to analyse whether local production (or the lack of it) had an impact on the prices. As the connection between these factors are not straightforward causality, therefore we are rather looking at whether they are moving together or not by calculating correlations.

For this analysis the data is used in a ‘pooled’ way, which means that we treat the year not as a temporal dimension. First the correlations between the measures are calculated:

Table 5 - Correlations between variables in the pooled dataset, own work, for the data sources used refer to the II. chapter

<table>
<thead>
<tr>
<th></th>
<th>GDP per capita</th>
<th>Production vol.</th>
<th>USD prices</th>
<th>GBP prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP per capita</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production volume</td>
<td>0.1051</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USD prices</td>
<td>0.7197</td>
<td>-0.0595</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td>GBP prices</td>
<td>0.7727</td>
<td>-0.0561</td>
<td>0.9758</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Here we can see an expected strong correlation between the USD and GBP prices, but also it shows that the GDP per capita have a strong connection with prices. It could be due to the fact that as we are using nominal prices, and as the GDP per capita is known to be growing over the years, we are only seeing the effect of time on both prices and GDP per capita.

To test that I ran a regression controlling for the observations year’s (dependent variable: GBP price / USD price, independent: GDP per capita, year). The resulting coefficients indicate that the effect of GDP per capita is growing even when controlled for the observation’s year. Which means that the level of local development does seem to have an effect on local silver prices. This is an ambiguous results as one hand silver as being a commodity should converge to a common price (which we have already seen do not happen fully) but on the other hand it could be understood intuitively. We can interpret this results with the assumption that the production and consumption of silver is differing in geographical dimensions. Therefore – and this is supported by the results – in the production countries the demand is lower for the commodity (negative coefficients for production volume), while in the more developed countries the demand is higher, which sets a higher price.

It should also be noted that in the period concerned here many of the European countries and (importantly) China were also on a silver standard92, which meant a high demand for silver and also a higher local price in developed countries.

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[17]
Using the population estimates data obtained from the CLIQ-Infra dataset it became available to investigate the effect of further country specific characteristics. Therefore – based on a subsample of the dataset (only using those years for which population data were available) – I ran some further simple regressions investigating the connection between the share of silver production in a country’s total production and characteristics of silver trade and production. Because the population data were limited in this case only 147 observations were used. The mean of the share of silver production to GDP is 0.1%.

The correlation table obtained from this limited data is presented in Table 8. Here we can see a strong connection between the total production value and the production as percentage of the total GDP.
Further analysis of this dataset reveals that the percentage of silver production relative to the total GDP – so to say the importance of silver in local production and output – is connected with the local price, but this connection is only visible if we take the GDP / capita measures into consideration. The correlation between the two variables is positive, therefore it suggests, that the share of silver production is higher in countries where the local prices are higher. Here the results also suggest that GDP / capita have a significant negative correlation with the share of silver production in GDP. This could be interpreted as in more developed countries the importance of silver production is lower. That result is quite intuitive and is in line with our expectations as we expect developing countries to be involved in processing raw materials.

To summarize my findings: in this section I analysed the data visually through plotting different periods of interest and describing their changes. Most of the significant variations in the data can be attributed to historically noted events. Following that the question of convergence of global prices following the 18th century was raised. Due to the limitations of the dataset the period where most of the data series overlap were investigated first (1900-1941) and wider, but less reliable selection of the dataset was also included later (1900-2010). In both cases the increase of standard deviation over time indicates that although the convergence of prices could have really impacted the global price of silver (take for example the bimetallic ratios mentioned by Flynn and Giráldez93) and although at the beginning of the century we see the convergence of the prices, towards the end of the century we see a trend for divergence.

Moving to the analysis of the pooled data we have derived that GDP / capita has a strong significant connection with prices, while actual local production has a negative connection.

93 Flynn and Giráldez, ‘Born with a “Silver Spoon”’. 

[19]
to it. As for the share of total local production relative to total GDP it was discovered that prices are correlated positively with production share and GDP / capita was correlated negatively with silver production share relative to GDP. Thus synthesizing these findings it could be assumed that countries with a higher GDP / capita ratio have higher local prices for the precious metal, while countries with a lower rate have lower prices and a higher share of production value relative to their GDP.

All in all, although the evidence presented should be interpreted with caution, we could conclude that by the geographical and temporal dimensions we can separate high demand country-year pairs, which are mostly developed countries and have higher local prices and producing country-year pairs, which are less developed, and have lower prices and in their case a higher share of GDP is derived from silver production.

4 DISCUSSION

In this part of the paper I would like to briefly present the possible uses of the dataset and to discuss the findings of the analyses concluded on the available data.

a. POSSIBLE USES OF THE DATASET

As it was already stated before the dataset is created as part of an ongoing research effort, therefore its use in a wider context is a trivial possibility. The dataset in itself could also provide a starting point for analysing historical economic conditions in the countries covered. Also because of the historical importance of the silver standard the calculated comparable prices could be used for certain periods as common denominator for converting local prices.

4.1 FINDINGS Based ON THE CONCLUDED ANALYSIS

As part of the description of the dataset and to investigate the underlying factors and relations effecting prices and productions I concluded analyses on the dataset. The results of the analyses presented above could help the understanding of how the price of silver was shaped globally and locally.

It is important to see the diverging trend in prices towards the end of the 20th century. However it is widely believed that international trade creates a convergence of commodity prices, it also should be emphasized that due to international trade and growing inclusion prices could be rather sensitive to political and economic impacts. Just as we see in the case of mentioned political events.

As for the results on the correlations between prices, production, its share relative to GDP and country level factors: the pooled OLS models point to a common connection between local price levels and development (GDP / capita) and also supports the previously stated local price notion as local production levels have negative correlation with local prices.
These results further suggest that in the analysed period there were determinants of commodity prices on the local level.

5 LIMITATIONS AND FURTHER RESEARCH

It should be emphasized once more that the first objective of this paper was to introduce the dataset of silver prices over a wide temporal and geographical spectrum and to describe the methods used in its compilation. Analysis based on the data is a further addition and the important part of the paper, nevertheless in the following section I will discuss the limitations to the two purposes separately.

First for the data and data collection part: a major limitation of the database is the lack of completeness of time-series for the countries. This makes some of the otherwise valuable data points irrelevant for the analysis of certain temporal phenomena. It is also an important limitation that data for some countries of Spanish America are not available, while they are considerable silver producers. The lack of population estimates is also a significant problem, as population estimates for the 18th and 19th century are rarely available.

There are also other data currently not in the database which could enrich its content. Appending trade data for the countries of the dataset could be a valuable addition, just as appending some kind of political dimension for example the stability of certain countries.

For the analysis part of the paper: the analysis concluded here had a twofold purpose. First to describe the data and second to suggest some relations between the variables. The main idea was the testing of the convergence and the correlations between country level and price variables. A possible further research direction would be to investigate the impact of historical events (like the ’79-80 Afghan invasion) deeper and in more dimensions.

6 CONCLUSION

The purpose of this paper was to introduce the dataset created and to describe it. I also tried to show how it can support further academic use. Also it was intended to analyse whether the convergence of global prices described in the literature94 were an existing phenomenon through the 20th century.

The dataset created as part of the research covers silver price data for more than 10 countries. Some of the countries are covered through a period of more than 150 years, some of them are only for 15-20 years, but the overlapping time-series enable cross-country analysis of prices in certain time-periods. The processes of data collection and conversion are described in detail in the second section, which I believe could help further beginner

94 Ibid.
researchers of economic history to speed up their data collection and to give better answers to their research questions.

I also undertook basic analysis on the created dataset to investigate its underlying connections and to have a statistic description of the data. I found that the international price of silver as a commodity was impacted by historical and economic events through the 19th and 20th century. I also found that contrary to previous periods the price trends in the 20th century show a diverging pattern.

In relation to the correlations between the variables of the dataset the results indicated that local characteristics do impact prices in the sample. On a deeper level we can interpret the results as in higher production country-year pair the local prices tend to be higher, while the local production volume could negatively effect the local prices. As for production relative to GDP I found support for the intuitively evident notion that in higher production per capita country-year pairs the share of silver production in GDP tend to be lower.

These conclusion could further support the use of the dataset and can point to the assumption that the international prices of silver as a globally demanded commodity are diverging through the 20th century and somewhat defined by country dependent factors.

7 REFERENCES


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Kiss-Dobronyi: Differences in silver prices across temporal and spatial dimensions

france/histoire/annuaire-historique/taux-de-change-et-prix-de-lor-et-de-largent/les-tableaux-de-series-1800-1873.html.


8 ANNEX

Full dataset currently available at:
https://drive.google.com/file/d/0BwqM4Vkn0yovemp5b211R3Vv3VzA/view?usp=sharing
Limited dataset with population estimates added available at: https://drive.google.com/file/d/0BwqM4Vkn0yovMVVRa0FmMlhDc0E/view?usp=sharing

Figure 7 - Convergence of global silver prices 1900-2010, own work, for the sources used refer to the II. chapter