Income inequality in the Duchy of Warsaw (1810/11)

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Abstract: In this paper we use administrative tabulations from occupation-based income tax (class tax) to estimate income inequality in the Duchy of Warsaw. We start off by estimating income inequality in the Department of Kalisz, and then use the decomposability of the Theil index to estimate national income inequality based on a sample of Theil indices corresponding to different settlement types.

According to our results, income inequality in the Duchy was at a moderate level, although in the biggest cities it was relatively high. Income inequality at county level was positively correlated with the mean income of the county.

Keywords: income distribution, inequality, Poland, Warsaw, social table

JEL codes: D31; N33

1. **Introduction**

Economic inequality is gaining the increasing attention of social scientists and economic historians. There are two main reasons why historians and social scientists are interested in economic inequality (Kaelbe & Thomas, 1991). Firstly, they are interested not only in economic growth but also its consequences. Secondly, the link between economic inequality and economic growth is among the most debated topics in economic history and economics (Kuznets, 1955). The analysis of income distribution may also yield valuable information on the structure of society and economic development. Data on the distribution of income may complement historical estimates of GDP and other macroeconomic aggregates. In recent years the choice of literature on pre-modern inequality has been growing very fast (e.g. Milanovic et al., 2011; Milanovic, 2018 Alfani, 2021).

In this paper we provide the first estimates of income inequality in the Duchy of Warsaw. To finance the development of military fortifications the Duchy of Warsaw introduced

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an occupation-based income tax (class tax), which may be considered to be one of the first quasi-universal income taxes in the history of Poland. Based on their occupations and wealth, taxpayers were classified into ten income classes with different amounts of tax to be paid. Although the state could not directly monitor the income of taxpayers, proportional taxation of income was a political goal (Pawłowski, 1960; Pawłowski & Mencel, 1965; Mencel & Kallas, 1996). Occupation-based income tax was implemented in the Napoleonic period also in the Kingdom of Naples (Malanima, 2006), and a similar tax was also collected in Prussia (Tilly, 2010). Based on administrative tabulations from the Department of Kalisz found in the Central Archives of Historical Records (pl. *Archiwum Główne Akt Dawnych*, reference code 1/175/0/2/227), we estimated income inequality in the biggest department of the Duchy of Warsaw. We then used the decomposability of the Theil index to estimate national-level income inequality based on a sample of Theil indices corresponding to the different settlement types (Reis, 2017). The estimates cover the fiscal year 1810/11. The tax schedule was briefly discussed by historians (Eisenbach, 1965), but tax data had not been used before to estimate income inequality.

The Duchy of Warsaw was a Polish state established by Napoleon Bonaparte, which existed in the years 1807-1815. It was the first attempt to re-establish Polish independence after the partitions, and it initially covered the area of the 2nd and 3rd Prussian partition. In 1809 Austrian West Galicia and the District of Zamość were annexed. After 1809 the Duchy had an area of around 155,000 square kilometers and a population of approximately 4,300,000 residents. The map of the Duchy is presented in Figure 1.

Figure 1. Map of the Duchy of Warsaw
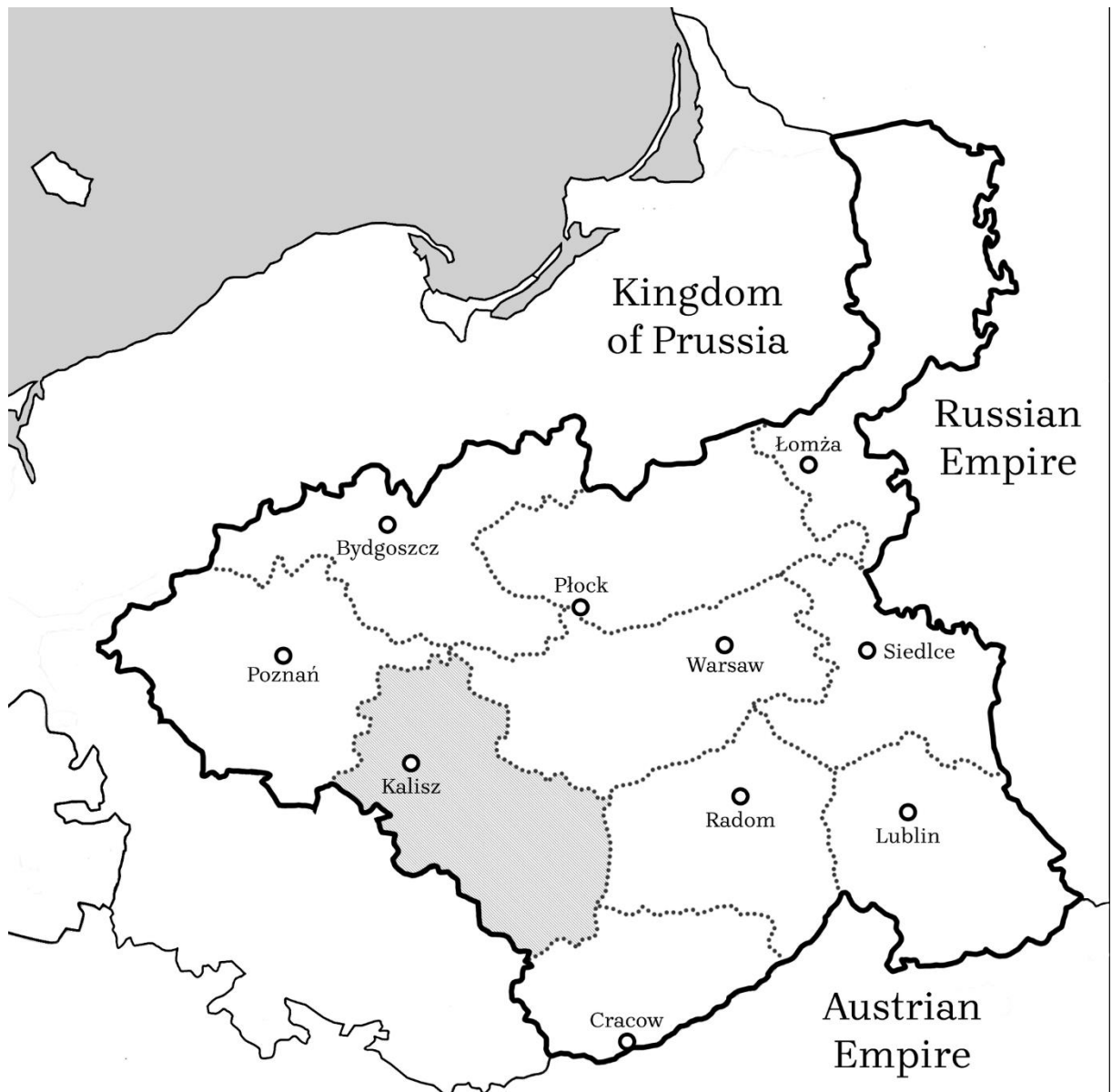
Note: The Department of Kalisz is highlighted in gray.

Source: own work based on Czubaty (2011), Maciej Szczepańczyk CC-BY 3.0; Mariusz Paździora CC-BY 3.0; Albertus CC-BY 3.0.

Although the Duchy of Warsaw existed only for a short time, and as a client state of the French Empire was not fully independent, it is sometimes seen by Polish historians as the first modern Polish state (Czubaty, 2018). The political system of the Duchy was based on French solutions, with a centralised government that enjoyed more power than the Polish government before the partitions. The political rights of lower social classes increased, and personal

submission of peasants was abolished, although serfdom continued. Opaliński (2020) investigates the position and new rights of peasants based on judicial records. The positions of Jews – at least in theory – also improved. The public finances of the Duchy were in continuous crisis due to spending on war, and also debts imposed by France, with military spending amounting to nearly 90% of public spending. To cover the public demand for revenue new taxes were introduced, and the tax system developed significantly in comparison with the pre-partition period. In 1812 tax revenue per capita (12.6 zł) was ten times higher than in 1768 (1.2 zł) in the Polish-Lithuanian Commonwealth (Krajewski, 2000). The nobility criticised the new rights of lower social classes and higher taxation (Godlewski, 1814). The economy of the Duchy was lagging behind in comparison with Western Europe, and mostly agrarian.

According to our findings, income inequality, both in the Department of Kalisz and in the Duchy of Warsaw, was at a moderate level, and significant income inequality existed only in the capitals of departments. Income inequality in Kalisz was similar to income inequality in Warsaw in 1833 and that in Kraków in 1578. Both cities were capitals of Poland at those times, while Kalisz in 1810/11 was only the capital of the department. There exists a strong and statistically significant correlation between mean incomes in a county and income inequality measured by the Gini index. The correlation between urbanisation and income inequality is positive, but not statistically significant, with the lack of statistical significance possibly driven by the small number of counties in our sample.

The literature review follows in the next section, while the data and empirical methods used in this paper are presented in Section Three, and estimates of income inequality are presented and discussed in Section Four. We start off by discussing estimates of income inequality in the Department of Kalisz, where tax data is available for each county, and then present the estimates of income inequality on the national (Duchy) level based on the bottom-up "additive" decomposition of Theil indices estimated for different settlement types (Reis, 2017). We also discuss the validity of our estimates, and present corrected estimates based on the method proposed by Modalsli (2015) for estimates of income inequality based on social tables. In Section Five we discuss the level of economic development of the Duchy in the context of tax data. The last section is a conclusion, discussing the limitations of our research and indicating directions for future studies.

2. Literature review

Economic inequality has been the topic of research of economic historians and social scientists for decades. In recent years the amount of literature on pre-modern inequality has grown significantly. Alfani (2019, 2021), Roine and Waldenström (2015), and Milanovic et al. (2011) provide a review of the literature on economic inequality in the pre-modern period, while Brenner et al. (1991) is a worthwhile reference when discussing older literature. Today we know that economic inequality is not a product of the industrial revolution, since significant levels of economic inequality predate modern economic growth. Milanovic (2018) identifies urbanisation, population density, and colonisation as the main causes of economic inequality in pre-modern times, and Alfani & Di Tullio (2019) see regressive war-related taxation as an important reason for growing inequality in the pre-modern period. Recent literature suggests that economic inequality may tend to grow continuously (Alfani, 2015; Alfani & Ammannati, 2017), unless stopped by extraordinary events such as epidemics or war (Alfani, 2010; 2020; Piketty, 2014, 2019; Scheidel, 2017). On the other hand, a decline in economic inequality during periods of economic growth has been identified in Portugal (Reis, 2017) and Finland (Bengtsson et al., 2019).

Our knowledge of the long-term evolution of economic inequality in Poland is significantly less advanced than in the case of developed economies, although the amount of available literature remarkably grown in recent years. Malinowski and Van Zanden (2017) estimate income inequality in Poland in the late 16th century. Malinowski (2016) observes that the skill premium (ratio of the wages of skilled labour to the wages of unskilled labour) and the gap between urban and rural income was very high in early modern Poland, while Van Zanden (2009) even argues that the skill premium in Polish cities was the highest in Europe.

Wagner (2016, 2020a, 2020b) estimates wealth inequality in the biggest cities of the Polish-Lithuanian Commonwealth in the 17th and 18th centuries, and Poniat (2015) measures wealth inequality in Grodno at the end of the 18th century, with both identifying significant levels of economic inequality. Wroński (2022b) provides measures of income inequality in Warsaw in the 1830s. According to his research income inequality in the city was very high at the beginning of industrialisation, and then declined between 1833 and 1925. Wroński (2022a) measures wealth inequality in the interwar period based on administrative data from extraordinary wealth tax, and observes extremely high wealth shares of the wealth groups at the very top (0.1%, 0.01%). Bukowski and Novokmet (2021) study the long-term evolution of income inequality in Poland since the last decade of the 19th century, while Kopczyński (2018,

2019, 2020) and Kopczyński and Rodak (2021) investigate the evolution of social inequality using anthropometric data. Brzeziński et al. (2020) provide top-adjusted measures of wealth inequality in the 21st century. In Section Four we compare our estimate of income inequality in the Department of Kalisz with other historical estimates of economic inequality in Poland.

Although the Duchy of Warsaw existed for less than a decade, it is a topic of significant interest to Polish historians, mainly because of the high number of reforms implemented during that time and the fact that some of the implemented reforms (for example a novel civil code) had a long-lasting impact. Grossman (1925) presents and discusses the outcomes of the population censuses conducted in 1808 and 1810, Grochulska (1991) and Czubaty (2011, 2017) review the general history of the Duchy, Von Żółtowski (1890) and Kowalczyk (2010) describe in detail the public finances and the economic policy of the Duchy, Kosim (1972) investigates the social positions of grand military suppliers, who were among the first bourgeois in the history of Poland, Grab (2003) presents the Duchy of Warsaw in the context of the Napoleonic transformation of Europe, and Koryś (2018) is a reference worth mentioning in the context of the economic history of Poland since its partitions for English-speaking readers

3. Data and methods

The tax scale divided taxpayers into ten income classes. The first income class, composed of soldiers and the poor without a stable source of income, was exempt from taxation. The next nine classes paid an increasing amount of tax.

Tax was not expressed as a share of taxpayers' income tax burden and increased with income. Minutes of meetings of the government of the Duchy show that the distribution of the tax burden was one of the most important topics on its agenda, with the aim to distribute tax proportional to income (Pawłowski, 1960; Pawłowski & Mencel, 1965; Mencel & Kallas, 1996). The opposition criticised the method, stating that proportional taxation of income results in unfair divisions of tax burden across regions of the country, with richer regions paying more than poorer regions despite the same population size (Godlewski, 1814). Tax was not directly related to earned income, because at that time it was not yet possible to closely monitor one's actual income. This is a common limitation in using historical data for the estimation of income inequality, but such data may be still used to estimate inequality indices (e.g. Tilly, 2010 for Prussia; Malanima, 2006 for the Kingdom of Naples). Moreover, data from class taxes is more advanced than data from social tables (they often only provide a mean income of social classes), which is often used to estimate inequality in the past. The classification of taxpayers into classes

was based on their occupation and wealth, which were seen as proxies for current income. In 1812, in the case of some officials employed by the state and also military officers, the tax rate class was based on income bracket, making it possible to assess the tax rate. In their case, the tax rate stood at approximately 1% (Księstwo Warszawskie, 1812). The tax scale is presented in Table 1.

Table 1. Tax scale

Tax class	Examples of occupations	Tax to be paid (zł) (1810/11)
I	The poor without a stable source of income, soldiers, officers up to the rank of lieutenant, monasteries	0
II	Peasants owning small farms, agricultural workers	1
III	Peasants owning medium-sized farms, servants, some craftsman	2
IV	Peasants owning large farms, homeowners in cities, merchants, some craftsmen, artists	4
V	Owners of a whole village, priests, junior surgeon, craftsmen employing others, innkeepers	6
VI	Owners of two villages, higher military officers, merchants in big cities, accountants, stewards	10
VII	Owners of 3-6 villages, doctors, notaries, public officials, owners of palaces	20
VIII	Owners of 7-11 villages, abbots, jewelers, goldsmiths, largest merchants	30
IX	Owners of 12 villages, archbishops and bishops, suppliers of the army, bankers	40
X	Owners of more than 12 villages, all persons receiving over 40,000 ZŁ from public funds	50

Source: own work based on data stored in the Central Archives of Historical Records (reference code 1/175/0/2/227).

Our data source reports the distribution of taxpayers in all the counties of the Department of Kalisz, which was the biggest among the 10 departments of the Duchy. Unfortunately,

statistics on the division of taxpayers among tax classes are not available in other departments[2]. Tax statistics are presented in Table 2.

Table 2. Classification of taxpayers in the Department of Kalisz (1810/1811)

County	II	III	IV	V	VI	VII	VIII	IX	X
Kalisz	5 961	4 028	1 256	157	850	279	51	38	37
Ostrzeszów	10 797	9 213	503	150	159	48	17	3	0
Szadek	5 819	8 296	557	274	99	22	20	14	9
Odolanów	6 756	6 148	835	91	55	27	9	7	11
Piotrków	7 925	4 545	832	164	70	43	21	14	9
Konin	10 788	3 574	968	114	5	20	5	17	7
Warta	5 479	4 325	494	123	51	52	21	25	4
Częstochowa	3 311	5 995	568	115	67	28	6	6	1
Sieradz	5 746	3 311	286	89	45	38	6	4	6
Wielun	4 578	3 256	208	72	43	20	7	4	19
Radomsko	5 400	2 965	66	37	25	17	17	4	2
Total	72 560	55 656	6 573	1 386	1 469	594	180	136	105
% of taxpayers	52.33%	40.14%	4.74%	1.00%	1.06%	0.43%	0.13%	0.10%	0.08%
% of revenue	27.79%	42.63%	10.07%	3.18%	5.63%	4.55%	2.07%	2.08%	2.01%

Source: own work based on data stored in the Central Archives of Historical Records (reference code 1/175/0/2/227).

Our data source does not report the number of persons classified in the bottom tax class and thus exempt from taxation. Because the number of taxpayers equaled 96.3% of households (Grossman, 1925), this exemption should only have a limited impact on estimates of income inequality. The poor without a stable source of income are the most important group excluded from the tax statistics. It is estimated that in the 1820s in Warsaw approximately 2.5% of the population did not have a stable source of income and was dependent on alms (Kołodziejczak, 1962). We therefore assume that 2.5% of the population enjoyed subsistence income, and we assume that their income equaled 60% of the income in the second tax class (first non-exempt class). Although our assumptions are to some extent arbitrary, this approach improves the

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[2] The Polish central archives lost over 90% of archival resources during World War II. The economic archive was completely burned down during the Warsaw Uprising.

coverage of the population by statistics. Computation of the cost of the subsistence basket is not possible, as data on prices in the Duchy of Warsaw exists only for Warsaw (the capital city), and applying urban prices to compute the cost of the consumption basket in a rural area could result in significant bias. The income of the poor should be significantly lower than the income of the working population (second tax class), but still higher or at least close to the cost of subsistence. Thus, 60% may be a good approximation. A change in the assumption on the income of the urban poor would have only a minor effect on our inequality estimates, because the first tax class includes only 2.5% of the population[3].

Slightly over half of the taxpayers (52%) were classified in the second class (the lowest among the classes that had to pay tax), and the two bottom classes of taxpayers together made up for 92.5% of taxpayers. The three middle classes (IV-VI) were populated by less than 7% of taxpayers, and less than one percent of taxpayers were assigned to four top tax classes (VII-X) Only 0.08% of taxpayers were classified to the top tax class, but they generated 2% of total revenue.

We measure income inequality using canonical measures such as the Gini index, Theil index, Mean Log Deviation (MLD) and income shares. The Gini index attaches the highest weight to the middle of the income distribution, while the Theil index is particularly sensitive to top incomes, and MLD is particularly sensitive to the bottom of the income distribution. While all three indices are rather abstract, income shares explain income inequality in a way that is very easy to understand. Since all measures of income inequality used in this paper are commonly used by historians and social scientists, we shall not discuss them here. Cowell (2011) provides an excellent review of inequality measurement methods. To estimate wealth shares and the Gini index we use a novel method of generalised Pareto interpolation[4]. Blanchet et al. (2021) prove that generalised Pareto curves may be employed to effectively estimate income shares and the value of the Gini index when only tabulated data is available. The method guarantees smoothness of the estimated distribution.

Historical estimates of economic inequality based on social tables are often downwardly biased, because they capture only between-group inequality, ignoring within-group inequality.

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[3] For example, if we change the assumed income of the poor from 60% to 40% of the second tax class, the Gini index in the capital of the Department increases from 0.535 to 0.538. The share of the bottom 50% is reduced from 16.8% to 16.6%. The income share lower than 40% is difficult to assume, because even the income of the poor has to be close to the subsistence cost. Therefore the impact of our assumption is limited.

[4] We acknolwedge the usage of toll gpinter software shared by the World Inequality Database (https://wid.world/gpinter/).

Modalsli (2015) proposes the correction method and provides a set of corrected revised historical estimates of income inequality. In our case, taxpayers were sorted by their occupation and not only the social class (e.g. peasants/urban citizens/nobility), as in the case of many taxes collected before partitions (Eisenbach, 1965). The classification of taxpayers is therefore relatively detailed. Although occupation (and in the case of landowners also the size of land owned) is only a proxy of income, it's for sure more precise than only the social class, so the bias should be smaller. To assess its size we apply the correction method proposed by Modalsli (2015), and also present revised estimates.

Our data source reports the distribution of income only in one (but the largest) of the eleven departments of the Duchy of Warsaw. To obtain estimates of income inequality on a national level we follow Reis (2017) and take advantage of the decomposability of the Theil index. While researchers usually decompose the Theil index to identify the contribution of between-group versus within-group inequality, we use decomposability to obtain national (total) measures based on within-group measures and between-group differences in mean incomes. The expression used in the estimation is

$$T = \sum (\frac{N_j}{N}) * \left(\frac{M_j}{M}\right) * T_j + \sum \left(\frac{N_j}{N}\right) * (\frac{M_j}{M}) * \ln (\frac{M_j}{M})$$

where T is Theil, N is the number of taxpayers and M is the mean income. The subscript j denotes local measures, while the symbols without subscripts denote national measures (Reis, 2017).

In the bottom-up additive decomposition of the Theil index we look at counties for which we have data (all counties in the Department of Kalisz) as a representation of settlement types in the Duchy (data on the distribution of income is missing for other departments). By using the decomposition techniques we can extrapolate our measures of income inequality in the Department of Kalisz to the national level. Such extrapolation is less reliable than a direct estimation of income inequality based on tax data, but it is the only way to obtain some measures of income inequality at the national level. To estimate the national Teil index we need to divide counties into groups. The classification should be based on characteristics relevant to the level of income inequality (Reis, 2017), available for all counties in the Duchy. Milanovic (2018) documents the link between inequality and urbanisation, population density, and population size (Milanovic, 2018), while we use the total population of the county as the classification criterion. We do not classify counties based on the urbanisation rate, because data

on the share of urban residents is not available for all counties in the Duchy. Since inequality is usually higher in capitals, where more high-skilled top incomes receivers live, we treat counties, which are the capitals of the districts as a separate type. The classification of settlements is presented in Table 3.

Table 3. Classification of settlements

Type	Population	Share in the total population of the Duchy	Counties in the Department of Kalisz
Capitals of districts	35 000 – 78 000	12.95%	Kalisz
Large counties	>50 000	22.71%	Ostrzeszów, Konin
Middle counties	35 001 – 49 999	44.77%	Odolanów, Warta, Piotrków, Radomsko, Wieluń, Szadek, Częstochowa
Small counties	< 35 000	19.58%	Sieradz

Source: own based on Grossman (1925)

4. Results

4.1 Department of Kalisz

The estimates of income inequality in the Department of Kalisz and each of the counties forming the Department are presented in Table 4. These estimates are directly based on data from tax tabulations available for all counties in the Department of Kalisz. The estimate for the whole Department is based on tax tabulations at the department level. According to our outcomes the Gini index equaled 0.35, the Theil index stood at 0.35, and Mean Log Deviation was equal to 0.22. The income share of the bottom 50% stood at 26%, the middle 40% controlled 41% of the total income, the top 10% received 32% of the total income, and the income share of the top 1% stood at 12%. All measures of inequality indicate a moderate level of income inequality.

Table 4. Income inequality in the Department of Kalisz, 1810-1811.

Region	Gini	Theil	MLD	The income share of:			
				Bottom 50%	Middle 40%	Top 10%	Top 1%
Department of Kalisz	0.3476	0.3507	0.2230	26.40%	41.23%	32.37%	12.31%
Kalisz	0.5351	0.6356	0.4871	16.76%	34.08%	49.16%	12.75%
Ostrzeszów	0.2775	0.2080	0.1454	29.25%	46.15%	24.60%	8.59%
Szadek	0.2960	0.2578	0.1692	30.88%	41.41%	27.71%	10.23%
Odolanów	0.2991	0.2511	0.1668	27.98%	44.80%	27.22%	9.32%
Piotrków	0.3470	0.3430	0.2176	27.43%	39.91%	32.66%	12.48%
Konin	0.3012	0.2727	0.1713	31.69%	38.76%	29.55%	9.76%
Warta	0.3608	0.3881	0.2365	25.79%	40.52%	33.69%	15.30%
Częstochowa	0.2699	0.2005	0.1435	33.11%	41.04%	25.84%	8.50%
Sieradz	0.3071	0.2951	0.1834	29.88%	41.90%	28.22%	11.38%
Wielun	0.3200	0.3717	0.2105	28.37%	42.48%	29.15%	13.19%
Radomsko	0.2732	0.2661	0.1574	31.94%	43.27%	24.78%	11.48%

Source: own estimation.

Income inequality varied significantly across counties. The capital of the Department – the county of Kalisz – clearly stood out. Whereas in the remaining counties the Gini index varied between 0.27 and 0.35, in the county of Kalisz it was equal to 0.54, which indicates a very high level of inequality. The level of income inequality in the county of Kalisz in 1810/11 was similar to the level of income inequality (0.54 vs. 0.59) in Warsaw in 1833 (Wroński, 2022b). Income inequality in Kalisz in 1810/11 was higher (0.54 vs 0.48) than income inequality in Kraków in 1578 (Malinowski & Van Zanden, 2017). We should keep in mind that in 1578 Kraków was the capital of Poland, while Warsaw in 1833 was the capital city of the Kingdom of Poland. Kalisz was only the capital city of the department.

Malinowski & Van Zanden (2017) find that in the late 16th century in Poland income inequality was higher in rural areas. Their finding is in contrast with literature, which suggests that income inequality is usually higher in urban areas (Milanovic, 2018). According to the authors serfdom was the most important reason for high inequality in rural areas. However, in our case – 250 years later and in another region of the country – we find that income inequality was highest in the largest city. This difference may be partly driven by the region investigated

– in western parts of the country land was more equally distributed than in the rest of the country. Large estates existed mostly in the eastern provinces.

There exists a strong, positive and statistically significant correlation between the mean income of taxpayers in the county and the value of the Gini index. Census data on the share of urban residents is available for all counties in the Department of Kalisz, and the correlation between urbanisation and income inequality in the Department of Kalisz is positive, but not statistically significant. The lack of statistical significance may be driven by the small number of counties in the Department.

In Figure 2 we compare the level of income inequality in the Department of Kalisz with other political entities in the 19th century. The result of the comparisons is clear – income inequality in the Department of Kalisz was relatively low.

Figure 2. Income inequality in the 19th century (Gini index)
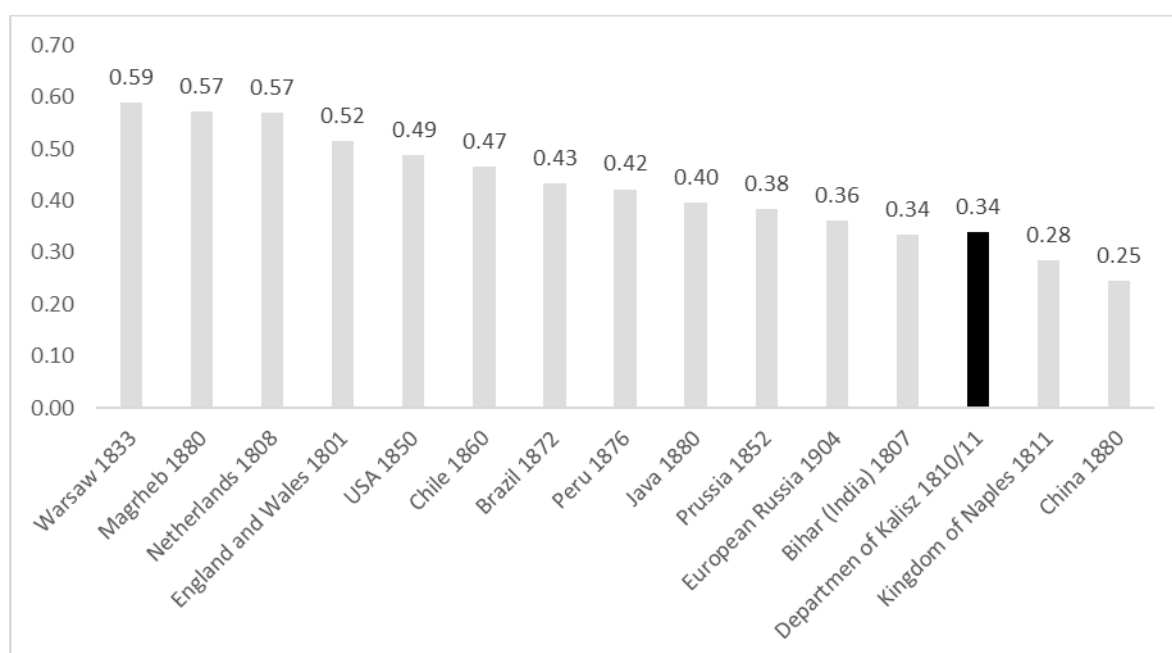
Sources: Milanovic et al. (2011), Milanovic (2018), Tilly (2010), Wroński (2022b), for the Department of Kalisz, our estimates presented in this paper.

4.2 National estimates

As described in Section Three, in order to obtain national estimates of income inequality we treat the counties of the Department of Kalisz as a representation of different types of settlements in the Duchy of Warsaw, and use the decomposability of the Theil index to extrapolate our measure at the national level. Our approach is similar to that of Reis (2017),

who investigated the long-term evolution of income inequality in Portugal. As explained above, we classify settlements according to their population size. The classification of the counties in the Department of Kalisz, income inequality and the mean income by settlement type are presented in Table 5. In Table 6 we present extrapolated estimates of income inequality in the Duchy of Warsaw and all departments (only the estimate for the Department of Kalisz is directly based on existing tax data).

Table 5. Income inequality and mean income by type of settlement.

Settlement type	Share in the population of the Duchy	Counties in the Department of Kalisz	Theil index	Mean income relative to the national average
Capitals of departments	12.95%	Kalisz	0.6355	163%
Large counties (pop > 50 000)	22.71%	Ostrzeszów, Konin	0.2351	87%
Middle-sized counties	44.77%	Odolanów, Warta, Piotrków, Radomsko, Wieluń, Szadek, Częstochowa	0.2950	97%
Small counties (pop < 35 000)	19.58%	Sieradz	0.2951	89%

Source: own estimation.

According to our results the Theil index was equal to 0.40, which indicates a moderate level of income inequality. According to Wroński (2022b) the Theil index in Warsaw in 1833 was equal to 0.83. Income inequality measured by the Theil index in Kalisz in 1810/11 was approx. 25% lower than in Warsaw twenty years later, while income inequality in the Duchy of Warsaw was only half of the income inequality in Warsaw 20 years later[5]. The value of the

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[5] Here we should keep in mind that income inequality in large cities is usually higher than at the country level. However, the author is not aware of other historical estimates of income inequality in Poland measured using the Theil index.

Theil index at the national level, as well as estimates by type of settlement, are presented in Table 5.

Income inequality varied significantly across departments, and was the highest in the departments with large cities. In the Department of Kraków the Theil index equaled 0.50, while in the Department of Warsaw it was equal to 0.45. The estimate for the Department of Warsaw may be underestimated, because it ignores the uniqueness of the capital of the Duchy, where income inequality might be significantly higher than in the capitals of the departments. The income inequality measured was lowest in the Department of Kalisz, where the Theil index equaled 0.35. Income inequality was low also in eastern parts of the country, with less urbanisation. In all the eastern departments (Lublin, Łomża, Siedlce) the Theil index was lower than 0.4, thus the level of income inequality was lower than in the whole duchy. The cross-department variation in the value of the Theil index is mainly driven by the share of the population of the department capital county in the population of the department, which is a direct consequence of our estimation method.

Table 6. Income inequality at the national level: extrapolation based on the bottom-up additive decomposition of the Theil index.

Area	Theil index
Duchy of Warsaw (extrapolation)	**0.4038**
Department of Bydgoszcz (extrapolation)	0.4364
Department of Kalisz (tax data)	0.3507
Department of Kraków (extrapolation)	0.5014
Department of Lublin (extrapolation)	0.3641
Department of Łomża (extrapolation)	0.3546
Department of Płock (extrapolation)	0.3641
Department of Poznań (extrapolation)	0.4125
Department of Radom (extrapolation)	0.4111
Department of Siedlce (extrapolation)	0.3824
Department of Warsaw (extrapolation)	0.4519

Source: own estimation.

Our extrapolated estimates of income inequality presented in this subsection shall be treated as indicative, because the data availability only allows for the classification of settlement based

on the population. Classification based on income would probably be better, but unfortunately other characteristics of settlements at the county level are not available. Changing thresholds in the classification of settlement types would change our results only slightly[6].

4.3 Robustness checks.

Our data source reports the number of taxpayers in each tax bracket, but it does not provide any data on the dispersion of income within the brackets. Moreover, tax brackets are based on occupation and wealth, but not income itself. Within-group dispersion is therefore not captured. To provide an estimate of the size of this bias we follow Modalsli (2015) and estimate the size of within-group inequality based on assumptions regarding the within-group dispersion. We use the value of the variance coefficient (c) proposed by the author.

The corrected estimates of the Gini index are presented in Table 7. In the case of very low within-group dispersion ($c = 0.1$), the Gini index rises from 0.35 to 0.37, while in the case of low dispersion ($c = 0.5$), the Gini index is equal to 0.43. If within-group dispersion is assumed to be on an intermediate level, the value of the corrected estimate is 0.48, while in the case of high within-group dispersion, the value of the Gini index is 0.54. This exercise shows that within-group dispersion may have a significant impact on the value of the Gini index. However, in all cases, its value is still on a moderate level, at least by historical standards. If we compare our corrected revised estimates with a set of 25 corrected historical estimates of income inequality based on social tables provided by Modalsli (2015), our estimate for the Department of Kalisz would be among the lowest. This is similar to the estimate for the Kingdom of Naples, where data is also based on the occupation-based class tax introduced during the Napoleonic period. Since in our case income (proxied by occupation and land owned) is the sorting criterion, within-group dispersion should be much lower than in the case of social tables, where groups may overlap (e.g. some townsmen may enjoy higher income than some nobles). Thus, we prefer the first two corrected estimates, based on the very low and low within-group dispersion.

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[6] If we limited the classification of settlements to only capitals of departments, and the rest of the counties (in this classification, clear income gaps exist across the settlement types) the Theil Index would equal 0.3987.

Table 7. Corrected estimates of income inequality (Gini index)

Within-group dispersion	Variance coefficient c	Baseline estimate (between-group inequality)	Correction for within-group inequality	Corrected estimate
None	0	0.3476	0	0.3476
Very low	0.1	0.3476	+ 0.0187	0.3663
Low	0.5	0.3476	+ 0.0811	0.4287
Intermediate	1	0.3476	+ 0.1373	0.4849
High	2	0.3476	+ 0.1966	0.5442

Source: own calculation.

Our estimates are based on the assumption that the tax paid was linear to income. In the case of public officials, whose income tax was determined by earned income, this assumption is confirmed (Księstwo Warszawskie, 1812), as the tax rate stood at approx. 1%. Unfortunately, in the case of the rest of the taxpayers, we do not have direct information on their income, meaning that in practice non-linearities might arise. For example, the difference between the tax paid by a top class and the class below equals only 25%, which can be treated as relatively small. To assess the potential impact of the regressivity of the tax system at the top we estimate income inequality by multiplying the tax paid by a top class by a factor of two. This approach is only indicative, but because of the lack of data on top incomes more advanced robustness checks are not possible. The results of the robustness exercise are presented in Table 8.

Table 8. Alternative estimates of income inequality

	Baseline estimates			Top-corrected estimates		
	Gini	Theil	Top 1% share	Gini	Theil	Top 1% share
Duchy of Warsaw		0.404			0.508	
Department of Kalisz	0.348	0.351	12.3%	0.374	0.421	15.5%
Kalisz (capital county)	0.535	0.636	12.7%	0.558	0.767	17.1%

The impact of the correction of top incomes on estimates of inequality depends on the chosen measure of income inequality. The Gini index is most sensitive to the changes in the middle of the income distribution, therefore the impact of change in top incomes on its value is limited, with the share of the top 1% increasing significantly after the revision. The Theil index also experiences a significant increase.

Thus, if someone prefers to measure income inequality using the Gini index, the potential regressivity of the tax schedule at the top is not a significant problem. However, if the Theil index or top wealth shares are the preferred measures of inequality, the issue of possible regressivity at the top is important. In this case our baseline estimate of income inequality may be seen as lower band estimates.

4.4. The long-term evolution of inequality in Poland

In the literature review we presented literature on historical economic inequality in Poland. In Figure 3 we compare our estimate of income inequality in the Department of Kalisz in 1810/11 with estimates of income inequality in Poland in other periods. Our comparison is based on the value of the Gini index, thus the possible regressivity of the tax schedule at the top only has a limited impact on estimates of income inequality in the Department of Kalisz.

Estimates of economic inequality in Poland assembled here are difficult to compare, because the areas under investigation, data sources and estimation methods differ across studies. Income inequality in the Department of Kalisz in 1810/11 was lower than income inequality in the Voivodship of Cracow in the late 16th century. However, income inequality in Kalisz (the capital of the Department) was higher than income inequality in Cracow, which was the capital of Poland at that time. Income inequality in Kalisz in 1810/11 was lower than income inequality in Warsaw in 1833, but higher than income inequality in Poland in the interwar period.

Research on historical economic inequality in Poland has developed significantly in recent years, but it's still at an early stage. We can collect estimates of income inequality in different regions in different periods, but we do not have a consistent series of income inequality in the same region over time. However, existing literature as well as estimates presented in this paper clearly show that economic inequality is not a by-product of economic growth, since income and wealth inequality was high also before the industrial revolution. It might have been even higher before the industrial revolution, than after it.

Figure 3. The long-term evolution of income inequality in Poland (Gini Index).
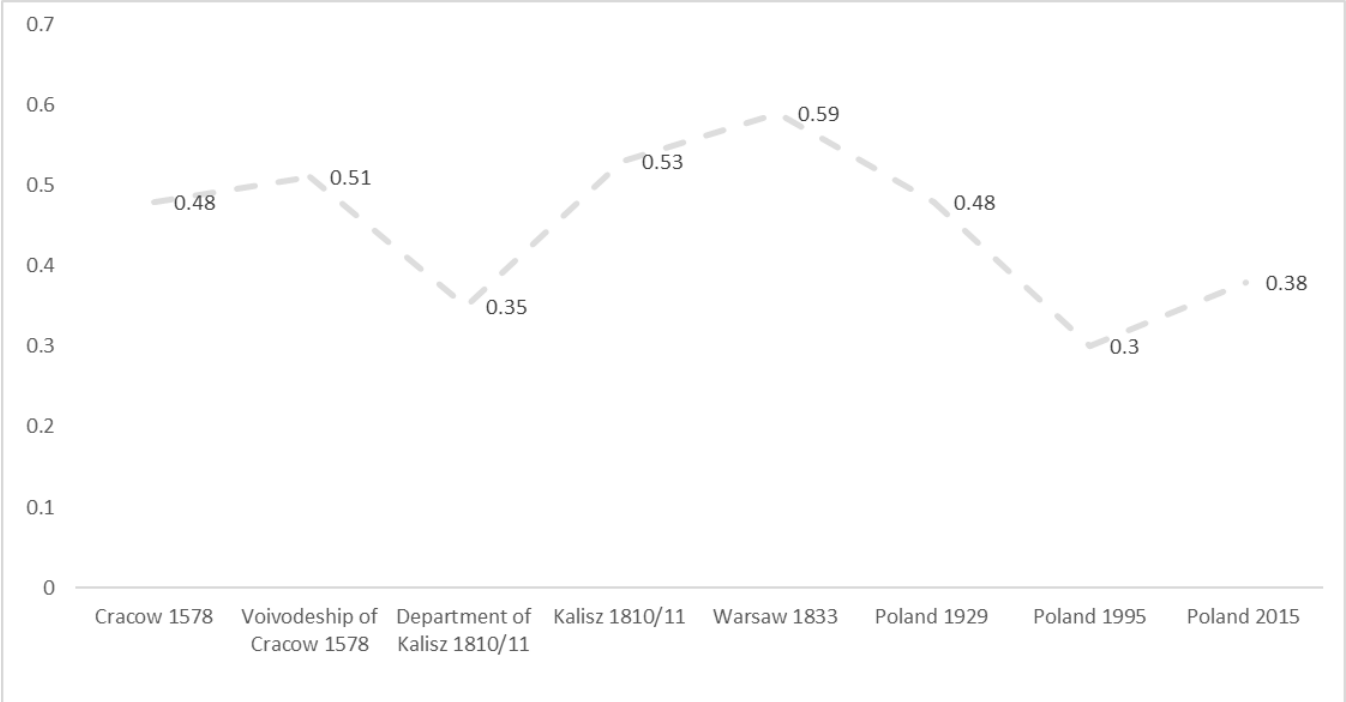
Note: As described above, the comparability of inequality estimates presented in Figure is limited.

Sources: Cracow, Voivodeship of Cracow in the late 16th century – Malinowski and van Zanden (2017) Department of Kalisz, our estimate presented in this paper, Warsaw in 1833 – Wroński (2022b), Poland in 1929 – Wiśniewski(1934); Poland in 1995, and 2015 Brzeziński et al. (2021).

5. The level of economic development of the Duchy of Warsaw

The tax scale may be seen as a mirror of the social structure of the Duchy, with people without a stable source of income at the bottom of the income hierarchy. Low tiers of the hierarchy were occupied by agrarian laborers and peasants. The position of peasants in the income hierarchy was mainly driven by the area of arable land they owned. The income of city dwellers was assessed as higher than the incomes of peasants. In cities, homeownership was seen as an important correlate of income. Wroński (2022b) shows that in the early 1830s Warsaw the share of homeowners in the bottom 70% of the income distribution was lower than 10%, whereas in the top decile it stood at approx. 40%. Landowners (mostly nobility), clergy, bankers, army suppliers, and other large merchants, as well as public officials, formed the elite in society. The income structure was strictly hierarchical, with most of the taxpayers included in the two bottom income classes. The middle class was nearly non-existent, a structure that is typical for the time.

As discussed in the introduction, political institutions of the Duchy were modernised based on French solutions (Czubaty, 2018), and the central government was much stronger than before the partitions. Tax revenue per capita increased tenfold in comparison with 1768 (Krajewski, 2000). Lower social classes enjoyed more political rights in the Duchy of Warsaw than before the partitions. The discrimination of Jews was forbidden by the constitution of the Duchy, although soon their novel rights were temporarily suspended for a decade. The modernisation of law generated significant backlash from the old Polish, noble elite (Czubaty, 2011, 2017, 2018). A modern civil service was created and gave rise to the development of a new class – intelligentsia (Janowski, 2008). Today the Duchy is often seen as the first modern Polish state (Czubaty, 2018). The class tax was significantly more advanced than taxes collected in Poland before the partitions. Before partitions classification of taxpayers was based mostly on social class, here more detailed classification criteria (occupation, land owned) were used. Lawmakers probably noted that the criteria used to divide the tax burden in the past were no longer adequate for the changing society. Tax scales acknowledged that some city dwellers e.g. bankers or army suppliers are richer than majority of land-owning nobles (Eisenbach, 1965).

The data from tax collection shows that although political institutions had been modernised, the social structure of the Duchy was still rather pre-modern, and its economy was mostly agrarian. Over 90% of taxpayers belonged to the two bottom non-exempt income classes, composed mostly of agrarian occupations and craftsmen living outside cities. According to the census results, 83% of the active population was employed in agriculture,

while 8.8% were craftsmen living outside cities. The share of the urban population in the Department of Kalisz was equal to 19%, which was nearly the same as in the whole Duchy, where it stood at 20% (Grossman, 1925). The similarity between administrative tabulation from taxation and census results confirms the validity of both sources. The top income classes were composed of landowners, public officials, clergy, merchants and bankers. Business owners, capitalists and industrialists are nearly non-existent in the tax scale, as the Duchy of Warsaw was before the times of the industrial revolution. The Duchy of Warsaw was a modern state with a pre-modern economy (dominated by agriculture) and pre-modern non-urbanised society, mostly composed of peasants.

The image of the Duchy's economy in Polish historiography is diverse. Old sources assess the economic situation of the Duchy as very bad and mostly focus on the strong negative impact of the continental blockade system imposed by Napoleon on the Duchy's economy (Skarbek, 1876). Poland was always a food exporter, and thus the blockade significantly affected the Duchy's agriculture, and therefore the whole economy. Recent contributions yield a more diverse picture of the economy, as on the one hand the authors agree that the blockade harmed the economy, while on the other hand, however, they also identify economic development caused by the economic policy of the Duchy, such as road investments. Military spending amounted to approx. 90% of public spending, and was a serious burden on the economy of the Duchy (Kowalczyk, 2010; Czubaty, 2011, 2018).

Because our data source provides information on the distribution of income only in a single year, we are not able to assess the impact of social reforms introduced in the Duchy on income inequality. This impact was probably limited, because the Duchy did not exist long enough to significantly change the structure of Polish society.

5. Conclusions

In this paper we provide the first estimates of income inequality in the Duchy of Warsaw in 1810/11. There are no other estimates of the income inequality in Poland at the beginning of the 19th century. Our data source was the tax data from occupation-based income tax introduced in the Duchy.

According to the results of our research, income inequality in the Duchy of Warsaw was moderate, varying across settlement types, and it was highest in counties that were capitals in their department. In 1810/11 the value of the Gini index in Kalisz was similar to that in Warsaw in 1833 (0.54 vs. 0.59). There exists a strong and statistically significant correlation between

income inequality measured by the Gini index and the mean income of taxpayers in the county. The correlation between urbanisation and income inequality is positive, but not statistically significant. The lack of statistical significance may be caused by the low number of counties in our sample.

The most important limitation of our estimates is the lack of direct estimates of the income of taxpayers. Taxpayers were classified into 10 tax classes, but we only know the amount of tax that was paid. This solution was standard at the time (e.g. class tax was collected also in Prussia). Although policymakers did try to achieve proportional taxation, the amount to be paid was expressed as a nominal value, not the share of taxpayers' income. On the other hand, however, if the tax was in practice regressive we would have underestimated income inequality. Ignoring within-class inequality is an important bias in the historical literature on economic inequality based on social tables (Modlasli, 2015), so we have applied the correction method proposed by Modlasli (2015) and also provided corrected estimates of the Gini index.

Although our knowledge of the long-term evolution of economic inequality in Poland expanded significantly in recent years, it remains limited. Thus, economic inequality in Poland is a promising research topic for historians and social scientists. The growing availability of historical estimates of economic inequality will probably allow for research on the link between inequality and growth before long. Disparities between ethnic/religious/social groups remain to be investigated. Although there are some estimates of long-term economic growth available for Poland (Bukowski et al., 2019; Koryś and Tymiński, 2021), better data on household income would be beneficial also in this area.

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