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The Belle-Epoque of Portfolios?

La Belle Epoque des Portefeuilles ?

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Résumé

Je reconstitue les performances historiques des portefeuilles individuels détenus par les investisseurs parisiens au cours de la Belle Époque, une période caractérisée par une concentration massive des richesses.

En utilisant la valeur des successions héritées comme proxy de la richesse ex ante, je démontre que les investisseurs plus fortunés ont non seulement bénéficié de betas plus élevés, profitant ainsi du marché haussier, mais ont également généré des alphas positifs se traduisant par des Sharpe ratios plus élevés. Leur performance est aussi tributaire d'une diversification orientée vers les actions et les actifs étrangers. L'hétérogénéité des rendements apparaît comme un facteur significatif contribuant à l'accroissement des inégalités de richesse pendant la Belle Époque.

Mots-clés : Allocation d’actifs, Diversification, Rendement du risque, Données des ménages, Patrimoine des ménages, Histoire financière, Inégalités de patrimoine

Abstract

I reconstruct the historical performance of individual portfolios owned by Parisian investors during the French Belle-Epoque, which was characterized by a massive concentration of wealth.

Using the value of inherited bequests as a proxy for ex ante wealth, I show that wealthier investors not only exhibited greater betas and thus benefited from the bull market, but also captured positive alphas which translated into greater Sharpe ratios. Their performance was enhanced by diversification tilted toward equity and foreign assets. I identify heterogeneity in returns as a significant driver of the rise of wealth inequalities during the Belle-Epoque..

Keywords: Asset allocation, Diversification, Risk Return, Household Data, Household Assets, Financial History, Wealth Inequality

JEL Codes: C81, D14, D15, G11, N2

INTRODUCTION

Persistent heterogeneity in portfolio returns, compounded over time, may contribute to wealth inequalities in the long-run. Benhabib et al. (2011) identify capital income risk, *i.e.* idiosyncratic returns on wealth, as one of the main drivers of wealth concentration. Yet, as pointed out by Piketty (2014), «many economic models assume that the return on capital is the same for all owners, no matter how large or small their fortunes. This is far from certain, however: it is perfectly possible that wealthier people obtain higher average returns than less wealthy people.» Intuitively, wealthy investors could exhibit a greater financial literacy, benefit from wealth advisers, diversify their exposure across a broader spectrum of assets and profit from economies of scale on transaction costs. This paper investigates heterogeneity in returns and its correlation with financial wealth in Paris in 1912, when wealth inequalities were so massive that the richest 10% of households owned 90% of total wealth, and the richest 1% owned 60%, according to Piketty et al. (2014).

Was wealth a relevant explanatory factor of the observed heterogeneity in risk-adjusted returns among individuals during this period? To what extent does the correlation between wealth and returns explain the growing wealth concentration during the *Belle-Epoque*? How diversified were Parisian portfolios at the eve of the First World War and was diversification correlated with wealth? How different were 1912 investors in their portfolio allocation choices compared to more contemporaneous ones, and what does this historical comparison reveal about changes in market efficiency and information diffusion?

I reconstruct the historical performance of 1,718 portfolios held by investors in 1912. The data consist of probate records of the total holdings owned by Parisians who died in 1912, which were scrupulously registered for tax and inheritance purposes. In addition, I directly measure the value of inherited wealth, which I use as a metric of *ex ante* wealth. The data were previously used by Piketty et al. (2014) but have been further expanded and completed since then. I merge this dataset with historical price series sampled from the French archives (*Cotes officielles*), from 1908 to 1912, in order to document the risk-return distribution of the 1912 portfolios, assuming static weights. I obtain the following four results.

First, wealthier investors enjoyed higher risk-adjusted returns, albeit the relationship was not linear. This finding is consistent with related studies such as Edlinger et al. (2018), who show with a different and smaller dataset that the Sharpe ratio increased with wealth during the *Belle-Epoque*. It also echoes with contemporaneous analyses such as Fagereng et al. (2020), who confirm this relationship between wealth and Sharpe ratio using exhaustive data on Norwegian taxpayers. Not only were risk-adjusted returns higher at the top of the wealth distribution, but top wealth deciles were also able to create positive *alpha*, that is excess returns over the market returns for that period. This result contrasts with Bach et al. (2020), who find that wealthy Swedish households, while earning a higher return on net wealth, did not capture any significantly greater alpha than the median household. Such difference suggests that wealthy 1912 Parisian investors had better investment skills or, even more likely, were exploiting an information advantage at a time where insider dealing was not sanctioned.

Second, portfolios were strikingly diversified in 1912, across multiple asset classes, countries and sectors. This finding is also consistent with Edlinger and Parent (2014), Edlinger et al. (2018) and Edlinger et al. (2019), who bring evidence of a fine understanding of the benefits of diversification among French investors long before Markowitz and the birth of Modern Portfolio Theory (MPT). In addition, diversification was positively correlated with wealth, as wealthier investors held more assets, and balanced their investments more uniformly. The same pattern was observed by Rutterford and Sotiropoulos (2016b) and Rutterford and Sotiropoulos (2018) for British investors, approximately during the same era, but the authors did not have any historical price data to further extend their research to the analysis of returns.

Third, portfolio allocation profiles varied with wealth: rich investors held on average more equity, more foreign assets, less French debt and less real estate than smaller investors, a result already exhibited by Piketty (2014). Furthermore, I break down the average performance of equities, corporate bonds and public bonds over the period, and find that capital gains in equities were on average higher than the total returns on the other asset classes, thus largely explaining why well-off investors obtained greater returns on their wealth in a bull market environment. My assessment of the relative performance of each asset class is consistent with Jorda et al. (2019), although I

find equity capital gains to outperform dividend yields. However, given the relatively higher volatility of stocks, risk-adjusted returns were actually higher on foreign public bonds, also mostly demanded by wealthy investors. Within each asset class, wealthy investors were able to earn greater risk-adjusted returns, which indicates sharper investment skills or information advantage. On the one hand, differences in portfolio composition across the wealth distribution largely explain heterogeneity in *unadjusted returns*; on the other hand, *risk-adjusted returns* were mostly driven by the relatively greater performance of larger portfolios within each asset class.

Fourth, this superior performance of larger portfolios was a significant driver in the rise of wealth inequalities over that period. Performing simple simulations, I find that the path of wealth concentration implied by the heterogeneity in returns coincides well with its actual trajectory, and that the limited social mobility during the *Belle-Epoque* can be well understood through the lens of inequalities in inheritance and inequalities in portfolio returns.

This paper is, to my knowledge, the first attempt to merge securities prices with actual portfolio compositions for this period, in order to reconstruct historical portfolio performance. Previous research on historical portfolios for France has either exclusively focused on the exact portfolio composition, such as Piketty et al. (2005) and Piketty et al. (2014), or on the sole price series, such as Esteves (2011). Yet data scarcity prevented hybrid analyses. Research on other countries, for instance Great Britain during the late Victorian era as in Rutterford and Sotiropoulos (2018), relied on much thinner datasets. France is probably the only country in the world to provide high-quality exhaustive data on the actual estate at death for all the decedents, and to simultaneously have extensive price records.

In addition to offering excellent data, Paris was also the second largest financial center prior to World War I, and the only stock exchange that could compete with the City of London, as noted by Goetzmann and Ukhov (2006). Yet it also featured important organizational peculiarities, such as a highly centralized price setting system and a competitive dual microstructure, extensively analyzed by Hautcoeur and Riva (2007). Nonetheless, research about Paris has been much scarcer than about London or New York.

Ultimately, *Belle-Epoque* in France represents the apex of wealth inequality, as shown

in Piketty et al. (2014), and consequently offers a relevant ecosystem to study how, in a highly uneven society, differences in initial wealth endowments generate long-term inequality through heterogeneous financial performance. I rely on a similar micro analysis, which contrasts with traditional macro data, but choose to depart from an inheritance-based explanation of wealth accumulation to study the influence of investment strategies on wealth inequalities. Indeed, Campbell et al. (2019) proves that wealthier investors earned greater logarithmic returns due to the compounding effect, which the authors identify as a major factor explaining the rise of inequalities. This paper aims to explain, historically, how and through which mechanisms wealthier investors earned greater risk-adjusted returns, thus reinforcing wealth inequalities in the long-run.

The paper is organized as follows. I first detail the data sources as well as the methodology used to estimate portfolios' individual performances. Then, I break down the portfolio of Parisian investors and investigate whether diversification increased with wealth, before ultimately analyzing the relationship between returns, initial bequests and wealth inequalities.

DATA AND PORTFOLIOS RECONSTRUCTION

DATA SUMMARY

Parisian Estates

The present research relies on two main data sources: the 1912 Parisian probate records on the one hand, which detail the holdings of all the Parisians who died in 1912, and the Data for Financial History (DFIH) database on the other hand, which contains information about price and dividend series.

French probate records are highly reliable.[1] In 1791, after the abolition of the Old Regime tax privileges, an inheritance tax was imposed (*impôts sur la succession*), which means bequests left at the death of an individual were recorded for tax purpose.[2] Estate tax rates were not only kept at low levels, but also strictly enforced by severe sanctions and difficult to evade, because of the requirements for financial institutions and public utilities to inform the fiscal administration when the name of the account owner changed.[3] Piketty (2011) stressed that there was ample evidence that this legal requirement has been applied relatively strictly in France, making the risk-reward from cheating extremely low.[4] Eventually, an unfair estimation of the bequests would be detrimental to at least one of the heirs, which further disincentivized manipulation.[5] Furthermore, changes in the structure of the fiscal system enhanced the quality of the probate records. Paris at that time was partitioned into nine independent fiscal zones managed by a fiscal office (*bureau*).[6] After 1902, bequests, which used to be recorded in the *bureau* on which they geographically depended, were centralized in

[1] Piketty et al. (2005) claim that «French historical sources on wealth distribution are perhaps the best in the world »(p. 237).

[2] The value of assets was estimated by the fiscal administration based on its average valuation over the past year. This system still prevails today.

[3] Even after the introduction of the progressive tax in 1902, tax rates remained below 2%. By comparison, the proportional tax direct heirs had to pay prior to 1902 was around 1%.

[4] Piketty et al. (2014) suggest that this tax system makes French probate records very reliable compared to the data for the United Kingdom and the United States, in which «only a small minority of the population paid the tax in these two countries»(p. 25, footnote 4).

[5] See appendix for more discussion about tax evasion.

[6] For every individual who died in Paris, the relevant fiscal office opened a new entry in the so-called *Table des successions et des absences*, and recorded information about the decedent, his or her wealth, the heirs and the date at which the new entry was created. These data were completed using the *Registre des mutations et des décès*, which further documents individual estates.

the fiscal zone of the decedent's main residence and had to be declared by the family up to six months after the owner's death (25 February 1901 Act).[7] Therefore, for 1912, neither attrition nor mismatching issues between individuals and assets could occur.

Due to the difficulty to gather data for each individual for each year from the beginning of the nineteenth century to the 1920s, the data from the tax records have been collected for the years 1872, 1882, 1892, 1897, 1902, 1912, 1922 and 1927. Only Parisian records were parsed because most of the French economic elite lived there, and a disproportionate share of the national wealth was concentrated in the city.[8]

Community versus separate assets

In France, the default matrimonial property regime was the "community of acquisitions", under which both spouses remained the sole owners of the assets they acquired *before* marriage (separate assets), while those acquired *after* (community assets) fell under the community, regardless of who actually purchased them. Therefore, using the same notations as in Piketty et al. (2014), the wealth of a household composed of husband *i* and wife *j* at time *t* is defined as:

$$w_{ijt} = a^C_{ijt} + a^S_{it} + a^S_{jt} \tag{1}$$

where w_{ijt} is the total wealth of the household, a^C_{ijt} the value of the community assets, a^S_{it} and a^S_{jt} the value of the separate assets of husband i and wife j respectively.

Under this matrimonial regime, both community and separate assets accrued to the community. However, separate assets sold after marriage, in order for example to purchase community assets, as well as bequests and *inter vivos* gifts received by one of the spouses, for example dowries, had to be registered and reimbursed by the community to the original owner at her death. When the first spouse died, the community

[7]This means that prior to 1902, if an individual living in fiscal zone 1 bought some shares in a company and recorded them in fiscal zone 2, the asset would be valued and taxed in fiscal zone 2 after the owner's death, which increased the risk of error at the aggregate level. After 1902, all the bequests would be registered in fiscal zone 1 (the owner's main residence).

[8]Piketty et al. (2014) show from the *Annuaire statistique de la France* that Paris represented 25% of the total French inheritance in 1912, while Paris inhabitants were about 7% of the total French population in 1912.

dissolved: the surviving spouse took possession of her separate assets and half of the community assets value. The other half and the decedent's separate assets (net of liabilities), which altogether composed the total wealth of the decedent at time of death, were taxed and redistributed to the heirs. If the husband died first, his net estate was therefore:

$$e_{it} = \left(\frac{a^C_{ijt} - a^S_{it} - a^S_{jt}}{2} \right) + a^S_{it} + a^R_{it} + V^S_{it} \tag{2}$$

with a^R_{it} and a^R_{jt} the value of the separate assets of husband i and wife j sold after marriage, and V^S_{it} the value of the gifts received by husband i after marriage.[9] The same held true if the wife died first, with replacing *i* by *j*.

As this information was vital for tax accuracy, the probate records specify for each asset owned by the decedent in 1912 whether it was a separate or a community asset. We therefore have details about all the community assets and separate assets owned by the decedent at time of death. Obviously, we do not have any information about the separate assets owned by the surviving spouse, since they were not needed to measure the decedent's net wealth. The great advantage of the distinction between separate and community assets is that it gives two snapshots, instead of one, of the wealth of Parisian investors: her wealth at time of marriage on the one hand and her wealth at time of death on the other hand. As, again, separate assets accrued to the community, the first snapshot of wealth gives the value of uncapitalized bequests owned by the first spouse to die. "Uncapitalized" here refers to the nominal amount, in *francs*, the individual inherited, as all the accrued value on this original amount contributed to grow the community wealth.

Unlike actual assets valued at the time of death, separate assets sold after marriage were valued at the time they were sold, with no inflation correction and no information about the time they were sold. Similarly, bequests and gifts were valued at the time they were received, with no information about that time and no inflation adjustment. I make simpler assumptions than Piketty et al. (2014) to estimate these times

[9]The reimbursement of a^R_{it} or a^R_{jt} was called "*reprises*" in the probate records when the community owed the decedent, and called "*recompenses*" when it also included what the decedent owed the community, in case one of the spouses had debts at time of marriage.

and adjust for inflation.[10] I assume that assets sales took place 5 years after marriage (or immediately after if individuals died less than 5 years after being married), and bequests were received at age 30 (or at time of death if the decedent was younger).[11] We therefore obtain the inflation-adjusted value of uncapitalized bequests:

$$b^0_{jt} = a^S_{jt} + a^R_{jt} \times \frac{Q_t}{Q_{jt_0}} + V_{jt} \times \frac{Q_t}{Q_{jt_1}} \tag{3}$$

with Q_t the price index at time of death t, Q_{jt_0} the price index at estimated time of assets sales for individual j and Q_{jt_1} the price index at estimated time j received her bequests. Thus b^0_{jt} represents a measure of *ex ante* wealth, with assets valued at time t. The main limitations of this measure of *ex ante* wealth are twofold: first, it excludes single and widowed decedents, as the former exhibited only one snapshot of wealth at time of death, while the latter had their original separate assets merged with half the community assets and their share in the inheritance of the first deceased, which we cannot disentangle. Second, it includes all the returns that accrued to the portfolio before marriage. On this last point however, marriage took place relatively early in the life cycle, and age at marriage was not correlated to wealth levels, making b^0_{it} very close to the exact value of the wealth inherited by investor i.[12] The correlation between matrimonial status and wealth at death was also quite weak (6%), although this relation is contaminated by age effect.[13] Another benefit of using an *ex ante* measure of wealth is that it does not suffer from this age-wealth relationship.

[10]The authors claim that assets sales tended to take place early in the marriage, and thus randomly draw the sales time from a uniform distribution between 0 and 10 years. Similarly, since the average age at parenthood was near 30 years old, the authors assume that parents died at the same age at their children and draw the time at which children received a gift or bequest from a normal distribution centered around 30.

[11]The results are not only robust to other assumptions, but almost independent from them, since the annual inflation rate was very low before 1914, around 0.1% according to Piketty (2011).

[12]The average age at marriage was 32 years old, with men marrying usually later (33.5 years) than women (29 years). Wealth and age at marriage were nearly uncorrelated (-8%), with the correlation being slightly stronger for women (-13%) than men (-2%).

[13]Widowed investors tended in average to die wealthier than married investors, who themselves tended to die wealthier than single individuals. Net wealth at death and age were positively correlated (10%).

Price series

The second source of data, "Data for Financial History" (DFIH) stores financial time series.[14] It contains a large amount of information about the two Parisian stock exchanges, the *Parquet* and the *Coulisse*, as well as about French and foreign, public and corporate issuers. A striking feature of the Paris Bourse of that time was indeed the separation between an official segment, the *Parquet*, and an unofficial yet tolerated segment, the *Coulisse*, which mostly traded OTC.[15] Insofar as only data from the *Parquet* were available, and since some of the riskier assets were traded on the *Coulisse*, it is possible that the risk profile of investors might be slightly downward biased, in particular for the wealthiest ones, although there were only 21 available securities traded on the *Coulisse* between 1908 and 1912, compared to the 659 securities retrieved from the *Parquet*.

DFIH include price series, dividend flows and re-adjustment factors, to account for price distortions caused by corporate events like stock splits. Price series were built by sampling price data from the *Cotes officielles* every fifteen days, for each year between 1795 and 1953. This means that I have a maximum of 25 data points per year for any asset. Assets were not continuously quoted on the stock exchanges as they are today, but were only priced when there were buy and sell orders from clients. If an asset was not traded on a specific day, the asset has simply no price for that day.

[14]Data For Financial History database Database, Paris School of Economics, version 25/05/2020. Hautcœur, P.-C., and A. Riva. The Data for Financial History (DFIH) Database. WP XXX. Paris: Paris School of Economics, 2018.

[15]As noted by Hautcoeur and Riva (2007), a reason why London was much more studied than Paris as a financial center lied in the structural differences between the two stock exchanges: while the London stock exchange was decentralized and more opaque, it was unique, thus providing free entry, lower transaction costs, greater liquidity, economies of scale, greater diversification. Paris official segment functioned much more like a Walrassian market: the stock exchange was centralized and the price was more transparent, mirroring the price discovery process as *agents* discussed with each other to set a fair price for everyone. The tradition of the *cri* ensured a public and centralized pricing. Concretely, before the opening of the *Bourse*, *agents de change* gathered in the same room with the orders they had to fill and talked to each other, updating their beliefs about what the fair price was, thus leading to the official *fixing*, following this Walrassian *tâtonnement*.

ARCHITECTURE OF THE TABLE

A dictionary to bridge historical sources

A significant part of the present research has been to match the Parisian estates data with the financial series from the DFIH database. Since there was no common key between the exact name of the asset as displayed in the DFIH database and the way the 1912 fiscal administration categorized each asset, I built a dictionary to translate the asset name of the estates to its DFIH equivalent, and *vice-versa*. The matching was performed semi-automatically using pre-processing methods common to standard natural language processing. Financial assets were split into two broad categories based on their name and asset class, as recorded in the probate records: bonds (both public and private) and shares. For each asset in the probate records, a maximum number of twenty candidates were sorted from the full DFIH database, based on the number of common words and lexicographical proximity. I discarded the assets with no matching candidate, after a manual verification in the DFIH table.[16] I then manually selected the most relevant DFIH equivalent for the assets with at least one candidate. 2,099 (42%) of the 5,017 unique financial assets in the 1912 probate records were matched, and 659 were extracted from the DFIH database. The large attrition is due to the sampling methodology, as non-traded assets had no price for a given day, and to the fact that some assets were not publicly quoted.

The final dataset was constructed by combining information from both the probate records and the DFIH time series. I kept in the table only individuals who held at least one asset that I was able to match with its DFIH equivalent. Portfolio weights were assumed static, meaning that I evaluated portfolios' performance from 1908 to 1912 as if their composition remained the same as in 1912, when the owner died.[17] This assumption is not that unrealistic: Brunnermeier and Nagel (2008) analyze how portfolio

[16]These assets were either securities with inaccurate names, such as *banque* (bank), *eaux* (water) or *crédit* (credit), or corporate securities issued by non-quoted companies. See Appendix Section A for more details about the unlisted seurities.

[17]Therefore, I assumed dividends were not re-invested. Transaction costs were not available but should not distort the results. Indeed, Hautcoeur and Riva (2007) highlight the difficulty to estimate transaction costs given the absence of bid-ask spread quotation. Estimations from brokerage commissions show that transaction costs were very low after the 1898 reform, at least for the *Parquet*. For instance, spot transaction on standard securities did not exceed 0.1% after 1898. However, commissions were negotiated and could be retroceded to important private clients.

allocation changes as a result of wealth fluctuations and find evidence of a strong inertia. Besides, French investors were likely to stick to a simple "buy-and-hold" strategy, as it was common in the UK according to Rutterford and Sotiropoulos (2019): individuals added assets to their portfolio over their lifetime and kept them until death, which makes sense in a dynastic altruism framework.[18] Ultimately, 1,718 portfolios were partially reconstructed. I chose to discard portfolios whose reconstructed value was less than half the total value of the actual portfolio, thus ultimately obtaining 1,329 reconstructed portfolios with a reconstruction rate of at least 50%. As bequests could only be computed for married decedents, I restricted most of the analysis on portfolios to the 578 portfolios of married investors with a reconstruction rate higher than 50%. Table 1 summarizes information about all individuals in the original dataset (column 1), those with some financial assets (column 2), and the portfolios of married investors reconstructed at least at 50% (column 3).

Attrition, thresholds in the reconstruction rate and subsetting to married investors naturally excludes many decedents and distorts the wealth distribution. The wealthiest individual in the table, owning over 33 millions francs in 1912, is not in the final set of reconstructed portfolios, despite being married. However, the wealthiest individual in the reconstructed portfolios, owning almost 10 millions francs, belonged to the top wealth decile in the original table. Some of the largest portfolios are thus at least partially reconstructed. Some of the wealthiest investors owned large shares in private companies, which partially explains attrition.[19] Even though the average net wealth is lower in the reconstructed portfolios of married investors than in the table with securities holders (525,741 francs versus 547,776 francs), the order of magnitude remains the same.

The attrition also changes the average composition of the portfolios. The share of equity, on both French and foreign companies, is much smaller in the reconstructed portfolios of married investors than in the whole table of securities holders, while the French rente, which was quite liquid and traded on the *Parquet*, was easily recon-

[18]Winock (2002) argues that, «most often, especially in the middle-class *bourgeoisie*, inherited and self-made wealth is invested cautiously: real estate, French *rente*, a portfolio made of safe stocks etc. The great *bourgeois* are passive capitalists, satisfied with the return on their capital. Overall, preference for saving is universal and the stability of the *franc Germinal* allows it. Even the modest *bourgeois* keeps a buffer, which can wait for tomorrow without trouble.»Winock maps this "universal" preference for saving to either a passive investment or a *buffer-stock à la* Deaton (1989).

[19]See Appendix, Section A.

structed. Table 2 shows the average fraction of wealth invested in each asset asset class for the security holders and the reconstructed portfolios.[20] I formally test if the attrition modifies the composition of the reconstructed portfolios compared to the original ones. Since the asset class weights are not normally distributed in the two tables, I use a Mann-Whitney U-test with $\mathcal{H}_0 : \mu_s = \mu_r$ where μ_S is the mean of the asset class weights in the security holders table and μ_r the mean of the asset class weights in the reconstructed portfolios table. The last column of the table shows the p-value of such a test, and apart from the French corporate bonds, $\mathcal{H}_0$ is rejected at near 0 levels. The analysis on the reconstructed portfolios of married investors, therefore, will be based on a sample where equity is under-represented and bonds, notably public ones, over-represented.

The size of the largest portfolios was absolutely huge. The average annual labor income of a coal mining worker in 1913 was about 1,800 francs, according to Trempe (1971), so the average estate at death (526.2 thousands francs in the reconstructed portfolios) represented 292 years of labor income for a worker and the maximum estate at death (9,935 thousands francs in the reconstructed portfolios) was about 5,500 years of labor income.

Chaulanges (1970) estimates that in France in 1913, there were 384 savings accounts opened for every 1000 individuals. The other 616 individuals did not earn enough to save or were keeping a small cash buffer at home, and therefore would probably not appear in the probate records as they would leave no bequest at death. Hence, assuming the same distribution between Paris and regions, although Paris probably had a higher proportion of people owning a saving account, the probate records represent a picture of the top 40% of the wealth distribution in Paris in 1912. Indeed, the bottom wealth decile held in average 1,300 francs at death, in cash, savings accounts or French rente. By contrast, in 2021, there were 55 millions of livrets A (saving accounts) in France owned by physical persons, *i.e.* 81% of the total population.

[20]The fraction of wealth invested in each asset class is defined differently in the two tables. In the security holders table, the fraction is the total value invested in each asset class divided by the total value of the decedent's investments. In the reconstructed portfolios, it is the total value invested in each asset class for matched assets divided by the total value of the matched assets. For the 83 perfectly reconstructed portfolios, the fraction of wealth invested in each asset class is the same in the security holders table as in the reconstructed portfolios table.

TABLE 1: DESCRIPTIVE STATISTICS FOR ALL INDIVIDUALS

	All individuals (N=12,552)			Security holders (N=2,033)			Reconstructed portfolios (N=578)		
	Mean	Median	Range	Mean	Median	Range	Mean	Median	Range
DEMOGRAPHICS									
Age	56.1	56.0	[0, 100]	62.0	62.0	[1, 100]	58.7	58.0	[18, 91]
Gender	0.4	0.0	[0, 1]	0.4	0.0	[0, 1]	0.3	0.0	[0, 1]
Married	0.4	0.0	[0, 1]	0.5	0.0	[0, 1]	1.0	1.0	[1, 1]
Widowed	0.2	0.0	[0, 1]	0.4	0.0	[0, 1]	0.0	0.0	[0, 0]
FINANCIALS									
Net estate	114.3	3.6	[0, 33,016]	547.8	118.0	[0, 33,016]	525.7	121.7	[0, 9,935]
Financial wealth	88.7	0.0	[0, 33,016]	547.8	118.0	[0, 33,016]	525.7	121.7	[0, 9,935]
PORTFOLIOS									
Equity (France)	11.3	0.0	[0, 6,207]	69.6	2.6	[0, 6,207]	51.9	1.6	[0, 2,797]
Equity (Foreign)	6.4	0.0	[0, 20,478]	39.8	0.0	[0, 20,478]	17.7	0.0	[0, 906]
Corp. bonds (France)	8.4	0.0	[0, 4,420]	51.8	1.5	[0, 4,420]	56.3	2.8	[0, 1,870]
Corp. bonds (Foreign)	3.9	0.0	[0, 3,145]	23.9	0.0	[0, 3,145]	18.3	0.0	[0, 1,016]
Pub. bonds (France)	4.2	0.0	[0, 4,361]	25.8	1.0	[0, 4,361]	27.1	2.3	[0, 1,215]
Pub. bonds (Foreign)	7.5	0.0	[0, 5,373]	46.5	0.0	[0, 5,373]	44.2	1.0	[0, 2,211]
Real estate	31.4	0.0	[0, 10,471]	151.6	0.5	[0, 10,471]	144.1	3.0	[0, 2,504]

Notes: Descriptive statistics for the main three tables (N being the number of individuals in each table). All financial and portfolio features are expressed in thousands francs. The negative values for estates and wealth are due to debts, which were registered in the probate records.

TABLE 2: MANN-WHITNEY TEST RESULTS ON THE PORTFOLIO COMPOSITION OF SECURITY HOLDERS VERSUS RECONSTRUCTED PORTFOLIOS

Assets	Security holders	Reconstructed portfolios	p-value (Mann-Whitney)
French Equity	0.31	0.2	0.0
Foreign Equity	0.05	0.04	0.009
French Corp. Bonds	0.23	0.18	0.061
Foreign Corp. Bonds	0.07	0.1	0.001
French Pub. Bonds	0.21	0.31	0.0
Foreign Pub. Bonds	0.13	0.16	0.0

Notes: This table shows the average fraction of wealth invested in each asset class for the security holders and the reconstructed portfolios of married investors. The last column shows the p-value of the Mann-Whitney U-test performed to test if the distributions of weights are the same in the two tables.

Wealth and portfolio reconstruction

I consider two measures of *ex post* wealth: the net estate at death, namely the net value of each individual's assets minus liabilities registered in the probate records, and the total *financial* wealth, *i.e.* the value of all the investor's financial assets registered in the probate records.[21] I proxy the *ex ante* wealth by the uncapitalized value of inherited bequests b^0_{jt}.[22]

The portfolio reconstruction rate is the ratio of the value of the reconstructed portfolio to financial wealth, *i.e.* the percentage of the financial assets value that I have reconstructed from the DFIH series. Many portfolios were almost identical as they were only composed of French 3% rente, and reached therefore a reconstruction rate equal to 1.[23] The reconstruction rate negatively correlates with wealth, as shown on Figure 1: richer individuals faced looser capital constraints and could diversify across a much broader spectrum of assets, including less liquid ones, thus making their re-

[21] Financial wealth might be larger than net estate if the decedent had outstanding liabilities. Denote $\tilde{a}^C_{it}$ and $\tilde{a}^S_{it}$ the value of financial assets owned by the community and of those owned by the decedent respectively. Then decedent's i financial wealth in t is $f_{it} = \tilde{a}^S_{it} + \frac{\tilde{a}^C_{it}}{2}$

[22] An important point is that the bottom of the *ex ante* wealth distribution is actually made of individuals with 0 inherited wealth. Therefore, how to partition them by deciles in the subsequent analysis, since they have identical zero wealth? I introduce a gaussian noise with mean=0 and variance=1 which bumps wealth by a maximum of a few *francs* and allows a partition by decile. This effect contaminates the first 3 deciles, hence any difference between the first 3 deciles should not be deemed significant, as it is likely an effect of this random partitioning.

[23] For such portfolios, I check that the weights for each asset class is the same in the security holders table as in the reconstructed portfolios table.

construction less exhaustive.[24]

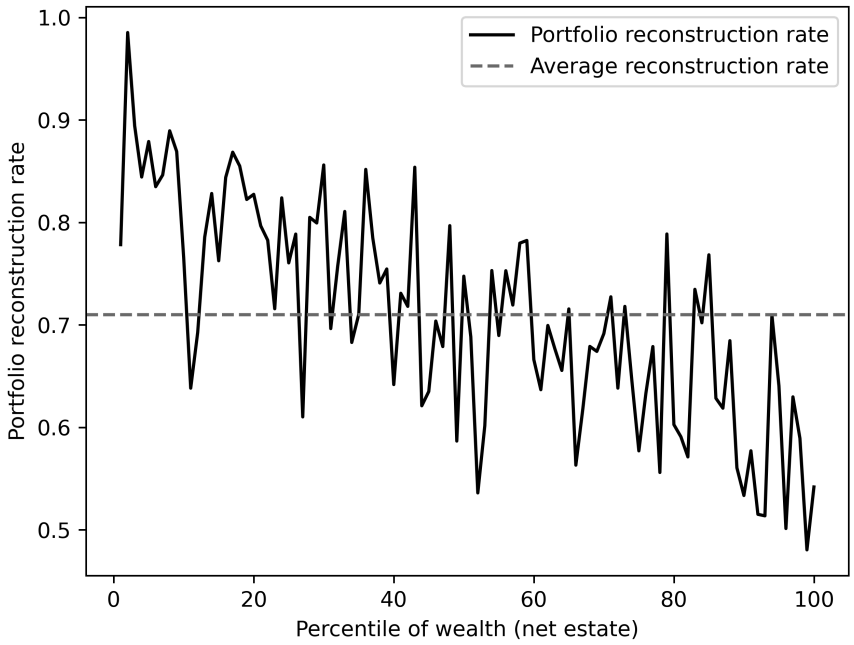

FIGURE 1: PORTFOLIO RECONSTRUCTION RATE AND WEALTH

Notes: This figure shows the average portfolio reconstruction rate by decile of wealth (net estate), and the average portfolio reconstruction rate (dashed line) in the whole sample.

COMPOSITION OF PARISIAN PORTFOLIOS IN 1912

PORTFOLIOS BREAKDOWN

Financial and non-financial estates

Parisian portfolios were already remarkably diversified in 1912, even though the MPT had not yet been formalized. Late 19thcentury financial innovations and higher expected returns progressively shifted wealthy individuals' investments from traditional real estate holdings toward corporate shares and bonds, as noted by Piketty et al. (2014). Figure 2 shows that the proportion of equity and corporate bonds in individual portfolios increased almost linearly with wealth but remained below the weight

[24]Section A, notably Table 15 shows some statistics about individuals owning shares in their own family firm.

associated with real estate holdings, albeit not for the wealthiest. Real estate is by definition expensive, hence the steep increase at the bottom of the wealth distribution, but its weight remained roughly constant in the middle of the wealth distribution and dropped for the wealthiest, who invested more heavily in financial assets.[25]

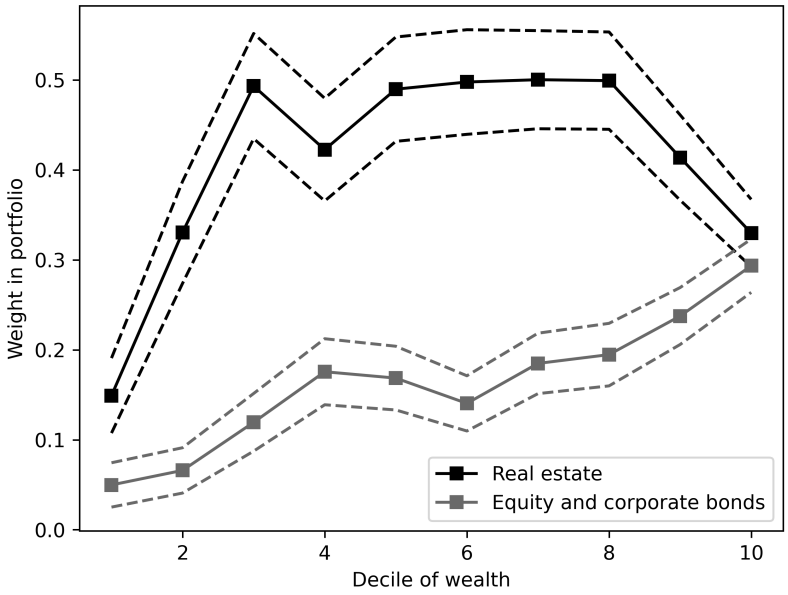

FIGURE 2: REAL ESTATE VERSUS EQUITY PER DECILE OF WEALTH

Notes: This figure shows the average percentage of wealth invested in real estate (black line) and corporate assets, namely corporate bonds and equity (grey line), by decile of net wealth at death. The "weight in portfolio" of real estate refers to the total value of the assets labeled in the probate records as real estate divided by the total value of the assets owned by an individual i. The same applies for corporate assets. The dashed lines represent the confidence interval, *i.e.* the average +/- the standard error by decile, *i.e.* $\frac{\sigma_k}{\sqrt{n_k}}$ with σ_k and n_k respectively the standard deviation and the number of individuals in bucket k.

The proportion of equity in the portfolio increased with wealth for French stocks, especially at the top of the wealth distribution, and in some convex way for foreign stocks, as shown in Figure 3, which is consistent with Piketty (2014).

A similar pattern existed for corporate bonds on Figure 4. Interestingly, holdings in foreign government bonds were also positively mapped to wealth, while the relationship between French bonds weights and wealth was illustrated by a hump-shaped curve (see Figure 5). This difference in patterns suggests that French *rente* was treated

[25]The progressive shift from "stone" to less tangible financial assets during the 19thcentury was mitigated by the aging of the rich investors: as the age-wealth profile became steeper, Parisian investors bought safe low-yields assets, which fueled the rise in inequalities, as capital was stuck in safe havens instead of trickling-down to entrepreneurs. The figures are consistent with Piketty (2014), in particular his decile comparison.

as a safe haven and became therefore relatively less attractive for wealthier investors, while foreign bonds delivering higher yields were more speculative.

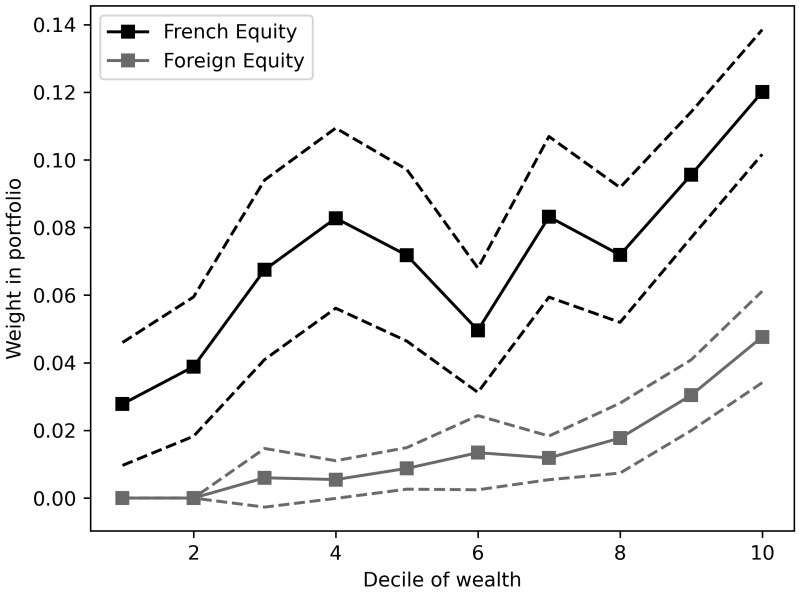

FIGURE 3: SHARE OF EQUITY IN AVERAGE PORTFOLIO BY DECILE

Notes: This figure shows the average fraction of net wealth at death invested in the shares of French (solid black line) and foreign (solid grey line) companies by decile of net wealth. The dashed lines represent the confidence interval.

Comparing with Hautcoeur (1994), the actual composition of Parisian portfolios seems much more balanced between bonds and equity than the capitalization of companies on the Parisian stock exchanges: in 1913, corporate shares accounted for 86% of the total capitalization in Paris, while bonds only represented 14%. It could be that Parisian investors had a greater appetite for corporate bonds, while French shares were more demanded by foreign investors, as institutional ownership in France at the time, although not negligible, was limited to very liquid instruments, in particular French debt.

Geographical dispersion of investments

At the beginning of the 20thcentury, British investor Henry Lowenfeld was already emphasizing the importance of geographical diversification to reduce portfolio volatility by seeking less correlated assets, as idiosyncratic shocks in a country were unlikely to

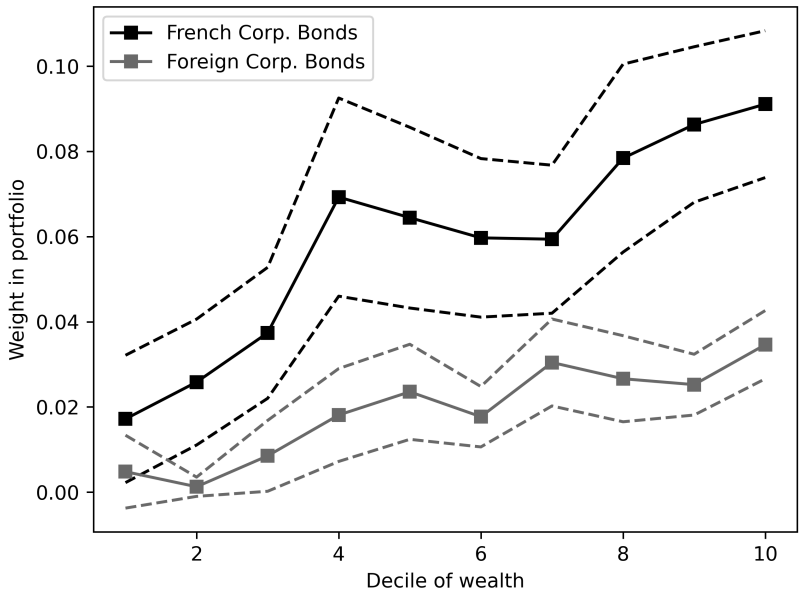

FIGURE 4: SHARE OF CORPORATE BONDS IN AVERAGE PORTFOLIO BY DECILE

Notes: This figure shows the average fraction of net wealth at death invested in the corporate bonds issued by French (solid black line) and foreign (solid grey line) companies by decile of net wealth. The dashed lines represent the confidence interval.

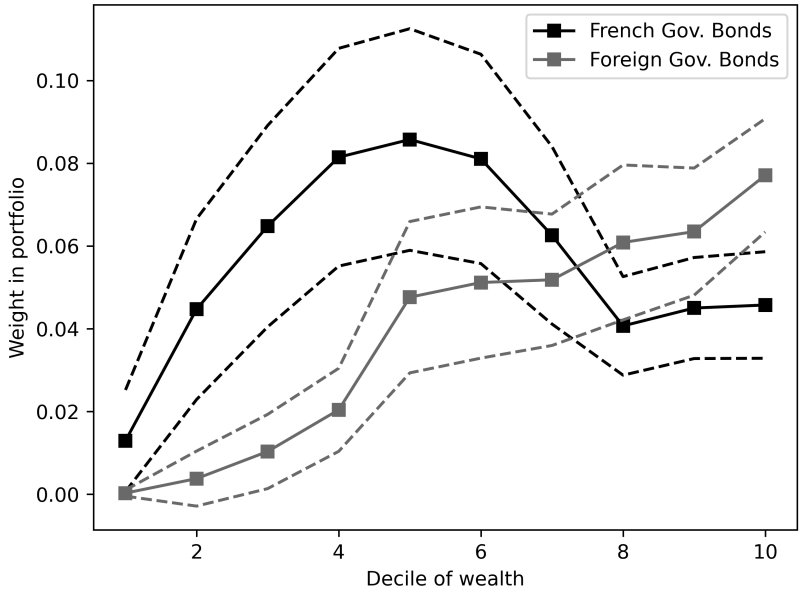

FIGURE 5: SHARE OF PUBLIC BONDS IN AVERAGE PORTFOLIO BY DECILE

Notes: This figure shows the average fraction of net wealth at death invested in the government bonds issued by France (solid black line) and foreign (solid grey line) countries by decile of net wealth. The dashed lines represent the confidence interval as defined above.

spread beyond its frontiers. Goetzmann and Ukhov (2006) claim that geographical diversification was well understood by early 20thcentury investors, both in Britain and in Europe.[26] Similarly in France, a substantial part of national wealth was invested abroad, and this proportion grew steadily in the early 20thcentury.[27]

Table 3 shows the weight of each region in the average portfolio per wealth decile. In 1912, 1,151 investors held at least one financial foreign asset, that is 56.6% of the 2,033 security holders. Richer investors were less subject to home bias, as they allocated a larger weight of their portfolio to foreign assets, but not uniformly over all regions. A significant share of the portfolio value was allocated to Russia only, which is nonetheless lower than previous estimates, but remained relatively high across the whole wealth distribution.[28] Apart from Russia, Southern America and Africa were the second and third most attractive regions for Parisian investors.[29] A significantly lower share of the portfolios was devoted to Northern America, a result which is consistent with both Edlinger et al. (2011) and Esteves (2011), who point out the remarkably low stake of French investments in this region. Consistently with Ageron et al. (2016), French investors shunned the Empire, which represented only 9% of the total net claims abroad in 1914.

[26]The authors offset the difference in returns by capping foreign returns to their domestic equivalent, and maintaining the covariance matrix fixed. Since foreign securities were still included in the optimal portfolios, the authors conclude that foreign securities were also purchased for hedging diversification purposes.

[27]Edlinger et al. (2011) note that 2.5% of French capital was invested overseas in the late 19thcentury, and that this proportion had doubled by 1914. The authors debunk the idea, supported for instance by Feis (1930), White (1933) and Lévy-Leboyer (1977), that French investments were politically, not economically driven, targeting countries to enlarge French influence in the region. The authors use a methodology similar to Goetzmann and Ukhov (2006), and find that including an optimally weighted set of foreign securities improved the CAPM-computed French market portfolio by at least 3%.

[28]Caron (1985) estimated that 27% of the total assets were invested in Russia in 1914. LeBris (2013) quotes a more prudent estimate established by Michalet (1968), who studied 1037 French portfolios in 1897 and estimated that Russian state bonds accounted for between 13% and 38% of total portfolio investments. I find that the value of Russian assets accounts for 6.2% of the total value of financial assets. The lower than expected weight allocated to Russia might be explained by the fact that the 1912 table is a snapshot at death of individual portfolios: younger investors were perhaps more eager to buy Russian bonds than their elders. Because of Russia's propaganda, Russian bonds were sometimes held in remote places, not necessarily concentrated in Paris. Russian bonds were also held by institutional investors, not only retail ones. Indeed, Russian bonds were eligible assets for trustees supervising the inheritance of orphans, as noted by Siegel (2014).

[29]Gold mines made Africa attractive for investors. Similarly, during the 1900s, Brazilian and Argentinian securities (mines and railways) were very attractive.

TABLE 3: SHARE (IN %) OF EACH REGION IN FINANCIAL PORTFOLIOS BY DECILE OF WEALTH

Wealth decile	Total foreign	Africa	Asia	Empire	North America	Russia	South America
1	6.6	0.2	0.5	1.5	0.5	1.2	2.8
2	9.3	0.9	0.4	0.5	0.2	4.8	2.6
3	12.5	1.5	0.4	0.4	1.0	6.7	2.4
4	19.9	1.9	0.7	1.4	0.6	9.7	5.6
5	18.5	2.2	1.2	1.5	0.8	7.7	5.0
6	19.2	3.3	1.5	1.5	1.9	7.2	3.8
7	17.3	2.8	0.9	1.3	1.2	7.4	3.8
8	17.7	4.1	0.9	1.6	1.1	6.2	3.7
9	20.3	4.6	1.3	2.4	1.2	6.3	4.4
10	22.7	6.7	1.4	1.7	2.5	5.2	5.3
All	16.4	2.8	0.9	1.4	1.1	6.2	3.9

Notes: This table shows the average fraction of financial wealth invested in foreign assets (equity, corporate bonds, government bonds) per region by decile of net wealth at death. For example, a 1912 Parisian decedent in the 2nd decile invested in average 4.8% of his or her wealth in Russian assets. The last row shows the average for the whole sample. The "Total foreign" column is the sum over the other columns.

Sectoral analysis

The emergence of new industries (cars, electricity distribution, pharmaceuticals) and new technologies (creation of *Air Liquide* in 1902, artificial silk following Hilaire Chardonnet's method) as well as the extension of transportation networks (the first metropolitan line opened for the 1900 Paris Exposition) considerably enlarged the spectrum of possible investments and thus provided investors with greater opportunities to diversify their risk. Table 4 shows the evolution of the fraction of financial wealth invested in various sectors per decile of wealth. Transport was the favourite industry of investors, and its weight rose quickly across the wealth distribution.[30] Mining, which I isolate from industrials, rose quickly as well with wealth level. Many decedents held what the French probate records registered as "*fonds de commerce*" (commercial property), which I categorize as "retail" and which encapsulates small local shops as well as large stores, hotels, restaurants and casinos. The negative relationship between retail holdings and wealth level suggests that a few "investors" were in fact small entrepreneurs or shop owners, who lied at the bottom of the wealth distribution, and left their commercial property as their main bequest when they died.

[30]Rutterford and Sotiropoulos (2016a) find that domestic railways was by far the most important sector in British portfolios, especially among female investors, which they explain by its relatively lower level of risk.

TABLE 4: SHARE (IN %) OF EACH SECTOR IN FINANCIAL PORTFOLIOS BY DECILE OF WEALTH

Wealth decile	Agriculture	Financials	Industrials	Mining	Retail	Transport	Utilities
1	0.6	3.2	2.6	0.8	15.3	5.6	0.6
2	0.6	5.0	2.3	1.3	20.5	5.6	0.9
3	0.2	5.8	1.7	2.0	15.4	5.6	1.4
4	0.8	7.2	5.3	1.4	6.9	7.0	1.1
5	1.3	8.8	3.5	1.6	8.1	11.6	0.7
6	0.4	5.6	5.9	2.3	4.5	12.9	2.1
7	0.7	7.4	7.3	2.1	5.1	11.4	0.9
8	1.2	7.4	4.7	2.2	4.2	11.8	1.4
9	1.3	6.5	6.5	3.8	3.8	14.8	2.6
10	1.7	9.7	8.5	4.3	4.1	15.0	2.0
All	0.9	6.7	4.8	2.2	8.8	10.1	1.4

Notes: This table shows the average fraction of financial wealth invested per sector by decile of net wealth at death. For example, a 1912 Parisian decedent in the 4th decile invested in average 1.4% of his or her wealth in the mining industry. The last row shows the average for the whole sample. Government bonds and unmatched assets make up for the remaining fraction of financial wealth.

HOW DIVERSIFIED WERE PARISIAN PORTFOLIOS IN 1912?

Diversification metrics

I measure diversification through three variables: the number of assets in the portfolio, the sum of squared portfolio weights (SSPW) and portfolio entropy. The sum of squared portfolio weights (SSPW) in a portfolio i with K assets is computed as:

$$SSPW_i = \sum_{k=1}^{K} w_{ik}^2 \tag{4}$$

The weights associated with each asset equal the fraction of the total value of the decedent's financial investments invested in this asset. SSPW takes values between $\frac{1}{K}$ (uniform distribution of weights across the whole range of assets) and 1 (a single asset in the portfolio). The third metric is the Shannon entropy and computed as follows:

$$H_i = -\sum_{k=1}^{K} w_{ik} \log(w_{ik}) \tag{5}$$

Entropy represents the disorder within a system. Its application to portfolio theory has been scarce, yet insightful to improve measures of risk.[31] The greater the portfolio

[31] Yu et al. (2014) compute entropy based on weights, as presented in this paper, and use it as a regularization method in the traditional MVO to derive less sparse solutions.

diversification, the higher the associated entropy, which takes values between 0 (single asset) and $\log(K)$ (uniform distribution across all assets).[32]

Concentration by wealth level

Table 5 shows that, for the 2,033 security holders, the average portfolio was composed of 14.15 unique assets. The right-skewed distribution of each variable indicates that few individuals held very diversified portfolios. [33] The maximum entropy and the minimum SSPW were achieved by the same individual, Isabelle de Gars de Tourcelles, whose net estate at death was estimated at 10,272,704 *francs*, the eighth richest individual in the sample.[34]

TABLE 5: DISTRIBUTION OF DIVERSIFICATION VARIABLES

	N	Mean	Median	Std	Min	Max
Number of assets	2033	14.15	7.0	19.79	1.0	222.0
SSPW	2033	0.44	0.33	0.34	0.02	1.0
Entropy	2033	1.42	1.33	1.09	0.0	4.45

Notes: This table shows the distribution of the three diversification variables. N is the number of individuals in the sample with at least one financial asset with strictly positive value.

Figure 6 shows the average number of holdings, SSPW and portfolio entropy by percentile of total wealth and exhibits a positive and convex relationship between diversification and wealth, with the top percentile holding in average more than 70 unique

[32]Indeed, H_i reaches its minimum when there is a Dirac in one asset, since $\lim_{x\to 0^+} x\log(x) = 0$. Conversely, the maximum is reached with a uniform distribution of the weights, because of Jensen's inequality for ϕ concave:

$$\phi\left(\frac{1}{N}\sum_{i=1}^{N} x_i\right) \geq \frac{1}{N}\sum_{i=1}^{N}\phi(x_i)$$

$$\phi\left(\frac{1}{N}\right) \geq \frac{1}{N}\sum_{i=1}^{N}\phi(x_i)$$

Choosing $\phi(x) = -x\log(x)$, I get:

$$\log(N) \geq -\sum_{i=1}^{N} x_i \log(x_i)$$

[33]The portfolio including the largest number of holdings was owned by Nicolas Frédéric Barbier, an engineer who held 222 different assets and left a very large bequest of 3,419,040 *francs*.

[34]The very top of the wealth distribution was actually balanced between men and women, for example Cécile Anspach (1840-1912), the wife of the *Baron* Gustave de Rothschild.

assets.[35] Compared to the results of Rutterford and Sotiropoulos (2018), diversification increased faster with wealth for French investors than for British ones.[36]

Despite important theoretical developments in our understanding of the benefits of diversification, today's portfolios do not seem more diversified than they used to be during the *Belle-Epoque*. Analyzing 40,000 US households from 1991 to 1996, Goetzmann and Kumar (2008) show that individual portfolios were quite under-diversified across the whole period, with more than 25% of the portfolios being composed of a single stock. Nevertheless, a salient difference between 1912 and today's investors is the ability of the latter to seek alternative ways of diversifying their risk through mutual funds. Bach et al. (2020) show indeed that Swedish middle-class investors achieved greater international diversification by investing in mutual funds, which also increased the average return on the bottom four deciles of the wealth distribution. Conversely, the burden of tight capital constraints was heavier on 1912 investors' shoulders, as mutual funds were not only less developed than today, but also only proposed undiversified and very liquid investment vehicles which relied primarily on French debt, as stated by Hautcoeur (2004). Therefore, the investment strategies offered by 1912 mutual funds were relatively similar to what modest households could achieve on their own.

Linear estimation and results

To understand the impact of wealth on portfolio diversification, I rely on three diversification metrics and estimate the following equation:

$$d_i = \alpha + \beta \log(w_i) + \gamma \frac{\pi_i}{w_i} + \sum_k \delta_k x_{i,k} + \varepsilon_i \tag{6}$$

where d_i is the diversification level of portfolio i proxied by the numbers of assets, the SSPW and the portfolio entropy, w_i the net wealth at death, π_i the portfolio value and

[35] Section C in the Appendix shows that the same pattern holds true for the reconstructed portfolios.

[36] The top decile in the UK held in average 14 unique assets, which corresponds to the average Parisian portfolio. Two explanations are possible: either there was an identical relationship in the late Victorian Britain and early 1910s Paris, but the wealthiest Parisians were richer than the wealthiest British people, or wealth played a more important role in portfolio diversification in Paris than in Britain.

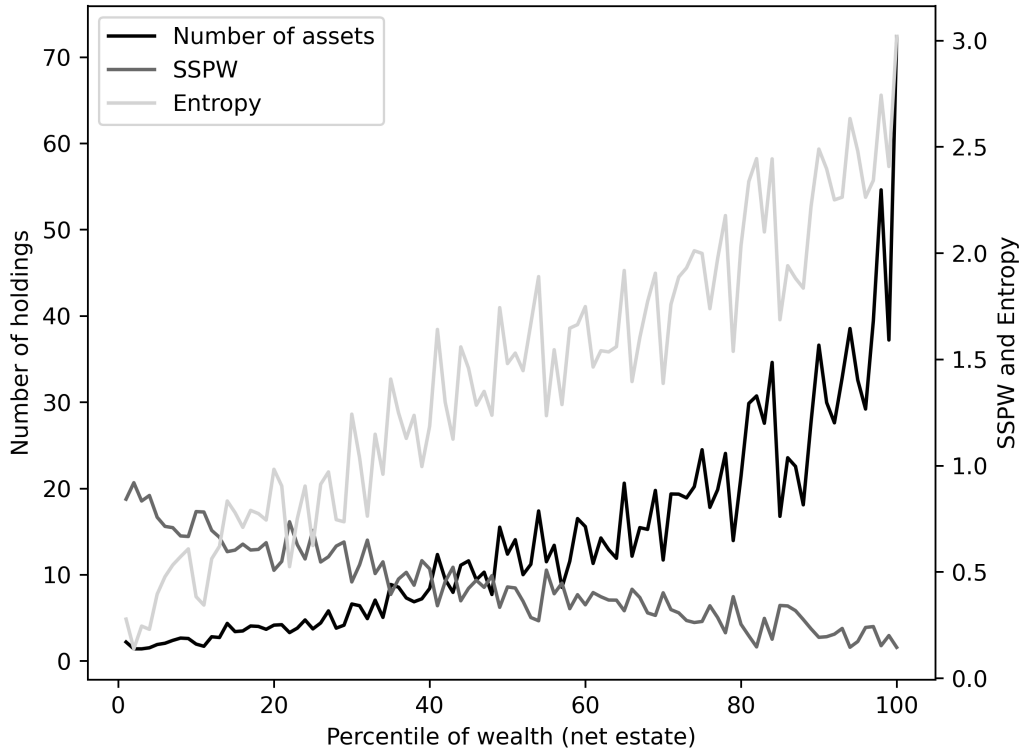

FIGURE 6: DIVERSIFICATION METRICS, AVERAGE BY WEALTH PERCENTILE

Notes: This figure shows the average value of each diversification variable by percentile of wealth (net estate). The number of assets (black line) is plotted against the left axis, while the SSPW (dark grey) and the entropy (light grey) are both plotted against the right axis.

$(x_k)_k$ a set of control variables, namely age, gender, matrimonial status and a dummy for France residence. The ratio $\frac{\pi}{w}$, *i.e.* the percentage of total wealth held in financial assets, is meant to test whether *a priori* diversified investors, *i.e.* those holding for example real estate or art works, sought the same level of diversification than those investing only in financial assets.

Table 6 shows the results obtained for each of the three specifications, using robust standard errors. Overall, the coefficients associated with the logarithm of wealth are statistically significant at the 1% level and have the expected sign: wealth is positively correlated with the number of holdings and entropy, but negatively correlated with SSPW. Keeping other variables constant, a 1% increase in wealth is associated with 0.051 additional unique assets in the average portfolio. Wealthier investors tended also to have more balanced portfolios, with a lower fraction of their capital invested per asset. The coefficient associated with the logarithm of wealth in the number of holdings specification is however much larger than in Rutterford and Sotiropoulos

(2018), which suggests that wealth effect was much more important in Paris at the beginning of the 20thcentury than in the late 19thcentury Britain. Most of the magnitude of the R^2 is conveyed by wealth itself, whose impact accounts for about 33% of the total variance of entropy.

Women's portfolios counted fewer assets in average, but without sacrificing portfolio balance, as entropy and SSPW were not impacted by gender. Investors who lived in France held more diversified portfolios, potentially because of the geographical proximity between investors and the Paris Bourse, which facilitated order transmission and information sourcing. Age and matrimonial status had virtually no impact on diversification. However, the larger the fraction of wealth invested in financial assets, the greater diversification, which makes sense as Parisians already investing in non-financial assets, such as real estate and artworks, not only had less money left to invest in financial markets, but were also sufficiently diversified across other asset classes and therefore sought less diversification in their financial portfolio.

Comparison of the small and large portfolios composition

Table 7 and Table 8 show the most popular assets in the bottom two and top two deciles of net wealth at death respectively. The portfolios at the two extremes of the wealth distribution exhibit some similarities as some of the most popular assets are the same, notably the French rente 3% and the *emprunt russe* (Russian debt) which are present in both tables. The French rente 3% accounts for more than 25% of the total wealth of the bottom 20% investors.[37] This percentage drops for the wealthiest but still remains above 10% as Parisian investors still kept a significant share of their total wealth in this safe haven. The Russian debt seemed to have been very popular across the whole wealth distribution, consistent with Table 3.

Some of the assets popular among the wealthiest but not among the smallest portfolios, such as the shares on the Suez canal, were expensive and probably not affordable for the smallest investors. Yet, bonds on the Paris-Orléans railway company traded at 1,255 francs and were still popular among the bottom 20% of Parisian investors

[37]The probate records differentiate between the *3% perpétuel à échéance annuelle* and the *3% perpétuel à échéance annuelle avec coupon payé le 1er octobre* (French 3% annual rente with coupon paid on October 1st), which the DFIH table treats as identical.

TABLE 6: OLS ESTIMATES OF WEALTH EFFECT ON DIVERSIFICATION

	Dependent variable:		
	Number of assets	SSPW	Entropy
	(1)	(2)	(3)
Wealth (log)	5.135	−0.081	0.297
	(0.244)	(0.003)	(0.009)
Age	−0.040	−0.001	0.001
	(0.025)	(0.0005)	(0.001)
isFemale	−2.476	0.014	−0.049
	(0.682)	(0.013)	(0.039)
isMarried	4.307	−0.009	0.104·
	(0.863)	(0.020)	(0.058)
isWidowed	1.176	−0.009	0.019
	(0.906)	(0.021)	(0.059)
French resident dummy	4.574	−0.146	0.402
	(1.129)	(0.028)	(0.080)
Portfolio value to wealth ratio	15.958	−0.283	1.017
	(1.108)	(0.021)	(0.060)
Constant	−56.610	1.707	−3.006
	(3.301)	(0.051)	(0.147)
Observations	2,020	2,020	2,020
R^2	0.358	0.338	0.421
Adjusted R^2	0.355	0.336	0.419
Residual Std. Error	15.880	0.278	0.828
F Statistic	159.977	147.054	209.401

Notes: This table reports the OLS estimates of regressing each diversification variable (the number of assets, the SSPW and portfolio entropy) on the logarithm of wealth and a set of variables that are described in the above section. The table reports robust (heteroscedasticity-consistent) standard errors in parentheses.

despite their relatively high price. The high returns on the Suez canal shares (6.5% annualized returns from 1908 to 1912) suggest that the lighter capital constraints on the wealthiest investors pushed their Markowitz efficient frontier higher and offered them wider investment opportunities, which were not available to smaller investors, neither through their single stock picking activity nor through mutual funds, which tended to invest in safe assets with low risk and low returns.

Another striking difference between the small and large portfolios is the higher degree of diversification of the latter compared to the former. Indeed, the top 10 assets of the bottom 20% investors represented 65% of their total wealth, while the top 10 assets of the top 20% investors accounted for only 34% of their total wealth. The tables also illustrate the relative preference of smaller portfolios for safe French rente while the wealthiest owned more equity and more international assets, notably the Emprunt Vice-Roi (Egyptian debt issued in 1870), which delivered high annualized returns through the observed period.

TABLE 7: MOST POPULAR ASSETS (BY AGGREGATED VALUE) IN THE 20% SMALLEST PORTFOLIOS

Name	Value (francs)	% Total Value	Price (francs)	Returns (%)
3% perpétuel, c. 1er oct.	127,768.5	16.8	96.2	2.1
Obl. Crédit Foncier de France	91,399.0	12.0	564.0	2.6
3% perpétuel	74,321.0	9.8	96.2	2.1
Ville de Paris 4%	68,567.5	9.0	542.3	3.3
Crédit Communal de France 5%	34,559.5	4.5	–	–
Emprunt Russe 4.5%	34,029.5	4.5	98.2	6.7
Obligation foncière	19,283.5	2.5	468.3	0.4
Chemins de Fer Paris-Orléans 4%	18,857.5	2.5	1,255.5	4.4
Chemins de Fer Ouest Algérien 3%	17,019.0	2.2	421.8	2.1
Crédit Foncier Communales 3%	14,929.0	2.0	503.7	2.0

Notes: This table lists the most popular assets (by aggregated value) in the first two deciles of the wealth distribution (20% smallest portfolios). Assets are sorted in decreasing order, hence the French rente 3% was the asset with the largest aggregated value in the bottom 20% of the wealth distribution. Value represents the total amount (in francs) of each asset owned by the bottom 20% of the wealth distribution. % Total Value is the percentage of the total wealth of the first two deciles each asset accounts for. Hence, the Ville de Paris 4% (bonds issued by the city of Paris with a coupon of 4%) represents 9% of the total wealth of the bottom 20% of investors. Prices and returns (if available) are computed from the DFIH time series.

TABLE 8: MOST POPULAR ASSETS (BY AGGREGATED VALUE) IN THE 20% LARGEST PORTFOLIOS

Name	Value (francs)	% Total Value	Price (francs)	Returns (%)
Act. Chemins de Fer PLM	21,050,820.5	6.0	801.8	-1.4
3% perpétuel, c. 1er oct.	19,327,411.0	5.5	96.2	2.1
3% perpétuel	18,292,153.0	5.2	96.2	2.1
Emprunt Russe 4.5%	13,764,288.0	3.9	98.2	6.7
Chemins de Fer Paris-Orléans 4%	12,401,212.0	3.6	1,255.5	4.4
Act. Canal Maritime de Suez	11,618,080.0	3.3	5,237.6	6.5
Egypte, Emprunt Vice-Roi 1870	6,838,278.0	2.0	102.8	6.4
Act. Banque de France	6,479,442.5	1.9	–	–
Chemins de Fer Ouest Algérien 3%	6,368,955.0	1.8	421.8	2.1
Act. Produits Chimiques d'Auby	5,496,603.0	1.6	–	–

Notes: This table lists the most popular assets (by aggregated value) in the top two deciles of the wealth distribution (20% largest portfolios). Assets are sorted in decreasing order, hence the Chemins de Fer PLM (shares on Paris-Lyon-Marseille railway company) was the asset with the largest aggregated value in the top 20% of the wealth distribution. Value represents the total amount (in francs) of each asset owned by the top 20% of the wealth distribution. of the total wealth of the last two deciles each asset accounts for. Hence, the Emprunt russe 4.5% (bonds issued by the Russian Empire with a coupon of 4.5%) represents 3.9% of the total wealth of the top 20% of investors. Prices and returns (if available) are computed from the DFIH time series.

HETEROGENEITY IN RETURNS

PORTFOLIO VALUE AND RISK-ADJUSTED RETURNS

Distribution of returns by wealth level

A positive correlation between wealth and returns is intuitive but not trivial: Campbell et al. (2019) find that small, undiversified portfolios of retail traders randomly outperform in average the portfolios of the wealthiest, but underperform on the long-run due to the strength of compounded returns.[38]

Due to the extreme sparsity of the price series, computing daily or even weekly returns was impossible, hence I chose to only compute annual returns by subtracting the last and the first available prices in the year. Volatility is computed straightforwardly as the weighted annualized standard deviation of returns, *i.e.* $\hat{\sigma}_i = \sqrt{A.\left(w_i \Sigma w_i^T\right)}$, with w_i the vector weighting each asset in portfolio i, Σ the unbiased estimate of the variance-covariance matrix, and A an annualization factor, set to 25.[39] The Sharpe ratio is computed as:

$$S_i = \frac{r_i - r_f}{\hat{\sigma}_i} \tag{7}$$

with r_i the average return on portfolio i over the period 1908-1912, and r_f the risk-free asset, set to 3%.[40] Finally, alpha and beta were computed by ordinary least squares, from the regression:

$$r^e_{i,t} = \alpha_i + \beta_i r^e_{M,t} + \varepsilon_{i,t} \tag{8}$$

[38]The authors find indeed that small portfolios earn higher average simple returns but lower logarithmic returns, due to the high dispersion of performance in small retail portfolios, while wealthier investors adopt a more cautious investing style.

[39]A strong but unavoidable limitation of this study is the high degree of sparsity in the price series. For instance, an asset which has only one data point has a variance of 0 and is treated as independent from the other assets. Furthermore, since not all assets were matched, the estimates neglect the interaction between the matched assets and the unmatched.

[40]Edlinger et al. (2019) report that the French investor Neymarck considered the 3% *rente* as a safe asset and a good benchmark, and turns out to be the most commonly held asset in the database, which is consistent with LeBris (2013), who affirms that the 3% French *rente* was the main French public debt asset held by French investors.

with $r^e_{i,t}$ (resp. $r^e_{M,t}$) the excess return on portfolio i (resp. on the market) at each period t. Two variables were selected to proxy market returns: on the one hand, an experimental replication of the "CAC 40" of that time from the DFIH database, *i.e.* an index tracking the performance of the 40 biggest French companies by capitalization over the period 1908-1912. On the other hand, a weighted sum of the returns on each asset — weighted by the fraction of the total value the asset represented in the 1912 probate records.

Figure 7 shows the average Sharpe ratio by decile of inherited bequests for married investors. Although there is no apparent linear relationship between inherited wealth and risk-adjusted excess returns, the top two deciles were the only ones to generate a Sharpe significantly positive and higher than the average Sharpe across the distribution. T-tests confirm this result.[41]

MEAN-VARIANCE PROFILES OF INVESTORS

Relative performance per asset class

The previous section showed that the wealthiest tended to invest more in equity and international assets, notably public bonds issued by foreign governments. Can these differences in portfolio profiles explain why the wealthiest were able to generate greater Sharpe ratios?

Table 9 shows the weighted average annual performance over the period 1908-1912 for the three main asset classes, namely equity (corporate shares), corporate bonds and public bonds.[42] Capital gains are measured as $C_t = \frac{p_t - p_{t-1}}{p_{t-1}}$, with p_t the price at time t, and yield is measured as $y_t = \frac{d_t}{p_{t-1}}$, with d_t the dividend or coupon paid in t. The

[41] To determine if the top 2 deciles had significantly greater expected risk-adjusted excess returns than the rest of the population, I perform several t-tests and Welch tests (assuming different variances). The results consistently suggest that the top 2 deciles had higher Sharpe ratios than the rest of the population (at 5% level assuming same variances and at 2% level assuming unequal variances). The lower Sharpe ratio of the eighth decile is due to one particularly low Sharpe ratio (-6.9). This individual, Henri Polycarpe Lepine, seems to have inherited a relatively large wealth in real estate, and owned only one financial asset, namely some shares in "La Fourmi Immobiliere", an insurance company which performed poorly during the period. Removing this individual from the eighth decile would yield an average Sharpe ratio of -0.016 for the eighth decile, closer to the average Sharpe ratio.

[42] Averages are weighted by the capitalization of securities in the table, *i.e.* the share of the aggregate value of the reconstructed portfolios each security represents.

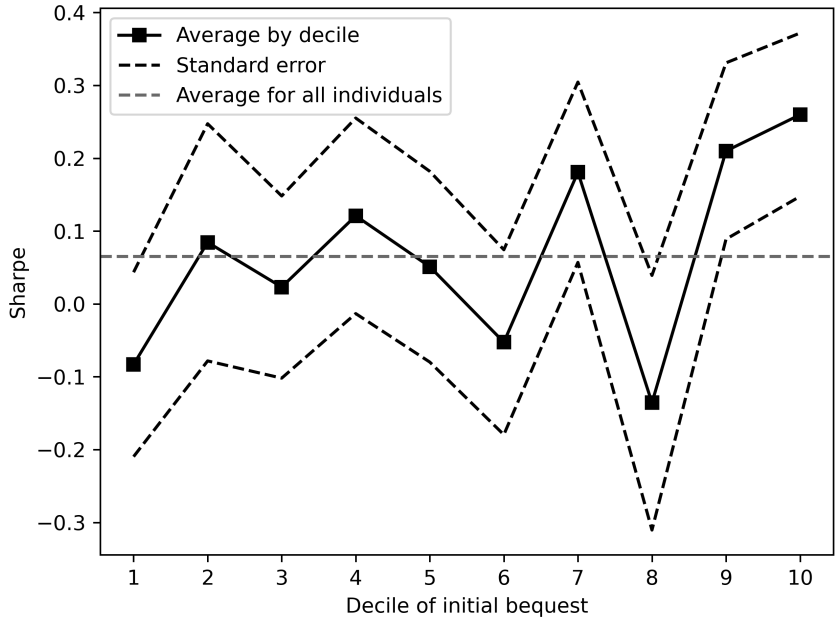

FIGURE 7: SHARPE RATIO BY DECILE OF EX ANTE WEALTH

Notes: This figure shows the average Sharpe ratio (solid black line) per decile of wealth (inherited bequests), with the standard error (dashed black line) and the average Sharpe ratio in the whole sample (dashed grey line).

maximum drawdown is computed as the largest downside move between any two data points over the period 1908-1912.

Foreign public bonds were the assets generating the greatest risk-adjusted returns. Equity was a riskier asset class in average than bonds, given its higher level of volatility and its larger drawdown, but delivered higher returns, mostly because of the bull market of that period, and possibly also reflecting a risk premium, although equity did not outperform bonds insofar as their risk-adjusted performance were similar. Consistently with LeBris (2013) and Jorda et al. (2019), yields outperformed capital gains for bonds, but dividends underperformed capital gains for equity. Foreign assets seemed to outperform French ones, not only because of public bonds outperforming French *rente*, but also in equity, although French corporate bonds outperformed foreign ones.

Since wealthier investors held less French *rente* and more equity and foreign assets, this comparison between asset classes suggests that rich Parisians were looking for high-yield risky assets. This finding is not trivial: as the age-wealth profile of investors became steeper, old and wealthy investors could have looked for relatively

safe assets, consistently with the life-cycle theory.[43] On the other hand, the portfolios of the richest were tilted toward the most profitable asset classes — foreign government bonds, and the riskiest ones — equities. The greater returns on equity, due to the bull market of that period, suggest that the portfolio performance of the wealthiest might be underestimated. Indeed, in Table 2, we showed that the reconstructed portfolios underestimated the fraction of wealth invested in equities. Since the wealthiest held relatively more equity in their portfolios, their performance is likely to be downward biased by the missing assets.

TABLE 9: ANNUALIZED PERFORMANCE (IN %) BY ASSET CLASS (1908-1912)

Asset class		Returns	Capital gains	Yield	Volatility	Maximum drawdown
Equity	All	4.45	2.6	1.86	9.13	-5.87
	France	4.12	2.09	2.03	8.97	-5.93
	Foreign	5.21	3.75	1.46	9.49	-5.72
Corp. bonds	All	2.71	-0.95	3.66	4.19	-2.78
	France	3.1	-0.75	3.85	4.33	-2.88
	Foreign	2.24	-1.18	3.43	4.02	-2.65
Gov. bonds	All	3.57	-0.16	3.73	2.99	-2.03
	France	2.2	-0.97	3.17	2.94	-1.65
	Foreign	4.64	0.47	4.17	3.04	-2.33

Notes: This table shows the average annual performance for each asset class (equity, corporate bonds and government bonds) between 1908 and 1912. Performance is measured by the annualized returns (in %), which is decomposed between capital gains (the change in % in the price of the asset) and yield (which is either the dividend on shares or the coupon on bonds, and not the yield to maturity). Volatility is the annualized standard deviation of returns. The maximum drawdown is the maximum loss (in %) between two data points in the time series. The performance of each asset is assessed as a whole ('All') and then split between those issued in France ('France') and those issued in foreign countries ('Foreign').

Relative performance by wealth level within asset classes

Given the relatively low risk-adjusted returns on equity over bonds, the superior portfolio performance of wealthy investors cannot be explained by differences in portfolio profiles and *inter*-asset class relative performance. Table 10 confirms that the risk-adjusted returns for each asset class increased with wealth, apart from French *rente*, which offered a constant 3% return. This suggests that, within each asset class,

[43] Age at death was indeed positively correlated with net wealth.

wealthier investors were making better investment decisions, due to better stock picking skills, information advantage or portfolio advisers. Indeed, some stocks delivered excess returns over the long-run, as shown by Le Bris et al. (2019) in the example of the Bazacle company, and could be adequately identified by well-informed and financially literate investors.[44]

TABLE 10: RISK-ADJUSTED RETURNS (IN %) BY DECILE PER ASSET CLASS (1908-1912)

Wealth decile	French Equity	Foreign Equity	French Corp. Bonds	Foreign Corp. Bonds	French Pub. Bonds	Foreign Pub. Bonds
1	0.13	0.08	0.3	0.22	0.68	0.67
2	0.2	0.09	0.56	0.26	0.69	0.99
3	0.02	0.05	0.7	0.16	0.62	0.55
4	0.12	0.03	0.58	0.17	0.66	1.3
5	0.16	0.05	0.58	0.2	0.65	1.06
6	0.19	0.03	0.64	0.26	0.71	1.02
7	0.26	0.15	0.64	0.32	0.73	1.04
8	0.47	0.19	0.7	0.64	0.68	0.91
9	0.3	0.2	0.79	0.39	0.68	1.84
10	0.32	0.33	0.86	0.4	0.71	1.32
All	0.22	0.12	0.63	0.3	0.68	1.07

Notes: This table shows the average annual risk-adjusted return (in percentage) per asset class and country of issuance by decile of wealth (initial bequests) between 1908 and 1912.

Alpha and beta distribution by wealth level

Did the 1912 wealthy Parisian investors exhibit better investment skills or was their performance mostly driven by the bull market of the late *Belle-Epoque*? Better investment skills would translate into greater *alpha*, while a higher correlation to the market would be captured by a greater beta. [45]

The answer is twofold. First, top deciles largely benefited from the bull environment at the eve of the First World War. Figure 8 shows the the top four deciles had a positive

[44]Bazacle was a French milling company founded in Toulouse, whose dividends yielded excess returns of 5% according to Le Bris et al. (2019). A 1912 decedent, Louis Courtois, whose net worth was valued above 6 millions *francs*, owned some Bazacle shares, which illustrates the positive relationship between wealth and stock picking skills.

[45]I only present the results with the second specification for the market returns, namely the returns of each asset weighted by the share of the aggregated value of the probate records it represented. Results for the first specification followed the same pattern, but with lower betas.

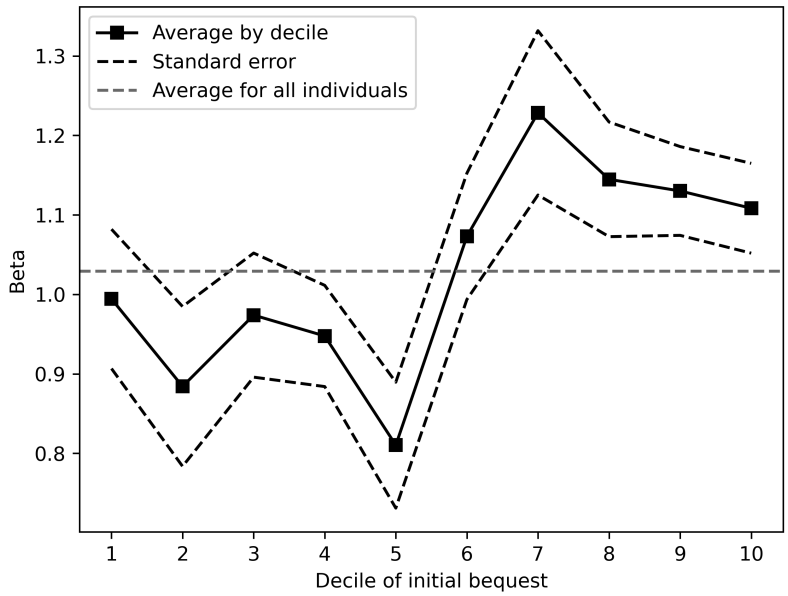

FIGURE 8: BETA BY WEALTH DECILE

Notes: This figure shows the average annual beta generated by wealth decile (initial bequests) between 1908 and 1912 (solid black line) with the standard error (dashed black line) and the average annual beta across the whole sample (horizontal dashed line).

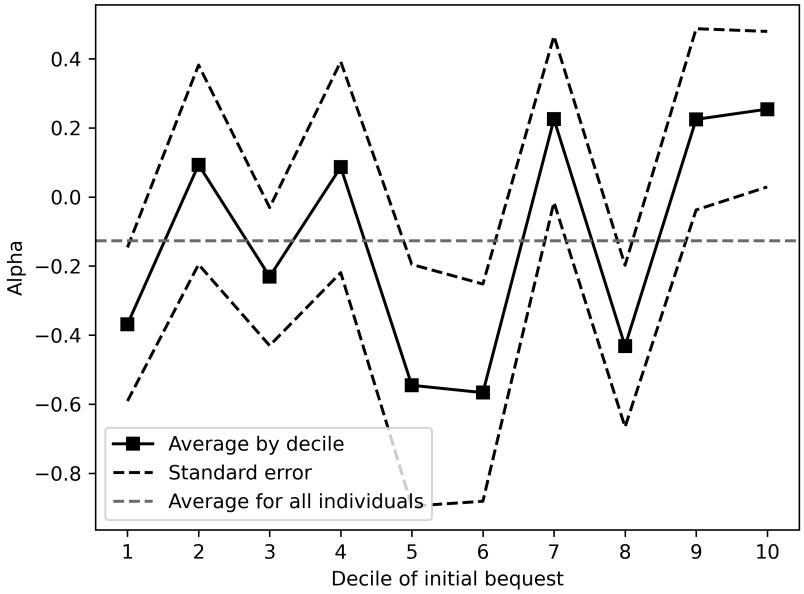

FIGURE 9: ALPHA BY WEALTH DECILE

Notes: This figure shows the average annual alpha of the reconstructed portfolios by wealth decile (initial bequests) between 1908 and 1912 (solid black line) with the standard error (dashed black line) and the average annual alpha across the whole sample (horizontal dashed line).

beta to the market returns, in contrast with the bottom deciles which probably suffered from the capital losses on French rentes during the period, while equities kept rallying. Second, top deciles were able to generate a positive alpha in average, which significantly differed from the alpha of the average portfolio, as shown in Figure 9. This could be explained by lighter capital constraints allowing wealthier investors to reach more optimal portfolios on a higher efficient frontier, but also by better investment skills or information advantage at a time where trading on insider information was not only possible, but also unsanctioned. Compared to the 2000s Swedish households analyzed by Bach et al. (2020), the 1912 Parisian investors also benefited from higher systematic risk, but unlike the former, generated a positive alpha on top of the market performance.

PORTFOLIO PERFORMANCE AND WEALTH INEQUALITIES

Rate of return and wealth trajectory

Parisians who inherited greater bequests did enjoy superior returns during the *Belle-Eoque*, partly favored by a bull market to which their portfolio was highly correlated, partly because of greater excess returns (alpha) on their investments. How did this superior performance of larger portfolios impact the distribution of wealth in the long-run? Can we, at least partially, explain the rising wealth concentration during the *Belle-Epoque* by this heterogeneity in returns?

I consider a simple scenario where each decile earns its average return every year and that this return remains constant over time. I start in 1860, that is when most of the 1912 decedents became young adults, and compound their returns until 1910. Figure 10 plots the results of this simulation for the top 10% and the top 20% of investors (by initial bequests), and compares the simulation against the actual data presented by Piketty (2014). Because I only consider married decedents with a reconstructed portfolio of at least 50%, the top decile in my table excludes some of the wealthiest individuals and therefore does not coincide with Piketty's top decile. However, aggregating the top 20% gives a share of total wealth in 1860 equivalent to what Piketty estimates for the top decile of wealth. The greater returns top deciles earned on their wealth

drives the concentration of wealth up throughout period, and roughly coincides with the actual rise in wealth concentration estimated by Piketty (2014). It suggests that the positive correlation between wealth and returns on wealth was a significant driver of the growing wealth concentration during the *Belle-Epoque*.

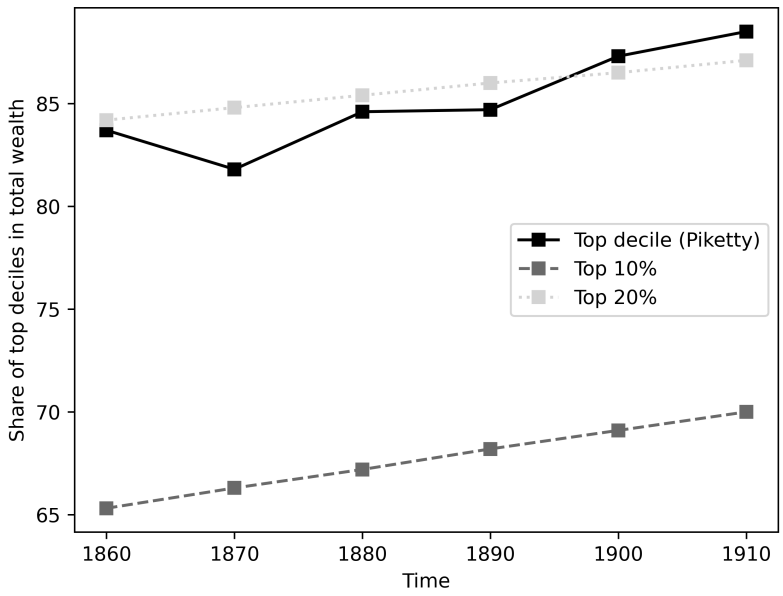

FIGURE 10: EVOLUTION OF WEALTH CONCENTRATION (SIMULATION VERSUS ACTUAL) 1860-1910

Notes: This figure shows the share of the total wealth owned by the top deciles (top 10% and top 20%) of initial bequests (with the start date arbitrarily fixed to 1860) and the evolution of this share assuming the same return on wealth every year. The top decile (Piketty) data represent the actual share of the total wealth owned by the top decile as presented in Piketty (2014).

I then repeat the same exercise, focusing on the top decile of inherited wealth, and consider two scenarii: one in which the top decile earns its superior returns, and one in which the top decile earns the average returns of the bottom decile during the whole period. Results are shown in Figure 11. The black line shows, as in Figure 10, that the fraction of the total wealth owned by the top decile kept growing at a rapid pace, assuming they owned every year their average returns (3.51%). On the other hand, assuming that the top decile earned the average returns of the bottom decile (2.96%), this fraction kept decreasing over time as shown by the grey line. It suggests that heterogeneity in returns was a significant driver of the rise of wealth inequality during this period.

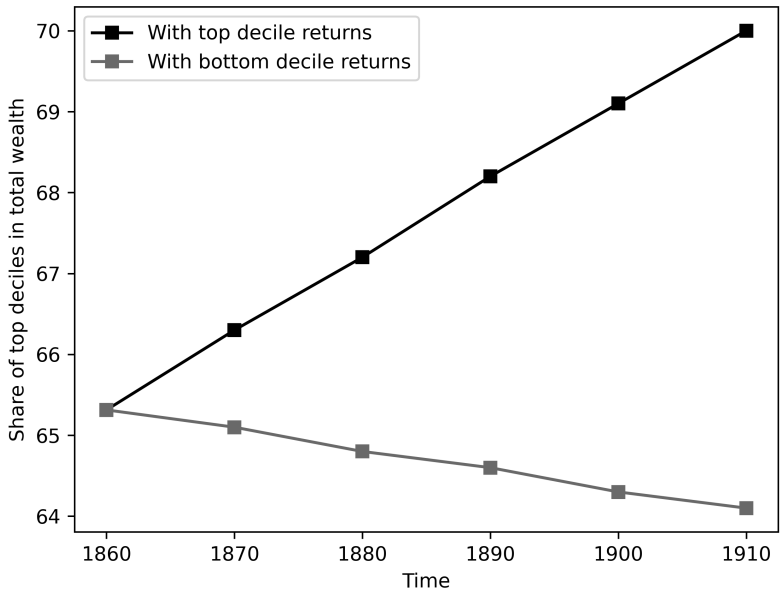

FIGURE 11: EVOLUTION OF WEALTH CONCENTRATION (SIMULATION WITH TOP AND BOTTOM DECILE AVERAGE RETURNS) 1860-1910

Notes: This figure shows the share of the total wealth owned by the top decile of initial bequests (with the start date arbitrarily fixed to 1860) and the evolution of this share assuming the same return on wealth every year. The black line shows the evolution over time of this share assuming the top decile earned its average return. The grey line shows the same evolution, but assuming the top decile earned the average return of the bottom decile.

Portfolio performance and social mobility

One of the paradoxes of the *Belle-Epoque* was that despite following the constitution of the III Republic and Jules Ferry's laws on a free and secular education, the period was characterized by limited social mobility as the fruits of economic growth were not redistributed equally: bourgeois thrived while lower social classes stagnated or receded, as shown by Winock (2002). How did heterogeneity in portfolio performance explain the limited social mobility during the *Belle-Epoque*?

Table 11 shows the actual transition matrix from the distribution of inherited bequests to the distribution of net wealth at death in 1912. It is defined as:

$$T[i,j] = \frac{d_{ij}}{dj} \quad \text{for } i,j \in [\![1,10]\!]$$

with d_{ij} the number of married investors who were in the j^{th} decile of initial bequests

and the i^{th} decile of net wealth at death, and d_j the number of married investors in the j^{th} decile of initial bequests.

The transition matrix illustrates the low degree of social mobility in the table. The first 7 deciles had virtually no chance to reach the top decile, which is entirely filled with Parisians whose inheritance placed them already at the top of the wealth distribution. The first deciles seem to display some mobility, but this is due to the fact that small portfolios were very much alike, with a lot of investors starting with no bequest or tiny ones, hence the initial differences in endowments at the bottom of the wealth distribution were almost nonexistent. The low degree of social mobility can also be seen in the middle of the wealth distribution, with individuals from deciles 6, 7 and 8 rarely receding to lower deciles but also rarely making it to the top two deciles.

TABLE 11: TRANSITION MATRIX BETWEEN DECILES OF INITIAL BEQUESTS AND DECILES OF NET WEALTH AT DEATH

	1	2	3	4	5	6	7	8	9	10
1	0.24	0.21	0.28	0.23	0.05	0.0	0.0	0.0	0.0	0.0
2	0.12	0.28	0.24	0.35	0.02	0.0	0.0	0.0	0.0	0.0
3	0.24	0.16	0.17	0.19	0.24	0.0	0.0	0.0	0.0	0.0
4	0.17	0.12	0.09	0.07	0.45	0.09	0.0	0.0	0.0	0.0
5	0.03	0.09	0.1	0.07	0.1	0.47	0.12	0.0	0.02	0.0
6	0.03	0.09	0.03	0.04	0.07	0.22	0.49	0.03	0.0	0.0
7	0.05	0.03	0.02	0.02	0.05	0.12	0.25	0.38	0.07	0.0
8	0.07	0.03	0.07	0.02	0.02	0.07	0.09	0.45	0.19	0.0
9	0.0	0.0	0.0	0.02	0.0	0.03	0.05	0.1	0.62	0.17
10	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.03	0.1	0.83

Notes: This table shows the transition matrix for married investors, from the deciles of initial bequests (columns) to the deciles of net wealth at death (rows). For example, 19% of those who belonged to decile 4 of initial bequest died in the 3rd decile of net wealth, while 9% of those who belonged to decile 3 of initial bequest died in the 4th decile of net wealth.

To estimate the impact of heterogeneous portfolio performance on social mobility, I perform a Monte Carlo simulation where, for each simulation, at each period from their marriage to their death (in 1912), investors randomly draw a return rate from the set of all possible rates of returns in the decile of initial bequests they belong to.[46] Therefore I obtain, for each individual, a sequence of returns which I compound to

[46]The distribution of the rates of returns was not the same in each decile. Therefore, instead of relying on strong parametric assumptions, I simply randomly draw a rate of return for each individual at each period from the set of returns observed in the decile of initial bequest the individual belongs to. For example, if an individual belongs to the 3rd decile of initial bequests, and got married in 1880, she will randomly draw, every year from 1880 to 1912, a rate of return from all the rates of returns observed in the 3rd decile of initial bequests.

obtain the distribution of capitalized wealth at death in 1912. For each simulation, I obtain a transition matrix which describes the transition from the deciles of initial bequests to the deciles of capitalized wealth at death, using the random sequence of returns each individual drew.

Table 12 shows the average transition matrix for 10,000 simulations. The bottom of the wealth distribution exhibits the same pattern of social mobility as in Table 11 because of the very small differences in initial endowments. However, given the huge endowments wealthy Parisians inherited, it was impossible for the bottom deciles to make their way to the top of the wealth distribution solely based on portfolio performance. Symmetrically, the probability for top deciles to recede to lower ones was near-zero, because their initial endowments were so large that it would take a large under performance versus smaller portfolios to recede to lower deciles, which was very unlikely given the superior returns the top decile enjoyed on their wealth. This simulation illustrates the analysis of Piketty (2014) regarding the importance of inheritance, as the difference in initial bequests was so huge between the bottom and the top deciles that it could not be offset by portfolio performance. However, it also shows the role played by heterogeneity in portfolio performance in the growing concentration of wealth during the *Belle-Epoque*, as the relatively higher returns wealthy investors enjoyed on their large portfolios contributed to slow down social mobility. Indeed, the trace of the Monte Carlo simulated matrix (6.2) is larger than the trace of the actual transition matrix (3.2), which suggests that social mobility implied by portfolio performance was less important than the actual social mobility.[47] If we compare the $9^{th}$and 10^{th}deciles in the bottom right corner between the two transition matrices, we can see that fewer investors receded to lower deciles in the MC simulated matrix, which also suggests that portfolio performance alone was a significant driver of wealth concentration during the *Belle-Epoque*.

[47]It echoes with Piketty et al. (2014) who show that the wealthiest individuals behaved as *rentiers*, *i.e.* consumed more than the capitalized value of their bequests, unlike smaller investors, who saved their labor income.

TABLE 12: MONTE CARLO SIMULATED TRANSITION MATRIX BETWEEN DECILES OF INITIAL AND FINAL BEQUESTS

	1	2	3	4	5	6	7	8	9	10
1	0.41	0.32	0.27	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.32	0.37	0.31	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.27	0.31	0.41	0.02	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.02	0.94	0.04	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.04	0.79	0.17	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.17	0.72	0.11	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.11	0.63	0.24	0.02	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.25	0.58	0.16	0.02
9	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.18	0.59	0.22
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.23	0.77

Notes: This table shows the transition matrix for married investors, from the deciles of initial bequests to the deciles of final wealth simulated by a Monte Carlo with n=10000.

CONCLUSION

Paris in 1912 was an interesting ecosystem to study the accumulation of wealth inequalities through the lens of returns on financial wealth. Not only was Paris dual stock exchange highly developed at that time, but the Parisian society was also characterized by extreme disparities in wealth concentration, and thus was a relevant environment to test for heterogeneity in returns and their correlation with wealth, which is made possible by the high quality of French tax records and price series. Overall, the average Parisian portfolio at the eve of WWI was strikingly diversified across a broad range of asset classes, sectors and regions. Although modern portfolio theory was not known yet, investors seemed to understand quite well the benefits of diversification. However, capital and institutional constraints prevented small investors to effectively diversify: some investors enjoyed colossal fortunes and were able to build large, performing and resilient portfolios, while some Parisians only held one or two unique securities, in general French public debt, that barely guaranteed a minimal return. Richer investors tended to hold more equity, more foreign assets and riskier securities, as they were able to diversify away the additional risk these high-yield assets carried.

Risk-adjusted returns increased rapidly with wealth, fueled by the enhanced performance on equity and foreign assets — largely owned by the wealthiest. Rich investors exhibited a larger beta and thus benefited from the bull market between 1908 and

1912, but were also able to generate some alpha significantly different from the median household, which contrasts with the Swedish households studied by Bach et al. (2020). Such difference suggests that financial markets grew more efficient during the 20thcentury, as dealing on insiders' information and leveraging social capital to source investment opportunities became less and less possible.

This paper further elaborates on previous work on the Parisian stock exchange, notably Hautcoeur (1994) and Hautcœur and Riva (2011), by diving into the granularity of Parisian actual portfolio composition, and extends the work of Piketty et al. (2005) and Piketty et al. (2014) by mapping portfolio breakdown with actual price series, thus reconstructing *a posteriori* the performance of 1912 Parisian portfolios. It therefore supports Piketty's intuition that the return on financial wealth increases with wealth and drives wealth inequalities over the long-run. The simulations notably show that the greater portfolio performance of the wealthiest investors was a significant driver of the rise in wealth concentration during the *Belle-Epoque*, and contributed to slow down social mobility. Ultimately, the paper documents the history of the *Belle Epoque*, in which the bourgeoisie was not a uniform, homogeneous and closed world but rather exhibited important disparities, although being somehow unified by a loose class consciousness, as pointed out by Daumard (1991) and Winock (2002). As the data assembled for this study can now bridge the composition of Parisian portfolios and their DFIH equivalent, I hope that the possibility to now map the actual portfolio composition of Parisian decedents to the price series will encourage further research on this topic as the DFIH database becomes more and more complete. As noted by Piketty (2014), the U-shaped trajectory of wealth inequalities during the 20thcentury should motivate a better understanding of how wealth inequalities accumulate over the long-run. This paper documents, from a granular and short-term perspective, one of the mechanisms through which, historically, wealth became more and more concentrated by generating higher returns for the wealthiest.

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APPENDIX

A UNLISTED SECURITIES AND ATTRITION

One of the main limitations of this paper is the missing prices for many securities, which not only makes the computation of risk and returns less accurate, but also lowers the number of reconstructed portfolios. There are three reasons why a security had no price: either the asset had a missing price in the DFIH database, which either means the asset was traded on the *Coulisse*, whose database is still under construction, or the asset was not very liquid and was not traded on any sampled day during the period; or the label in the probate records was too equivocal to allow a clear identification of the actual security; or the asset was indeed unlisted. While it is possible to identify which assets were traded on the *Coulisse*, disentangling actual unlisted securities and equivocal labels is impossible. Hence, "unlisted" securities here refer to securities with no entry in the DFIH database, *i.e.* either securities not listed on the exchange or unidentified listed assets.

As I choose to only consider the portfolios whose reconstructed value is at least 50% of the total value of the actual portfolio, the number of portfolios in the analysis drops from 1,718 to 1,329, *i.e.* 389 portfolios are discarded because their reconstructed value is less than half of the original portfolio. In terms of value, the 1,718 reconstructed portfolios are worth 343,286,715 francs, while the 1,329 selected portfolios are worth 283,048,260 francs, *i.e.* 82.5% of the value of the 1,718 reconstructed portfolios.

Figure 12 shows the number of portfolios discarded (*i.e.* with less than 50% of their total value being reconstructed) by decile of net estate in the total population of reconstruction portfolios. As expected, this number increases with wealth.

Figure 13 shows the average discarded value by decile of net estate. The evolution is obviously very steep at the top of the wealth distribution.

One of the main results of this paper is that wealthier investors tend to generate greater Sharpe ratios on their portfolios than less wealthy investors. By definition, we cannot evaluate how robust this result is to the absence of unlisted securities in the portfolio, but there is some reason to believe that results should be robust. There is a total of

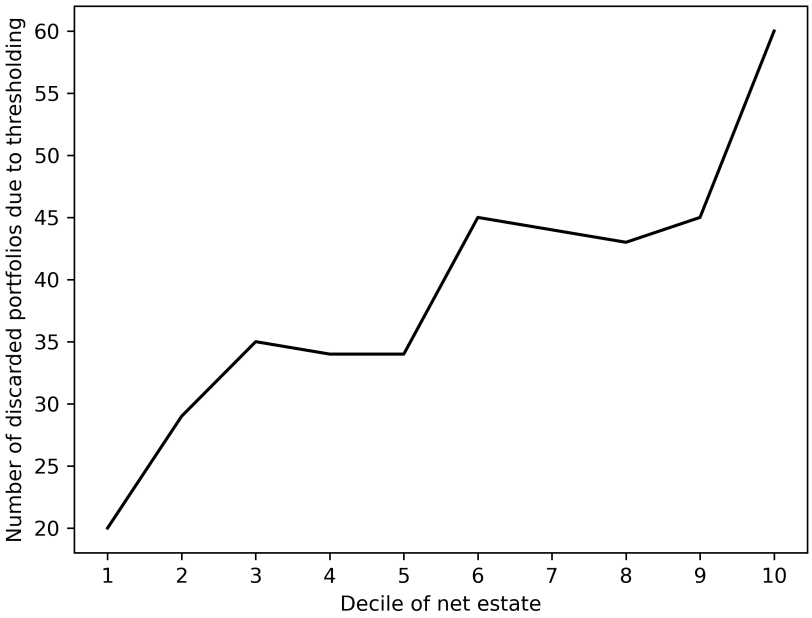

FIGURE 12: NUMBER OF DISCARDED PORTFOLIOS BY DECILE OF NET ESTATE

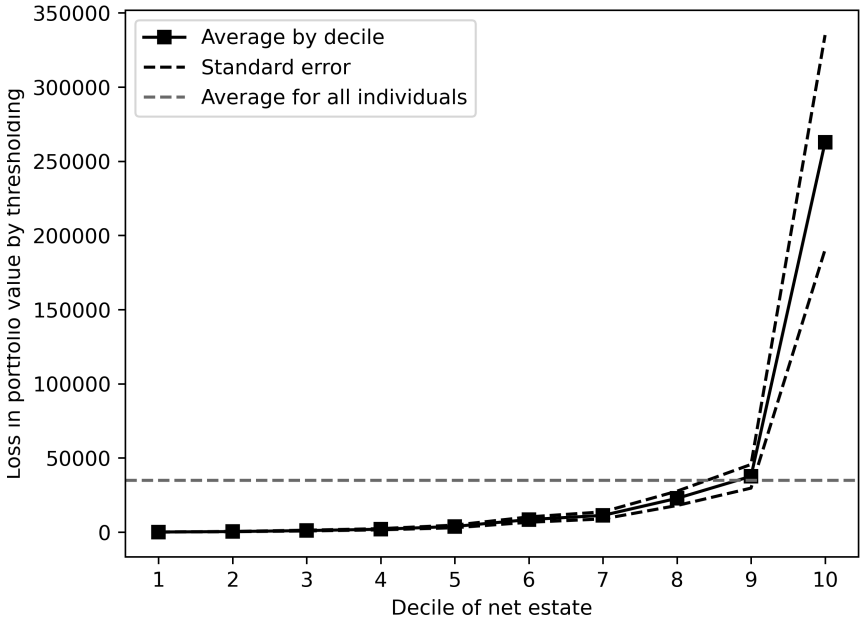

FIGURE 13: DISCARDED VALUE BY DECILE OF INITIAL BEQUEST

5,128 unique financial assets in the database, 2,008 of which are matched with a DFIH, while the remaining 3,120 have no corresponding entry. In terms of value, the missing 3,120 assets represent 31% of the total value of the table. For the equivocal listed names, a reasonable assumption would be to say they are uniformly drawn from the

listed assets, and thus would not distort the results. For the unlisted assets, Bach et al. (2020) show that one of the main drivers of the increasing relationship between wealth and returns is the fact that wealthier investors own a significant share of their wealth in private equity, where they are able to capture higher returns.

Figure 14 shows the average percentage represented by unlisted securities in the total wealth by decile of wealth. The spike for the fourth decile coincides with the sample of Parisians who owned shops, and as such owned a large fraction of their estate in unlisted assets. For the upper deciles, the relationship seems to be almost linearly increasing, which suggests that the wealthiest investors tended to invest more in less liquid private equity. Conversely, the bottom of the wealth distribution owned little unlisted securities, as they were probably not rich enough to hold risky private equity investments or *fonds de commerce* (shops).

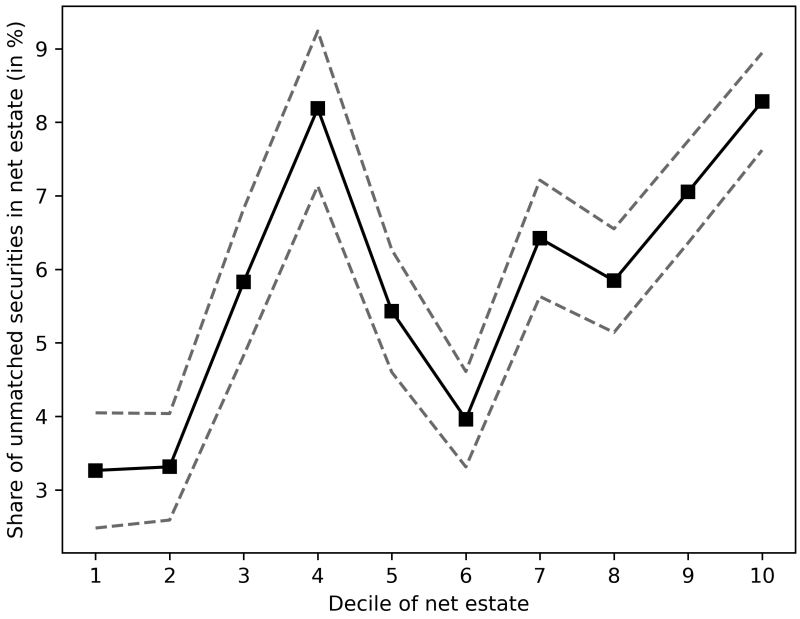

FIGURE 14: AVERAGE PERCENTAGE OF UNLISTED SECURITIES IN NET ESTATE PER DECILE

Table 13 shows that most of the unlisted securities were in France, which includes all the shops and unlisted companies owned by the 1912 decedents, but could also suggest a home bias. Table 14 shows a high percentage of "Other" due to the aforementioned issue of many "unlisted" securities being actually assets with an equivocal label. Private investments in mining unlisted companies seems relatively strong.

Given that the wealthiest investors held a relatively greater fraction of their wealth in mining companies, this partially explains why the reconstruction rate falls for the top deciles.

TABLE 13: SHARE (IN %) OF EACH REGION IN THE VALUE OF UNMATCHED SECURITIES BY DECILE OF WEALTH

	Value	Percentage
Africa	4,671,479.0	3.6
Asia	1,299,195.0	1.0
Empire	1,768,377.0	1.4
Europe	25,191,457.0	19.6
France	75,488,740.0	58.8
Northern America	7,020,679.0	5.5
Russia	2,205,053.0	1.7
Southern America	10,678,475.0	8.3
Total	128,323,455.0	99.9

Notes: This table shows the total value (in francs) of unlisted securities for each region (left column) and the percentage each region represents in the total value of unlisted securities (right column).

TABLE 14: SHARE (IN %) OF EACH SECTOR IN THE VALUE OF UNMATCHED SECURITIES BY DECILE OF WEALTH

	Value	Percentage
Agriculture	3,297,208.0	2.6
Financials	9,145,026.0	7.1
Industrials	8,875,770.0	6.9
Mining	15,105,583.0	11.8
Other	55,267,953.0	43.1
Retail	16,699,865.0	13.0
Transport	18,169,711.0	14.2
Utilities	1,762,338.0	1.4
Total	128,323,454.0	100.1

Notes: This table shows the total value (in francs) of unlisted securities for each sector (left column) and the percentage each sector represents in the total value of unlisted securities (right column).

A natural question is whether investors in the top decile owned large shares in private, unlisted companies, and whether this explains the attrition at the top of the wealth distribution. In particular, did the wealthiest decedents have large investments in companies they owned or managed? Identifying these private businesses is really not straightforward. I choose to restrict this analysis to the companies which are named after the decedent, and which I assume are family firms owned or managed by the

decedent's family. This is most likely not fully accurate, as some decedents could have invested in companies with the same name by pure coincidence. I perform some manual checks to verify to the best of my abilities that the decedent was actually either an owner or a manager of the company. For example, Stanislas Rouart (1833-1912) was indeed a famous industrialist and art collector who owned shares in the so-called "Société des Frères Rouart". Table 15 shows some statistics about these individuals. Most of the decedents who owned shares in a company named after them were among the wealthiest in the dataset, and a significant fraction of their wealth was invested in these businesses.

TABLE 15: SHARES IN PRIVATE BUSINESS

Deciles	N	Average Shares Value	Average Net Estate	Pct of Wealth	Pct of Financial Wealth
2	1	42,282	22,334	1.89	1.00
4	4	70,080	89,594	0.74	0.76
5	3	113,102	173,112	0.85	0.84
6	10	84,448	334,568	0.25	0.50
7	5	138,808	564,519	0.37	0.64
8	11	246,260	957,593	0.33	0.55
9	14	667,781	5,698,282	0.18	0.41

Notes: This table displays some statistics about the 1912 decedents who owned shares in a company named after them. Percentages should be between 0 and 1, but some individuals had debts and therefore, this percentage is higher than 1. Four of these decedents would have belonged to the 4th decile of net estate in the table of reconstructed portfolios. The 'Pct of Wealth' is computed as the total value of shares owned in private companies named after the decedent divided by the net estate at death. 'Pct of Financial Wealth' is computed as this total value divided by the total value of financial assets owned by the decedent.

B ON TAX EVASION

Even though there is some evidence to believe that the probate records accurately reflect the actual portfolios owned by the 1912 decedents, some assets were more easily hidden than others. Artworks or jewelry for instance, could be used to discretely process intergenerational transfers. On this point, Oosterlinck (2017) shows that one of the motives to hold artworks is their ability to hide wealth. Nonetheless, the probate records include paintings, statutes, books, cars, jewels and animals (cattle and live-

stocks), which were very mobile assets, and for some, such as jewels, easy to hide.[48] Their presence in the records suggests that even assets which could easily be hidden seemed to have been scrupulously declared. Moreover, artworks were mostly owned by the wealthiest. Hence, even though some assets may have successfully be hidden, this would not modify the place of individuals in the distribution of wealth, as the wealthiest would simply be wealthier.

A more challenging point is the presence of to-the-bearer securities, *i.e.* certificates that were not registered, and thus could have been more easily hidden from the tax authorities. The wealthiest would probably have benefited more from this feature, as they owned relatively more shares, while the bottom deciles mostly owned French rente, which was registered and not to-the-bearer. Given the relative underperformance of French rente versus equity, undeclared to-the-bearer securities would most likely not challenge the results.

C DIVERSIFICATION

Figure 15 shows the evolution of the diversification metrics with inherited wealth for the reconstructed portfolios, and suggests that the pattern displayed in Figure 6 still holds true for this subsample of portfolios, with the wealth metric used being the inherited wealth instead of the net estate value.

[48] Paintings were notably owned by the wealthiest. The most valuable painting in the table nears 1 million francs.

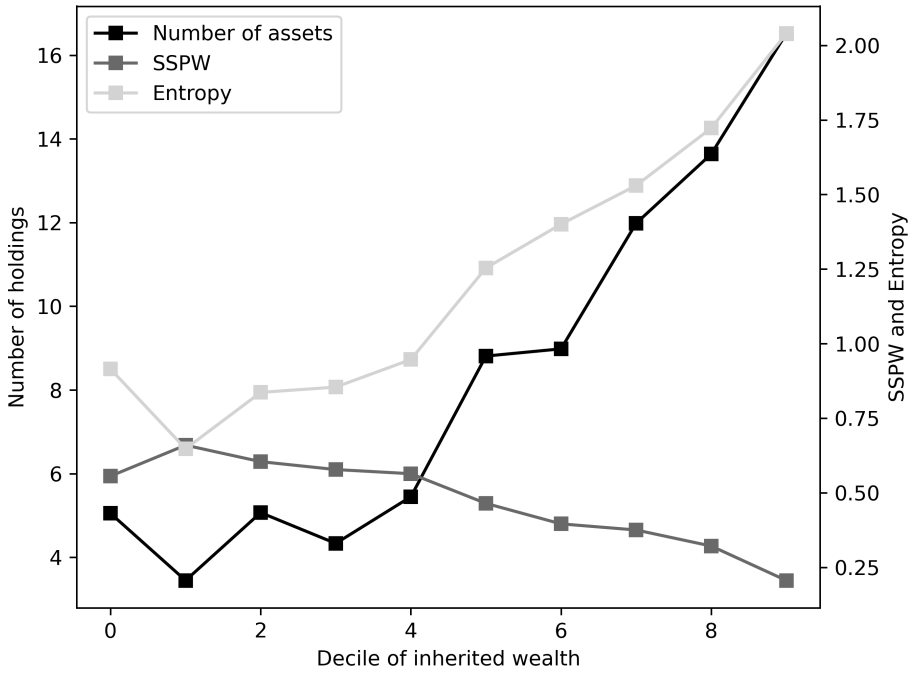

FIGURE 15: DIVERSIFICATION METRICS, AVERAGE BY WEALTH DECILE FOR RECONSTRUCTED PORTFOLIOS

Notes: This figure shows the average value of each diversification variable by decile of inherited wealth for the reconstructed portfolios. The number of assets (black line) is plotted against the left axis, while the SSPW (dark grey) and the entropy (light grey) are both plotted against the right axis.

D LIQUIDITY AND FRENCH-FAMA FACTORS

The three-factors model developed by Fama and French (1996) models the excess returns on a portfolio as a linear combination of market excess returns, the relative performance of small market capitalizations versus large ones, and the relative performance of high-book-to-market stocks. The third factor cannot be computed from the DFIH table, but the database contains enough information about the market capitalizations of listed stocks to compute the "small-minus-big" (SMB) factor.

I extract the market caps of all the listed stocks and consider the market capitalizations as of December 1912. I compute the difference in returns of the 40 smallest stocks by market capitalization versus the largest 40 stocks. Figure 16 shows the average difference in returns per year of the smallest 40 stocks versus the largest 40 stocks. During the 1908-1912 period, smaller stocks underperformed larger ones.

FIGURE 16: AVERAGE RETURNS OF THE SMALLEST 40 STOCKS VERSUS THE LARGEST 40 STOCKS

I then compute the SMB factor by regressing:

$$r_{i,t} = \alpha_i + \beta_i r_{M,t} + f_i SMB_t + \varepsilon_{i,t}$$

where $r_{i,t}$ is the excess return on portfolio i at time t, r_M the market excess return, SMB_t the spread in returns on the 40 smallest versus the 40 largest stocks by market cap. To compute the market returns, I only use here the index built from the French 40 largest stocks by market cap in the DFIH database. The results by decile of initial bequests are plotted in Figure 17. There is not much evidence of the SMB to substantially vary across the wealth distribution, even though the bottom deciles seem to have been overexposed to the underperformance of smaller stocks.

However, adding the SMB factor improves the R^2 of the regressions, as suggested by comparing Figure 18 and Figure 19, the former showing the R^2 of the regression without SMB factor, the latter including the SMB factor.

Given the average positive Sharpe ratio over the period and the poor relative performance of small stocks, the residuals of the regression including the SMB factor have in average a positive sign. The drop in R^2 when including the SMB factor at the top of

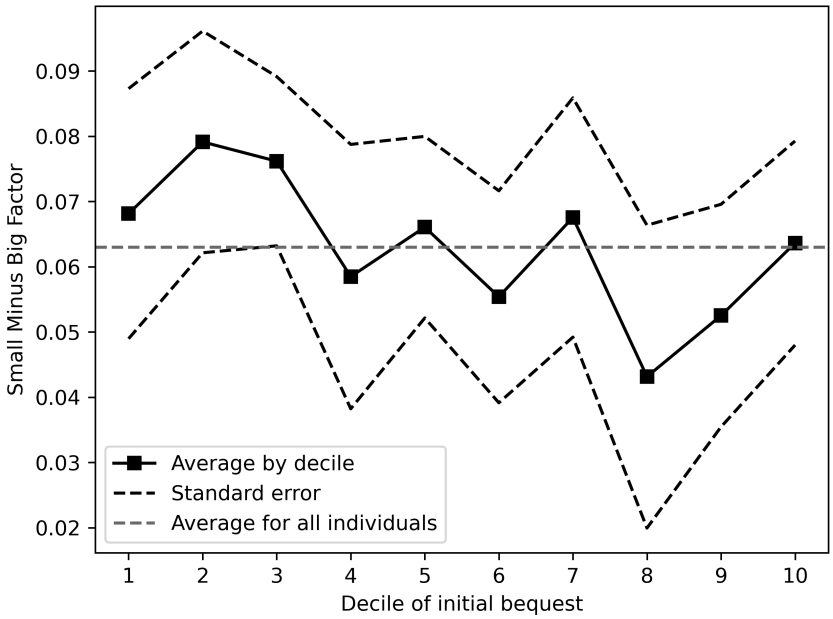

FIGURE 17: DISTRIBUTION OF SMB FACTORS BY DECILES OF INITIAL BEQUEST

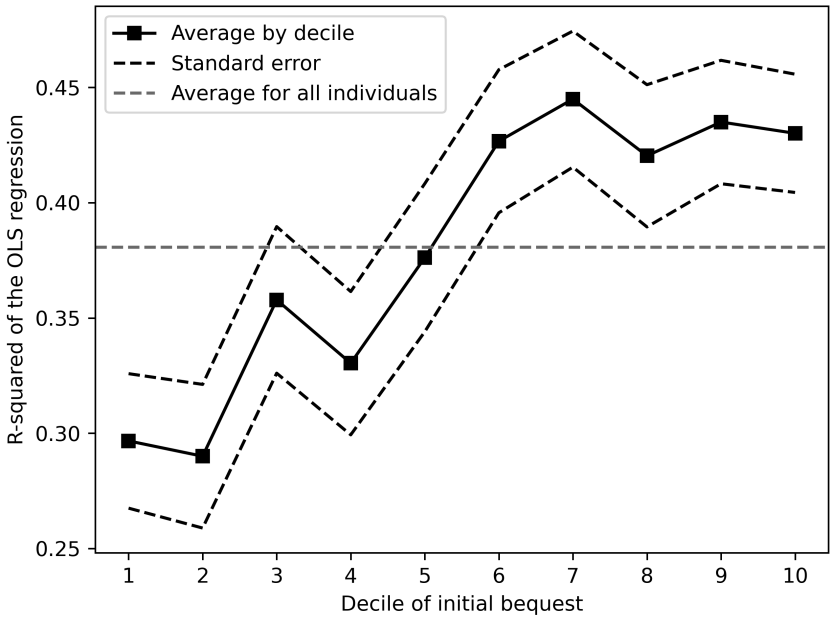

FIGURE 18: AVERAGE R^2 OF REGRESSING PORTFOLIO EXCESS RETURNS ON MARKET EXCESS RETURNS ONLY (NO SMB FACTOR)

the distribution suggests that the wealthiest were able to generate some returns that cannot be explained by the usual French-Fama decomposition. A possible explanation could be that the wealthiest investors were compensated by some liquidity premium

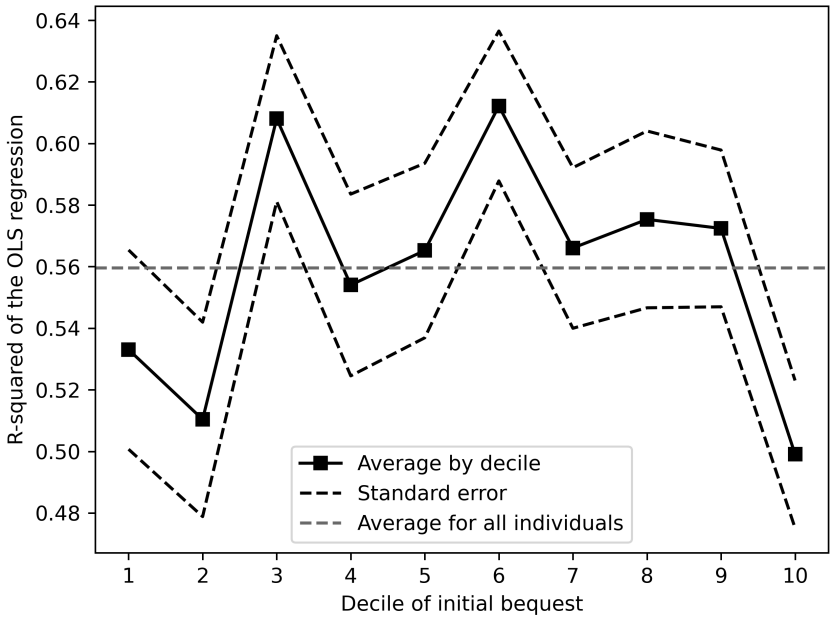

FIGURE 19: AVERAGE R^2 OF REGRESSING PORTFOLIO EXCESS RETURNS ON MARKET EXCESS RETURNS AND SMB FACTOR

for the risk of bearing less liquid securities in their portfolio. To measure liquidity for each stock, I simply take the average number of days per year for which there is a price, and divide by 25. Recall that the prices are sampled from the archives every 15 days, hence a maximum of 25 prices per year. The liquidity of a portfolio is simply the weighted average of the liquidity factors. Figure 20 shows the average liquidity per decile of initial bequests, and suggests that the top deciles owned less liquid assets. The average is about 81%, meaning that investors owned assets for which there was a price 81% of the time in the sampled days. The liquidity profile of the wealthiest is also heavily upward biased by the fact that unlisted securities, which are less liquid by definition, are removed from the portfolios.

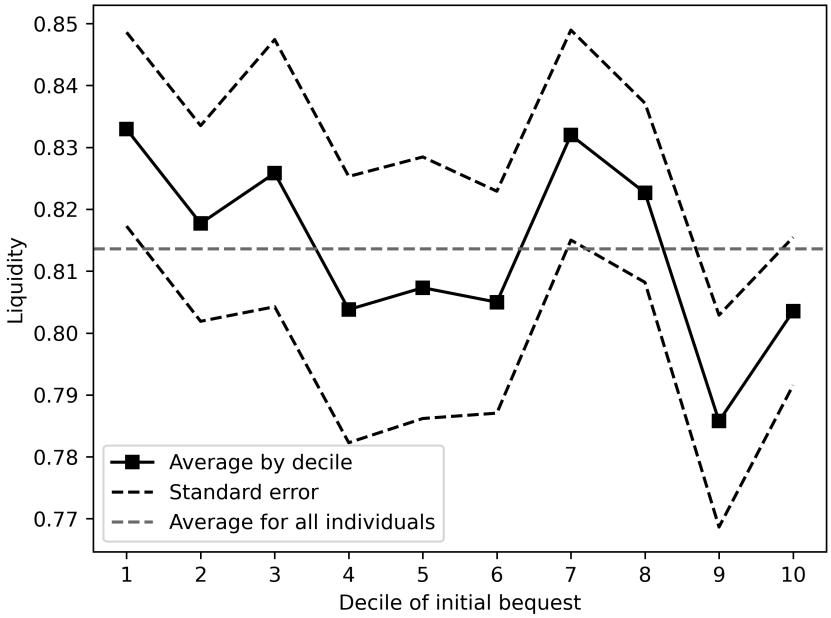

FIGURE 20: AVERAGE LIQUIDITY FACTOR BY DECILES OF INITIAL BEQUESTS