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British Investment Overseas 1870–1913: A Modern Portfolio Theory Approach ⋆

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Abstract. We use a mean-variance approach to address the classic puzzle of British capital export in the 19th century. Our analysis shows that foreign securities listed in London offered significant diversification benefits to British investors. In simple terms, international diversification reduced risk. Conservative estimates of the optimal investment portfolio for a domestic investor suggest that the balance between foreign and domestic security offerings on the London Exchange was close to what classic equilibrium models of asset prices would suggest.

1. Introduction

The vast sums of capital invested by the British in overseas enterprises in the late 19th and early 20th centuries have been the focus of more than a century of economic discourse. Beginning with J. A. Hobson's theory of over-savings as the motivation for capital export and imperialism as its consequence, scholars have long disputed both the cause and the effects of the unprecedented flow of capital from a single nation into enterprises beyond its borders. While exact estimates of British overseas investment in the 19th century vary, there is general agreement that by 1914, Britain had acquired a historically unprecedented position as a global creditor.[1] Between 1865 and 1914 as much British investment went to Africa, Asia, and Latin America as to the United Kingdom itself (Davis and Huttenback, 1986). Between 4 to 8 percent of the gross national product annually was exported annually by British investors in the years 1871–1913, a number significantly higher than the capital export of other developed nations at the time (Pollard, 1985). Much of overseas investment passed through the Stock Exchange of London, which floated issues of foreign sovereign debt, foreign corporate debt and equity securities,

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[1] Morgan and Thomas (1962) estimate that during one hundred year period, 1815–1914 the total British investment overseas amounted to £4,000 million, compared to British GDP of £2.5 billion in 1914.

and securities of U.K. incorporated business which primarily engaged in business overseas.

When a country sends a substantial amount of its financial capital abroad, a natural question arises whether this capital export was excessive. Some historians have asked whether these outflows starved domestic enterprise of capital that would otherwise have stimulated the development of the industry at home.[2] For example, Kennedy (1982) argues that a diversion of capital from overseas to home purposes would have added 25–50 per cent to the British national income. Crafts (1979), on more restrictive assumptions, estimated it at 25 per cent. If this was indeed the case, the argument goes, then Britain could possibly have enjoyed a higher standard of living – if only Victorian investors had allocated a larger proportion of their portfolio to domestic issues. To explain why investment abroad was so large, considering the potential economic benefits to the support of domestic enterprise, some scholars have cast the City of London as a booster for foreign – as opposed to domestic – business. The implication is that domestic capital was "pushed" not "pulled" by marketing efforts on behalf of foreign interests. The proponents of this market failure hypothesis argue that London's capital markets discriminated against domestic industry in favor of overseas investments, to the ultimate detriment of domestic investors.[3]

A contrary view is that British investors were simply responding to higher expected returns offered by overseas ventures, and that the monetary return from these investments added to national income.[4] To study this, Edelstein (1982) constructs a sample of 566 common and preferred stocks and bonds, domestic, colonial, and foreign, between 1870 and 1913 and computes realized rates of return. He concludes that on average, for the years 1870–1913, the United Kingdom's holdings of overseas portfolio investments realized a higher, price-deflated rate of return than its holdings of domestic portfolio investments.[5] Davis and Huttenback (1986) compute rates of return from company accounting records. These data are taken from the records of 482 British firms, operating either at home, in the empire, or in the rest of the world. Like Edelstein, they find that overall, from 1860 to 1912, British firms operating in the empire had higher returns than domestic enterprises, and also outperformed British companies operating overseas outside the empire.[6]

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[2] A general discussion of British industrial development and its relation to the British expansion overseas is contained in several works of Cain and Hopkins (1980, 1986, 1987, 1994).

[3] O'Rourke and Williamson (1999) review and critique the capital market failure view of British overseas investment.

[4] See, for example, Pollard (1985). He argues that capital export was consistent with neo-classical economic models. Offer (1993) reviews the evidence collected by Edelstein (1982) and Davis and Huttenback (1986) and concludes that rates of return on foreign investments were attractive.

[5] Data is described in Edelstein (1982) Chapter 5.

[6] Davis and Huttenback (1986, p. 107). One limitation of their study is that it does not allow a true comparison between home and overseas investment, because it consists exclusively of British firms. It does not account for differences in performance between British and overseas management, especially when the overseas management managed on its home turf.

Edelstein further argues that the risk of foreign and domestic assets was not the same. To address this, he computes risk-adjusted returns taking into account the differential systematic risk exposure of foreign vs. domestic asset classes. Using a form of the Capital Asset Pricing Model to adjust for the co-movement of international stocks with a domestic index, he finds that foreign equities returned a significant 1.58% risk-adjusted return per annum more than domestic equities over the period 1870–1913.[7]

Edelstein's analysis, based on modern portfolio theory, clearly demonstrates that investors who held international assets received a good deal in light of the contribution of these assets to the systematic risk of a strictly domestic portfolio, but it is silent on the question of whether the amount of capital directed to foreign vs. domestic enterprise through the London market was disproportionate, given the covariance structure of international and domestic assets.

In this paper we use modern portfolio theory to test the proposition that the British allocation to overseas investment in this period was, in some sense, too much than would be justified in a rational decision-making framework – absent the presumed "salesmanship" of financial intermediaries. Simply put, we take into account expected returns, risks, and diversification opportunities simultaneously to re-revisit the question of whether the decision to buy foreign securities was individually rational and if so, to what extent did British investors benefited from international investing.[8] Finally, we ask whether the aggregate proportion of investment devoted to foreign securities was excessive, in light of what modern portfolio theory would suggest.

We use the data on returns on domestic and foreign assets compiled by Edelstein (1982).[9] Our findings, therefore, can be compared to the results obtained by other researchers whose main focus is on the return characteristics of these data series. The main contributions of our analysis are three-fold. First, we find that diversification was a potentially important explanation for British investors' overseas investments. Mean variance analysis shows that, given the average returns, variances and co-variances among domestic and foreign assets, rational investors maximizing expected return for a given level of risk should have taken advantage of the diversification opportunities and included a significant proportion of foreign assets in their portfolios. This finding is implied to some extent by Edelstein's earlier empirical study. We also document analytical studies by researchers at the time proposing precisely this motivation for international investing.

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[7] Pollard (1985, p. 496).

[8] Several classic international asset pricing models are focused on the portfolio problem of domestic investors: Black (1974), Stulz (1981a, 1981b), Errunza and Losq (1985), and Eun and Janakiramanan (1986). An international Consumption CAPM is developed in Trzcinka and Ukhov (2004). For a corporate finance perspective see Errunza and Senbet (1981), Stulz (1999), Stulz and Wasserfallen (1995), Errunza and Miller (2000).

[9] See the description of annual return series on various asset classes in Edelstein (1982), Chapter 5.

Our second contribution is to provide a metric for evaluating the aggregate demand for overseas investments. Estimates of British actual overseas investment as a percentage of total investment range from 28 per cent by Hobson (1914) and Feis (1930) to 47.7 per cent by Edelstein (1982), with an average estimate of approximately 34 per cent.[10] Our results for the optimal portfolio weights from mean-variance analysis are surprisingly close to these. For example, when we consider eleven UK equity asset classes and four world-wide equity asset classes, the optimal portfolio given reasonable assumptions about investor risk aversion should hold 38 per cent in investment overseas.[11] In short, we find evidence in support of a neo-classical equilibrium between the supply of foreign securities and the demand by investors given the covariance structure. These results are robust to standard bootstrapping tests about the robustness of portfolio weights.[12]

Finally, in order to "stress-test" the role of diversification as the motive for capital export, we perform the following experiment. We maintain the correlation matrix and the standard deviations of all asset classes, but set the expected return on each foreign asset class equal to that of the corresponding UK asset class. Since returns on UK asset classes are lower during the time period of study, this effectively penalizes investment abroad. This allows us to explicitly examine whether expected return differentials alone motivated overseas investment. Even with this penalty, we find that it was still optimal to include a significant proportion of foreign assets in the portfolio and take advantage of the diversification opportunities that investing overseas offers.

Overall, our analysis suggests that capital export was a consequence of opportunity and understanding of diversification, and that the composition of the securities market in this period is remarkably close to what would be expected of an unconstrained capital market in equilibrium, rather than from a market pushed towards overseas investing at the expense of profitable domestic business opportunities.

Although our analysis has implications for the study of financial history, it is also potentially useful to scholars concerned with the question of the home bias in international investing. Considerable recent research has offered both rational and "behavioral" explanations to explain the propensity of modern investors to abjure the diversification benefits of cross-border investing. Our study highlights an important period in the history of investing in which no home bias was apparent – on average – among British investors. Thus, any explanation purporting to explain the modern home bias puzzle must also explain investing conditions of an earlier era.

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[10] Pollard (1985, p. 491).

[11] The results are presented in Table X and discussed in a later section of the paper.

[12] C.f. Jorion (1985).

2. The Investment Opportunity Set

2.1. LONDON MARKET

The history of British overseas investment before our period of study has been well studied by previous authors.[13] Perhaps the most important feature of this development is the repeated experience of lending to foreign governments through the flotation of bond issues over more than 150 years. By the late 19th century, the London market well understood the risks of foreign investment, having experienced not only the financial dynamics associated with the Napoleonic Wars, but also the first Latin American debt crisis of the 1820's. As Sylla et al. (2005) argue, while the scale of UK overseas investment may have increased through the 19th century, there was a continuity in terms of fundamental characteristics such as security issuance and assessment of risk.

In addition to government issues, British investors also had access to foreign corporate stocks and bonds. Table I, reproduced from Morgan and Thomas, shows the decade-by-decade aggregate listings on the London Exchange, classified according to the categories in *The Investors Monthly Manual* – the leading source of price information used by British investors.[14] The table documents the growth of the market as a whole, the increasing relative significance of foreign stocks and bonds, and the detailed industrial classification for domestic company issues – many of which were "global" in the modern sense of the word. Nitrate, oil, rubber, tea and coffee companies incorporated in Great Britain effectively did much of the business overseas, extracting, processing and selling agricultural and mineral products. Securities issued by continental European railways and US railroad securities were among the largest asset classes. Depending on the source of data, in 1893 US railways accounted for 8.8% to 11% of the total nominal value of securities quoted in London. Other industries included banking, chemicals, steel, manufacturing, telegraph (and later, telephone), gas and light, waterworks, and tramways. The latter five industries are often jointly referred to as infrastructure securities. Although not detailed in the table, the offering of foreign government securities increased in number and capitalization over this period.

Table IV, taken from Ripley, summarizes the investment opportunities available to a British investor at the end of the period of our study in 1913. By this time, foreign stocks and shares quoted in London had a nominal value of nearly £6,800 million, 60% of the value of all quoted securities. Investors had access to securities issued within the empire, including Canadian, Indian, and Australasian securities. Investors could purchases stocks and bonds issued by North American and South American governments and corporations, as well as securities from all European states, the Middle East, Japan, and China (Table V). Overall, the investment oppor-

[13] See, for example, Feis (1930) *Europe the World's Banker*, Yale Press, or more recently Ferguson (2001) *The Cash Nexus: Money and Power in the Modern World, 1700–2000*, Basic Books.

[14] Table II reproduced from Ripley (1934) shows the data for 1843. Table III gives par value of overseas securities quoted on the London Stock Exchange in January, 1893.

Table I. Nominal value of securities quoted on the London stock exchange (£ million)

	Jan. 1 1853	Jan. 1 1863	Jan. 1 1873	Jan. 1 1883	Dec. 28 1893	Dec. 31 1903	Dec. 13 1913	Dec. 31 1920
British Funds, etc.	853.6	901.9	858.9	871.6	810.2	936.2	1,013.0	5,418.2
British Government Guaranteed & Nationalisation Stocks								
Corporation, County Stocks, Public Boards, etc. Gt. Britain & N. Ireland	–	–	–	50.0	91.4	166.0	277.1	335.0
Corporation Stocks, Indian, Colonial and Foreign	–	–	35.3	13.0	43.9	48.1	156.5	159.5
Dominion Provincial & Colonial, Government Securities	–	24.7	47.3	130.6	264.9	334.6	455.7	540.5
Foreign Stocks, Bonds, etc.	69.7	146.7	403.9	831.5	2,384.6	2,884.3	3,133.9	2,394.2
Railways:								
Gt. Britain & Northern Ireland	193.7	245.2	374.0	658.1	854.8	1,104.6	1,217.3	1,259.5
Indian (and Native Loan)	Inc. in	68.7	102.0	80.0	105.5	134.0	151.4	159.9
Dominion & Colonial	Foreign			51.6	119.0	154.5	313.4	323.3
American	–	–	82.7	307.6	743.7	1,107.5	1,729.6	2,534.7
Foreign	31.3	132.0	168.6	378.0	596.1	581.9	736.1	870.9
Banks and Discount Companies	6.5	17.7	103.7	55.8	62.6	200.2	294.4	392.0
Breweries and Distilleries	–	–	–	–	52.1	118.4	103.8	120.8
Canals and Docks	16.6	15.3	9.8	33.2	41.7	41.4	19.9	14.8
Commercial, Industrial, etc.	21.9	26.7	19.7	18.9	93.3	256.5	438.6	669.2
Electric Lighting & Power	–	–	–	–	34.9	70.2	75.3	105.8
Gas	5.7	7.3	12.8	21.8			74.2	70.6

Table I. Nominal value of securities quoted on the London stock exchange (£ million) (continued)

	Jan. 1 1853	Jan. 1 1863	Jan. 1 1873	Jan. 1 1883	Dec. 28 1893	Dec. 31 1903	Dec. 13 1913	Dec. 31 1920
Financial Trust, Land, Investment & Property	–	–	7.3	33.5	124.6	176.5	248.7	255.8
Insurance	6.6	8.5	2.2	12.8	12.4	63.8	66.4	67.2
Investment & Unit Trusts	–	–	–	–	–	–	–	–
Iron, Coal, Steel & Copper	–	–	5.8	13.4	15.4	287.2	329.8	413.1
Mines	7.4	5.2	7.6	20.8	32.9	41.1	60.2	11.4
Nitrate	–	–	–	–	–	–	7.6	6.5
Oil	–	–	–	–	–	–	23.6	79.6
Rubber	–	–	–	–	–	–	24.9	32.3
Tea and Coffee	–	–	1.1	1.6	1.6	9.7		
Shipping	–	–	7.1	10.8	11.8	28.7	45.3	66.8
Telegraphs & Telephones	–	–	12.2	29.6	34.9	41.8	141.1	146.0
Tramways and Omnibus	–	–	1.7	6.4	11.9	24.4	117.5	119.7
Waterworks	2.1	4.5	6.1	10.8	16.9	22.2	7.2	8.8
Total	1,215.1	1,604.4	2,270.0	3,641.4	6,561.1	8,833.8	11,262.5	16,576.1

Source: Morgan and Thomas (1962), pp. 282–283. They cite Burdett's Official Intelligence, Stock Exchange Official Intelligence, and Stock Exchange Official Year Book.

Table II. Nominal value of securities quoted on the London stock exchange in 1843

No.	Type	£
	British and Irish Funded Debt	773,000,000
	Loans to Foreign Governments (including the United States)	121,500,000
	Total Government Bonds	894,500,000
70	Railway Companies	57,448,000
	Banking and Interest Companies	46,450,000
59	Canal Companies	17,862,000
8	Dock Companies	12,177,000
	Turnpike Trusts	8,775,000
	East India Company	6,000,000
	South Sea Company	3,663,000
24	Foreign Mining Companies	6,465,000
81	British Mining Companies	4,500,000
107	Assurance Companies	26,000,000
27	Gas, Light and Coke Companies	4,327,000
11	Water Companies	2,536,000
5	Bridge Companies	2,124,000
4	Literary Institutions	1,003,000
196	Shipping, Land, Asphalt, Loan, etc. Companies	25,000,000
	Total	224,330,000

tunity set of a British investor at the end of 1913 is a list of companies that occupies ninety pages of *The Investor's Monthly Manual*, printed in a rather small font.

2.2. THE INFORMATION ENVIRONMENT

Successful development of a financial market requires access to information. With British investors placing their capital at risk in remote parts of the world, it is only natural to expect a strong demand for information about their investments. The emergence of London as the world financial center took place at a time of revolutionary improvement in information transmission.[15]

[15] Kaukiainen (2001) argues that there was a substantial improvement in the speed of world-wide information transmission even before the introduction of the electric telegraph. He collects data from the *Lloyd's List* and argues that between 1820 and 1860, transmission times dropped substantially, in many cases to a third or even a fifth and in no case to less than about a half. The median interval in days between dispatch and receipt between London and St. Petersburg went from 25 days in 1820 to 7 in 1860. For other routes these numbers are: London and Gibraltar, 21 and 8 days; London and Constantinople, 38 and 10 days; London and Bombay, 145 and 26 days; London and New York, 32 and 13 days.

Table III. Par value of overseas securities quoted on the London stock exchange in January, 1893

Type	£
Colonial Government Securities	225,000,000
Foreign Government Securities	525,000,000
Colonial and Foreign Corporation Stocks	20,000,000
Railways in British Possessions	75,000,000
Railways in India	65,000,000
Railways in United States	120,500,000
Railways in Other Foreign Countries	127,500,000
Banks operating abroad	50,000,000
Foreign Breweries	3,500,000
Gas Companies operating abroad	6,500,000
Iron Companies operating abroad	500,000
Land and Mortgage Companies	100,000,000
Tea Companies	2,500,000
Telegraph Companies	10,000,000
Waterworks Companies operating abroad	3,000,000
Tramway Companies operating abroad	4,000,000
Miscellaneous Companies – Colonial and Foreign	30,000,000
Total	1,368,000,000

Source: Ripley (1934, p. 154).

The first electric telegraph line established in Europe by Sir Charles Wheatstone (1802–1875) linked London and Birmingham in 1838. In France the first line was constructed in 1844 between Paris and Rouen. The lines between Paris and Orleans, and Paris and Lille were constructed in the years 1847 and 1848. The first line constructed in the United States was put in operation in June, 1844, between Washington and Baltimore. The next year it was continued to New York and Boston, and in 1846 to Buffalo and Harrisburg.[16]

At first telegraph lines used overhead copper wires. As technology improved, it became possible to lay telegraph lines under water. Prescott wrote in 1866: "The English were the first to lay submarine cables, and are now far in advance of the rest of the world in their manufacture, and in machinery for laying them".[17] By 1860, three lines were in existence between England and the Continent. Submarine cables connected England and Ireland, and Denmark and Sweden. Nearly one hundred submarine cables totaling more than 25,000 miles had been laid around the world, uniting about one-half million miles of land lines in America, Great Britain,

[16] Prescott (1866).
[17] Prescott (1866), p. 174.

Table IV. Capital publicly invested by Great Britain overseas, December 1913

Geographical Distribution		Asset Classes and Industries	
Description	£, in '000	Description	£, in '000
Canada and Newfoundland	514,870	Colonial Governments	675,464
Australia	332,112	Foreign Governments	284,059
New Zealand	84,334	Total Government Loans	959,523
Africa – South	370,192		
Africa – West	37,305	Municipal	147,547
India and Ceylon	378,776		
Straits Settlements	27,293	Colonial Railways	306,460
Hong Kong	3,104	Indian Railways	140,796
British North Borneo	5,820	American Railways	616,581
Other Asiatic Colonies	26,189	Foreign Railways	457,177
Total India and Colonies	1,779,995	Total Railways	1,521,014
United States	754,617	Banks	72,909
Cuba	33,075	Breweries	17,980
Philippines	8,217	Canals and Docks	7,111
Argentina	319,565	Commercial and Industrial	145,332
Brazil	147,967	Electric Lighting and Power	27,310
Mexico	99,019	Financial, Land and Investment	244,187
Chili	61,143	Gas and Water	29,216
Uruguay	36,124	Insurance	246
Peru	34,173	Iron, Coal, and Steel	30,535
Miscellaneous American	25,538	Mines	272,789
Russia	66,627	Motor Traction, etc.	1,059
Egypt	44,912	Nitrate	11,623
Spain	19,057	Oil	40,579
Turkey	18,696	Rubber	40,982
Italy	12,440	Shipping	794
Portugal	8,136	Tea and Coffee	22,443
France	8,020	Telegraphs and Telephones	43,692
Germany	6,364	Tramways	77,790
Miscellaneous European	54,580		
Japan	62,816		
China	43,883		
Miscellaneous Foreign other than European or American	69,697		
Total Foreign	1,934,666	Total Industrial, etc.	1,086,577
Grand Total	3,714,661	Grand Total	3,714,661

Source: Ripley (1934, p. 175).

Table V. London stock exchange: Government securities (British, colonial and foreign stocks)

The table shows the number of different issues for each government. The figures for 1869 are from *The Investor's Monthly Manual* published on January 30, 1869. The figures for 1890 are from *The Investor's Monthly Manual* published on January 31, 1890.

	Number of securities			Number of securities	
	1869	1890		1869	1890
American			Hungarian	–	3
United States	7	2	Indian	12	4
Virginia	2	3	Italian	4	3
Massachusetts	1	5	Jamaica	–	3
Antigua	1	–	Japanese	–	1
Argentine	4	24	Mauritius	4	4
Austrian	3	3	Mexican	3	2
Australian	12	26	Montevidean	1	–
Belgian	2	1	Moorish	1	–
Brazilian	5	8	New Granada	4	–
British	16	12	Natal	2	5
British Colombian	4	–	New Brunswick	1	–
British Guiana	–	1	New Zealand	7	10
Canadian	7	22	Nicaragua	–	1
Cape of Good Hope	6	10	Norwegian	–	3
Ceylon	3	3	Nova Scotia	2	–
Chilean	5	4	Orange F. State	–	1
Chinese	–	4	Paraguay	–	2
Columbian	1	1	Peruvian	2	2
Costa Rica	–	2	Portuguese	2	1
Cuba	5	–	Prussian	–	1
Danish	7	2	Queensland	2	5
Danubian Principalities	2	1	Russian	10	17
Dutch	4	2	San Domingo	–	1
Ecuador	2	1	Sardinian	1	1
Egyptian	9	5	Spanish	4	3
Fijian	–	1	Straits Settlements	–	1
French	2	3	Swedish	3	3
Greek	2	5	Trinidad	–	2
Guatemala	1	1	Tasmanian	2	4
Hawaii	–	1	Turkish	10	9
Honduras	1	2	Uruguay	–	2
			Venezuela	5	1

Europe, India, Africa, Asia and Russia.[18] The Atlantic cable, connecting Ireland with Newfoundland and New York, and thus permitting Europe to communicate telegraphically with America, was laid in 1858 and the first public dispatch – that of the Queen to the President of the United States – was received on August 17 of the same year. Communications broke down, however, in September. The first fully successful Atlantic cable was completed in 1866.

The speed of information transmission through the telegraph system also improved continuously. Kaukiainen (2001) compares overseas dispatch times to London before and after the introduction of telegraph. The dispatch time between London and Bombay decreased from 145 days by post in 1820 to 3 days in 1870 by telegraph. Similarly, information transmission between London and Hong Kong dropped from 141 days in 1840 to 3 days in 1870 and transmission times between London and Sydney dropped from140 days in 1820 to 4 days in 1870.

The financial community quickly adopted the telegraph. By 1908, there were nine wires between the London and Paris stock exchanges. London was connected to all European financial centers, as well as more remote locations – New York (1866), Melbourne (1872), and Buenos Aires (1874). In 1871, the annual volume of telegrams between London and New York reached 42,000. Although the most rapid long-distance telegraph communications existed between the London Stock Exchange and New York, similar links were established throughout the world through a network of submarine and land lines.[19] Even with the invention of the telephone, in 1876, the telegraph remained an important channel of communications.[20] Telephone service was for a long time quite limited. And although the line between London and Paris operated since 1891, there was no transcontinental telephone until 1915.

These technological developments changed the informational environment of British investors. By 1870, with the development of the electric telegraph network, British investors could receive news concerning political events world-wide, economic and trade news, and even news regarding the weather and the storms affecting the crops in the colonies.

3. Investment Theories and Diversification

3.1. AN EARLY PORTFOLIO THEORIST

A fundamental assumption of our study is that British investors understood the benefits of international diversification before the formal development of modern portfolio theory. Correlation analysis, the statistical foundation of modern portfolio theory, dates only to 1888.[21] How, then, could the insights of the theory explain his-

[18] Shiers (1977).

[19] Michie (1987).

[20] Professor Bell and Colonel Raynolds demonstrated the possibilities of the telephone to Queen Victoria on 14th January, 1878.

[21] Galton (1888).

torical phenomena? In this section we demonstrate that detailed empirical analysis of the benefits of international diversification date to at least to the first decade of the 20th century.

In 1904, Henry Lowenfeld, a London investment advisor and writer, developed a what he called "The Theory of Geographical Diversification" which was intended to protect against the loss of capital and at the same time provide a steady stream of income to the investor. To illustrate the theory, he proposed a model portfolio of securities divided among British, North American, Swedish, South African, Indian and South American railways. In his 1909 book *Investments Practically Considered* he tested the performance of this portfolio out of sample. While somewhat disappointed with the modest gain in prices of the five year sample period, he noted with some satisfaction that, while the two British issues in the portfolio declined significantly in value, the foreign issues rose, providing the predicted protection against capital depreciation of the portfolio.[22] Although he did not employ the formal statistical tool of correlation analysis, he was able to convincingly demonstrate the benefits of an internationally diversified portfolio to investors.

Lowenfeld's (1907) book *Investment: An Exact Science* more completely developed a quantitative approach to evaluate the benefits of an equal-weighted, industry-neutral, international diversification strategy. He argued that superior investment performance could be obtained by spreading capital in equal proportion across a number of geographical areas and carefully re-balancing back to these proportions on a regular basis.[23]

To support the recommendation for international diversification, Lowenfeld postulated that different factors affected securities from different countries; the dominant factor being the market factor ("Market Influence" in his terminology) for that country. In support, Lowenfeld displayed a chart showing the price movements of twelve British stocks (actually fixed income securities) from the year 1893 to the end of 1906 to argue the existence of a large degree of co-movement between them. He pointed out that even if an investor held a mixed assortment of British stocks he could not expect the movements in the value of the investments to counterbalance each other, because all of them are subject to the influence from the home market-wide risk factor. This logic is similar to modern international asset pricing theories that model returns as a function of an asset's exposure to the world market factor, and of the national market factor in the asset's domestic market.

To show that this logic applies to financial markets in other countries, Lowenfeld provides charts of price movements of the stocks of Great Britain, France, Germany, Switzerland, Belgium, Canada, Japan, USA, and Argentina (the figure is reproduced in Appendix A). He concludes that the value of all securities that come from the same country is influenced by that country's market factor. At the same time he points out that securities from different countries do not have the same degree of co-movement as securities within one country. According to Lowenfeld:

[22] Lowenfeld (1909, p. 35).

[23] Lowenfeld (1907).

> If an investor divides his capital equally among a number of stocks, every one of which is under a different trade influence, then each of these divisions of his capital will constitute a distinct investment risk, and a true system of averaging investment risks is thereby established.[24]

Lowenfeld also observes that when holding a diversified international portfolio an investor can achieve a higher level of return for the same level of risk compared to the case when only domestic securities are held in a portfolio:

> An investor who geographically distributes his capital can, with safety, afford to hold stocks which yield a larger income[25] than he can hope to receive from an Investment List which disregards the important point of Geographical Distribution.[26]

Lowenfeld's book shows that British investors, including the managers of banks, insurance, and finance companies, as well as large private investors, had a sophisticated way of thinking about investments. In many ways the views expressed in the book correspond to the ideas of Modern Portfolio Theory, which was formally developed more than forty years later. He advocates, for example, analyzing investments from a portfolio point of view and explains "the necessity of considering all investments held as one harmonious whole, of which all the component parts must properly balance each other".[27]

Lowenfeld also considers how an internationally diversified portfolio should be constructed for an investor who has limited wealth. He recommends that the first stock that an investor buys for his portfolio be of "a general international character".[28] In other words, the first stock should be a stock that represents a world market portfolio. The second stock should be a British stock. Consistent with the principle of diversification, the author recommends that the next sum should be invested "in a stock whose trade influence is most likely to be in diametrical contrast to that of Great Britain".[29] Once again, he expresses a view consistent with modern financial theory, namely with the formal statistical result that the lowest variance of a portfolio can be achieved when assets in the portfolio are negatively correlated.

While many of the insights of modern portfolio theory are evident in Lowenfeld's work, a few essential elements are lacking. While Lowenfeld proposes a diversified portfolio, he does not have the tool to identify an optimal portfolio, or even an efficient set of portfolios. Indeed the equally weighted international portfolio he proposes is not a solution that emerges from modern portfolio theory.

[24] Lowenfeld (1907, p. 51).

[25] That is, riskier stocks.

[26] Lowenfeld (1907, pp. 53-54).

[27] Lowenfeld (1907, pp. 72–73), emphasis as in the original text.

[28] Lowenfeld gives the following examples: Shipping Companies, Marine Insurance Companies, and Cable Companies.

[29] Lowenfeld (1907, p. 90).

Investors aware of his writings in the early part of the 20th century would surely have understood and appreciated the reduction in risk that could be achieved by international diversification, however, to the extent they followed his investment advice, domestic securities would have represented a relatively small fraction of their portfolio.

3.2. THE RISKS OF FOREIGN INVESTING

How well did British investors understand the risks of foreign investment? Investors in Britain had a sufficiently long history of active involvement in international financial markets to accumulate negative experience and to learn the fact that placing capital in foreign lands can be risky. According to Morgan and Thomas, "By 1843, British citizens were believed to hold over £120 million of foreign bonds, including those of the American states, but at least £50 million were in default with dividends anything from five to twenty-five years overdue".[30]

Investors clearly understood the risks, and were familiar with the difficulties that arose when foreign securities were in default. In 1875 the Government appointed a Select Committee to investigate the circumstances surrounding many foreign loans and the reasons for default on such loans. Loans raised by Honduras, San Domingo, Costa Rica, and Paraguay with the total nominal value of £10 million were the subject of inquiry. The Committee uncovered unsound lending practices on part of the syndicates that were formed to take portions of the loan at a price considerably below the issue price and re-sell the loan to the public. Honduras incurred a debt of £5,990,000 in the nominal principal value, and in return for the liability provided security in the form of an abandoned section of a railway line 53 miles in length for which the builder received £689,000. The Committee remarked of San Domingo that "it is clear that the Republic felt the improvidence of a bargain by which in return for a sum of £320,000 it was to repay in respect of interest and sinking fund annuities amounting to a total sum of £1,472,500, or in other words, more than 18 per cent per annum for twenty five years".[31] Overall, at the end of 1878, 54% of Britain's loans to foreign governments were in total or partial default.

Another period of crisis, this time resulting from heavy borrowing by Argentina, were the years 1888 through 1893, and again in 1896. Argentina carried a heavy burden of external debt, the amount at the beginning of 1890 was approximately £22 million, experienced high inflation, and generally was in poor financial condition. In 1890 it became evident that the Argentine Government could not meet its obligations and guarantees on external railway and other loans and prices of Argentine securities fell dramatically in London.[32] The price of the Argentine Government Bond of 1886 fell by 17.5% from the end of 1889 to the end of

[30] Morgan and Thomas (1962, pp. 86–87). Their work contains an extensive discussion on early defaults.

[31] Ripley (1934, pp. 102–103).

[32] Ripley (1934, pp. 152–153).

1890. The Buenos Ayres 1882 bond fell by 31.5% during the same period.[33] A series of renegotiations between a committee of English creditors chaired by Lord Rothschild and the Argentine Government took place in 1893 and 1896, and some of the losses of the bondholders were recovered.

The risks of foreign investments must be considered jointly with yields. And in many cases investments in foreign government loans gave a very reasonable rate of return. Writing in 1881, Nash listed approximately 130 foreign government securities with a total market capitalization of over £1,400 million, about half of which were believed to be in British ownership. For stocks that had been issued that long, he traced the dividend history back to 1870, found remarkably few defaults, and reported an average dividend yield of 5.87%.[34] By the 1870's, British investors evidently understood the risks of foreign investment. They also understood the benefits that come from international diversification, and paid attention to both risk and return when placing capital abroad.

4. Framework of Modern Portfolio Theory

4.1. THEORY

Let there be N risky assets available to the investors. The investment opportunity set is described by the vector of expected returns on the N assets, $\bar{\mathbf{z}}$, and by $\mathbf{\Sigma}$, the covariance matrix. Modern portfolio theory assumes that the investors' preferences can be represented by a utility function defined over mean (the expected return) and variance of a portfolio's return. The assumption is that investors favor higher means and smaller variances. Minimum-variance portfolios are portfolios that have the smallest variance for every level of expected returns. In the absence of a risk-less asset the minimum variance portfolio with expected return μ is the solution $\mathbf{w}(\mu)$ to

$$\begin{aligned} &\min \tfrac{1}{2}\boldsymbol{w}'\mathbf{\Sigma}\boldsymbol{w} \\ &\text{subject to } \mathbf{1}'\boldsymbol{w} = 1 \\ &\qquad\qquad \bar{\boldsymbol{z}}'\boldsymbol{w} = \mu \end{aligned} \tag{1}$$

Vector $\mathbf{w}$ is the vector of weights of risky securities in the portfolio. When no positivity constraints of the form $w_i \geq 0$ are imposed, unrestricted short sales are permitted. With no short sale restrictions and no risk-free asset available, in mean-standard deviation space, with mean return on the y-axis and standard deviation on the x-axis, the set of minimum variance portfolios is a hyperbola, as illustrated in Figure 1.[35] When a risk-less asset is available a Capital Allocation Line (CAL) obtains. It is a straight line which intersects the y-axis at the risk-free rate and

[33] End-of-the-year prices are from *The Investor's Monthly Manual*, December 31, 1890, p. 620.

[34] Morgan and Thomas (1962, p. 91).

[35] Markowitz (1952) and Merton (1972).

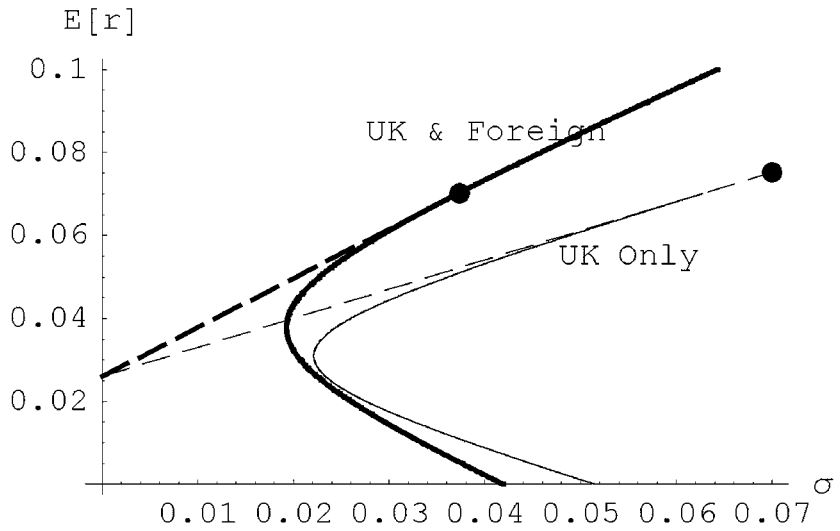


Figure 1. UK Only and UK and Foreign Efficient Frontiers. The plot displays two minimum-variance frontiers constructed without short-sale restrictions, lines tangent to the frontiers with origin at the risk-free rate, and two tangency portfolios. UK-Only frontier is constructed using three asset classes: UK Equity, UK Preferred, and UK Debt. UK and Foreign frontier contains three UK asset classes and adds Foreign Equity and Foreign Debt. Data is from Edelstein (1982).

is tangent to the minimum variance frontier constructed from risky assets. The Capital Asset Pricing Model identifies the tangency point as the market portfolio. The Sharpe ratio, which equals the slope of the CAL, characterizes the risk-return trade-off of the market portfolio and is computed as

$$S_p = \frac{r_p - r_f}{\sigma_p}, \tag{2}$$

where r_p is the expected return on the market portfolio, r is the risk-free interest rate, and σ_p is the standard deviation of the return on the market portfolio. Portfolios with higher Sharpe ratios offer more attractive risk-return trade-off.

Investors frequently face short-sales constraints. When no risk-free asset is available, the optimization problem (1) is modified by adding short sales constraints $w_i \geq 0$ for all assets, $i = 1, \ldots, N$. Generally, with positivity constraints the frontier is not a hyperbola.[36] If a risk-free asset is available, it is still possible to draw a straight line with the intercept equal to the risk-free rate tangent to the minimum variance frontier. The tangency point is the market portfolio in this case, and its Sharpe ratio (the slope of the line) characterizes the risk-return trade-off that the investors in the economy face.

To evaluate the role of the foreign assets we first construct minimum variance portfolios with only domestic assets. We then include foreign assets in the invest-

[36] Dybvig (1984).

ment opportunity set and construct minimum variance portfolios again. We follow this procedure to quantify the improvement in the risk-return trade-off due to the inclusion of foreign investments.[37]

4.2. EVIDENCE FROM FIVE BROADLY DEFINED ASSET CLASSES

We begin our minimum-variance analysis by using five broadly defined asset classes: UK Equity, UK Preferred, UK Debt, Foreign Equity, and Foreign Debt. The asset classes are defined by Edelstein. Table VI displays expected annual returns on the five asset classes, standard deviations, and correlations. Foreign equity has a higher return than domestic equity, 8.66% compared to 6.61%. Foreign debt has a higher return than domestic debt, 4.94% and 3.35%, respectively. At the same time, with a standard deviation of 9.36% foreign equity is riskier than domestic equity, which has a standard deviation of 7.38%. Foreign debt does not appear to be riskier than domestic debt. Foreign debt returns have a standard deviation of 2.37% compared to 2.36% for domestic debt. This, however, can be attributed to the fact that the foreign debt asset class includes a much greater number of securities than the domestic debt asset class. By including a large number of government and industrial bonds from around the globe, foreign debt already takes advantage of diversification opportunities. Examination of the correlation matrix reveals a high correlation between domestic common and preferred shares (0.71). The correlation between domestic and foreign equity returns is lower at 0.39.

Data from Table VI is used to construct a mean-variance frontier with only British asset classes and a frontier that uses all five asset classes. The two frontiers are shown in Figure 1. No short sale restrictions are imposed. We refer to this case as "unconstrained". The figure illustrates a substantial improvement in the risk-return trade-off resulting from the inclusion of the foreign asset classes. The hyperbola constructed with foreign assets is located higher and to the left compared to the hyperbola that utilizes domestic assets only, indicating that any level of expected return μ can be attained with less risk σ when foreign assets are used. Figure 2 is similar to Figure 1, except that no short sales are allowed – investments in all assets are constrained to be positive. Inclusion of foreign assets clearly improves risk-return characteristics of the frontier. The market (tangency) portfolio constructed with only UK assets has an expected return of 5.21%, standard deviation of 3.89%, and a Sharpe ratio of 0.67. When foreign asset classes are included, the market portfolio has expected return of 5.02%, substantially less risk (2.40%), and a Sharpe ratio of 1.01.

Table VII shows the characteristics of the market portfolios created with different mixes of assets. Both the unconstrained and constrained cases are shown.

[37] An alternative approach to quantifying the diversification benefits to international investing is employed by Chabot and Kurz (2003). The authors investigate diversification using a database of individual securities listed on the London Exchange. Their work came to our attention after completing our paper; however, the general conclusions of the two papers are supportive.

Table VI. Mean, standard deviation, and correlation coefficients

The table shows average returns, standard deviation of returns, and correlations for five asset classes: UK Equity (UKEQ), UK Preferred (UKPREF), UK Debt (UKDEB), Foreign Equity (FOREQ), and Foreign Debt (FORDEB). All numbers are annualized. The data corresponds to Edelstein, 1982, Table 5.5, p. 126.

	UKEQ	UKPREF	UKDEB	FOREQ	FORDEB
Mean (%)	6.608	5.010	3.346	8.663	4.945
Standard Deviation (%)	7.378	3.685	2.365	9.357	2.373
	Correlation Coefficients				
UKEQ	1.000				
UKPREF	0.714	1.000			
UKDEB	0.576	0.686	1.000		
FOREQ	0.394	0.312	0.306	1.000	
FORDEB	0.509	0.546	0.662	0.615	1.000

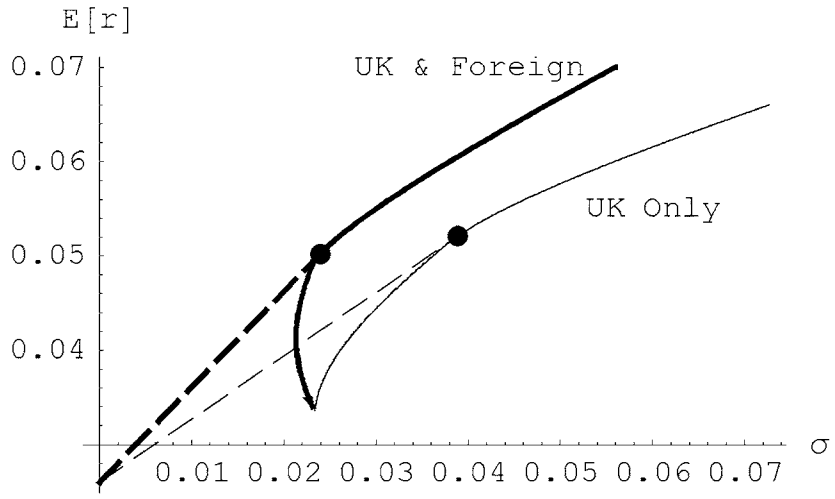


Figure 2. Constrained Optimization: UK Only and UK and Foreign Efficient Frontiers. The plot displays two minimum-variance frontiers constructed when investments in all assets are constrained to be positive (no short sales allowed), lines tangent to the frontiers with origin at the risk-free rate, and two tangency portfolios. UK-Only frontier is constructed using three asset classes: UK Equity, UK Preferred, and UK Debt. UK and Foreign frontier contains three UK asset classes and adds Foreign Equity and Foreign Debt. Data is from Edelstein (1982).

Without short-sale constraints the UK market portfolio has an expected return of 7.51%, a standard deviation of 6.99%, and a Sharpe ratio of 0.70. When foreign stocks and bonds are included, the Sharpe ratio increases to 1.18. The market portfolio has an expected return of 7.02% and substantially less risk (3.73%). The analysis suggests that given the risk and return characteristics of the five asset classes, rational investors maximizing expected return for a given level of risk should take advantage of the diversification opportunities and include foreign asset classes in their portfolios.

To highlight the role of diversification, we perform the following experiment.[38] We maintain the correlation matrix and the standard deviations of all asset classes, but set the expected return on each foreign asset class equal to that of the corresponding UK asset class. Since returns on UK asset classes are lower, this effectively penalizes investment abroad. The expected return on foreign equity is now set to 6.61%, down from 8.66%. All the benefits from investing abroad are now caused by diversification, not by higher returns offered by foreign assets. The results are presented in Table VIII. Without short-sale constraints, the market portfolio with penalized foreign assets has a Sharpe ratio of 0.75, below the un-penalized value of 1.18, but still higher than the UK-only domestic portfolio with a Sharpe ratio of 0.70. The results are stronger when short-sales are not allowed. In this case, the penalized market portfolio that includes foreign assets achieves a higher expected return than the UK-only portfolio (5.32% vs. 5.21%), and has a lower risk (3.86% vs. 3.89%). Foreign equity is riskier than domestic equity. Foreign debt is riskier than domestic debt. The returns on foreign assets and the corresponding domestic assets are set to be the same. Yet, it is still optimal to include foreign assets in the portfolio and take advantage of the diversification opportunities that investing overseas offers. The analysis also gives a benchmark level of investment abroad. Under the realistic assumption of no short sales, and with foreign assets being penalized by setting their expected returns to the lower values of UK expected returns, the market portfolio still has 14% of wealth invested in foreign equity.

The benefit of equalizing the mean returns of domestic and foreign asset classes is that our analysis is robust to a range of assumptions about risk aversion. There is no implicit trade-off off between mean and variance in a situation in which the expected returns are equal. The diversification result is thus driven solely by differences in the variance and covariance between domestic and international asset classes.

4.3. ANALYSIS OF UK AND FOREIGN EQUITY

The analysis can be refined in several ways. First, the number of asset classes can be increased. Instead of simply analyzing UK equity securities as one asset class, it is

[38] Ukhov (2005) studies changes in the mean-variance frontier caused by addition of a new asset to the set of risky asset and discusses the role of covariances in determining the relationship between the existing and the new frontiers.

Table VII. Optimal portfolio characteristics

Optimal portfolios are constructed using different investment opportunity sets of UK and foreign assets. Short sales are allowed in the unconstrained case. No short sales are allowed in the constrained case. The table reports expected return, standard deviation, and the Sharpe ratio for the market (tangency) portfolio. Portfolio weights are also reported. Bootstrap standard errors are in parentheses (10,000 draws for constrained optimization and 50,000 draws for unconstrained optimization).

	Market expected Return (%)	Market St. Dev. (%)	Sharpe Ratio	Market Portfolio Weights				
				UKEQ	UKPREF	UKDEB	FOREQ	FORDEB
UK Assets Only								
Unconstrained	7.51	6.99	0.70	0.285	1.945	−1.230		
	(0.18)	(0.35)	(0.05)	(0.021)	(0.100)	(0.117)		
Constrained	5.21	3.89	0.67	0.126	0.874	0.000		
	(0.16)	(0.32)	(0.05)	(0.020)	(0.090)	(0.105)		
UK Assets & Foreign Equity								
Unconstrained	9.37	7.95	0.85	0.046	1.830	−1.408	0.532	
	(0.26)	(0.36)	(0.03)	(0.011)	(0.082)	(0.113)	(0.034)	
Constrained	6.03	4.22	0.81	0.000	0.721	0.000	0.279	
	(0.21)	(0.30)	(0.03)	(0.000)	(0.061)	(0.090)	(0.030)	
UK Assets & Foreign Debentures								
Unconstrained	7.11	3.82	1.183	0.0058	0.533	−1.330		1.790
	(0.13)	(0.11)	(0.04)	(0.009)	(0.026)	(0.082)		(0.072)
Constrained	4.95	2.33	1.009	0.000	0.105	0.000		0.895
	(0.10)	(0.02)	(0.05)	(0.000)	(0.021)	(0.003)		(0.022)
All Five Asset Classes								
Unconstrained	7.02	3.73	1.184	0.013	0.517	−1.323	−0.025	1.817
	(0.13)	(0.12)	(0.05)	(0.008)	(0.026)	(0.074)	(0.009)	(0.060)
Constrained	5.02	2.40	1.011	0.000	0.109	0.000	0.019	0.872
	(0.10)	(0.02)	(0.046)	(0.000)	(0.022)	(0.006)	(0.002)	(0.023)

Table VIII. Optimal portfolio characteristics when expected returns are set to be equal

The rate of return on foreign equity is set equal to the rate of return on UK equity, and the rates of return on UK debt is set equal to the return on foreign debt. Optimal portfolios are constructed using different investment opportunity sets of UK and foreign assets. Short sales are allowed in the unconstrained case. No short sales are allowed in the constrained case. The table reports expected return, standard deviation, and the Sharpe ratio for the market (tangency) portfolio. Portfolio weights are also reported. Bootstrap standard errors are in parentheses (10,000 draws for constrained optimization and 50,000 draws for unconstrained optimization).

	Market expected Return (%)	Market St. Dev. (%)	Sharpe Ratio	Market Portfolio Weights				
				UKEQ	UKPREF	UKDEB	FOREQ	FORDEB
UK Assets Only								
Unconstrained	7.51	6.99	0.70	0.285	1.945	−1.230		
	(0.18)	(0.35)	(0.05)	(0.021)	(0.100)	(0.117)		
Constrained	5.21	3.89	0.67	0.126	0.874	0.000		
	(0.16)	(0.32)	(0.05)	(0.020)	(0.090)	(0.105)		
UK Assets & Foreign Equity								
Unconstrained	7.90	7.15	0.74	0.163	1.886	−1.321	0.272	
	(0.19)	(0.33)	(0.04)	(0.013)	(0.089)	(0.114)	(0.019)	
Constrained	5.32	3.86	0.71	0.056	0.803	0.000	0.141	
	(0.14)	(0.27)	(0.04)	(0.002)	(0.077)	(0.094)	(0.018)	
UK Assets & Foreign Debentures								
Unconstrained	7.31	6.70	0.70	0.268	1.856	−1.237		0.114
	(0.13)	(0.28)	(0.05)	(0.017)	(0.081)	(0.117)		(0.031)
Constrained	5.21	3.89	0.67	0.125	0.875	0.000		0.000
	(0.07)	(0.19)	(0.05)	(0.015)	(0.052)	(0.064)		(0.026)
All Five Asset Classes								
Unconstrained	10.79	10.87	0.75	0.246	2.894	−1.342	0.560	−1.358
	(0.25)	(0.40)	(0.04)	(0.014)	(0.103)	(0.096)	(0.026)	(0.052)
Constrained	5.32	3.86	0.71	0.056	0.803	0.000	0.141	0.000
	(0.15)	(0.27)	(0.04)	(0.002)	(0.078)	(0.095)	(0.018)	(0.005)

possible to include different industries in the study. We consider return indices from eleven UK industries. We assume throughout this section that UK investors limited the number of asset classes in their portfolios. When investors face fixed transaction costs, such as brokerage commissions, and have limited funds available, they take transaction costs into account while forming portfolios. This results in investors not using all assets in the opportunity set, but only investing in a sub-set of assets. We assume for tractability that investors used seven assets in their portfolios. There are 330 different subsets of seven UK equity securities assets drawn from eleven. The three sub-sets that result in a market portfolio with the highest Sharpe ratios are listed in Table IX. In the constrained case the best combination of seven assets produces a market portfolio with Sharpe ratio of 1.055, in the unconstrained case this number is 1.372.

Next we include four world equity classes in the investment opportunity set. There are 6,435 different subsets of seven assets drawn from 15 equity asset classes. The three sub-sets that produce market portfolios with the highest Sharpe ratio are given in Table X. Including foreign equity improves the best possible case. For the constrained case, the Sharpe ratio of the market portfolio is now 1.149 and 1.50 for the unconstrained case. When foreign equity is included in the opportunity set, the expected return on the market portfolio increases when compared to the UK-only case from 8.79% to 9.28% (constrained case), and from 12.4% to 13.5% (unconstrained case). Figure 3 shows the mean-variance frontier constructed with the seven best UK-only equity asset classes and with the seven best selected from 15 UK and world equity indices. The figure illustrates the improvement in the risk-return trade-off that results from the inclusion of overseas investments.[39] It is important to point out that the positivity constraints used in this analysis are consistent with real limitations to shorting sector indices and individual securities on the London market. Although short-selling was certainly practiced through much of this period, it is unlikely that it would have been used by a long-term investor to maintain an optimal position in tern of risk and return of the portfolio.

4.4. EQUITY AND DEBT

We repeat the previous analysis but now include UK and foreign debt. The investment opportunity set now includes 19 asset classes: 5 UK Equity indices; 2 UK Preferred Share indices, 4 UK Debt indices, and 8 foreign asset classes (4 equity and 4 debt). Again, we assume that portfolios contain seven assets. There are 50,388 different subsets of seven asset classes drawn from nineteen. The sub-

[39] The results hold not only for the very best group of 7 assets. In the unconstrained case when groups of 7 assets are ranked by the Sharpe ratio of their market portfolio, all top 200 groups contain at least one foreign equity asset class. The average optimal investment overseas across these 200 groups is 68%. In the case of short-sale constraints, when groups of 7 assets are ranked by the Sharpe ratio of their market portfolio, all top 1,000 groups contain at least one foreign asset class. The average optimal overseas allocation across these 1,000 groups equals 47%.

Table IX. UK equity: Selecting 7 out of 11 asset classes

We consider all possible sub-sets of seven asset classes drawn from eleven UK equity asset classes. There are 330 such sub-sets. For each sub-set we construct the optimal market portfolio (with the short sale constraint, reported in Panel A and without the constraint, reported in Panel B). We rank the sub-sets by the Sharpe ratio and report results for the three best cases and three worst (lowest Sharpe ratio) cases. UK Equity Asset Classes: (1) UKRAIL – UK. Railways; (2) UKFIN – UK Finance: Banks and Insurance; (3) UKTXTL – UK Textiles; (4) UKFD – UK Food and Drink; (5) UKIRN – UK Iron, Steel, Coal and Heavy Industry; (6) UKIND – UK Industrial, including Mechanical Equipment, Electrical Equipment, Building and Construction Materials, and Chemicals; (7) UKUTIL – UK Utilities; (8) UKCD – UK Canals and Docks; (9) UKSHIP – UK Shipping; (10) UKTT – UK Telegraph and Telephone; (11) UKTO – UK Tramway and Omnibuses. Bootstrap standard errors are in parentheses (10,000 draws for Panel A, and 50,000 draws for Panel B).

Panel A: Constrained Optimization

				Top 3 Portfolios			Worst 3 Portfolios		
				# 1	# 2	# 3	# 328	# 329	# 330
Market: Sharpe				1.055	1.053	1.053	0.739	0.730	0.696
				(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.05)
Market: Mean, %				8.79	8.75	8.75	7.37	7.98	7.90
				(0.19)	(0.19)	(0.19)	(0.07)	(0.11)	(0.11)
Market: St.Dev, %				5.87	5.84	5.84	6.45	7.37	7.61
				(0.09)	(0.09)	(0.09)	(0.17)	(0.14)	(0.26)
Asset	Asset	Mean	St.Dev.	Portfolio Weights					
No.	Class	(%)	(%)	# 1	# 2	# 3	# 328	# 329	# 330
1	UKRAIL	4.66	8.77				0.000	0.000	0.000
							(0.022)	(0.030)	(0.024)
2	UKFIN	7.48	6.31	0.400	0.404	0.404			
				(0.011)	(0.011)	(0.011)			
3	UKTXTL	7.69	9.32	0.194	0.208	0.208	0.350		0.477
				(0.016)	(0.016)	(0.016)	(0.015)		(0.014)
4	UKFD	13.73	15.77	0.129	0.124	0.124			
				(0.006)	(0.006)	(0.007)			
5	UKIRN	9.68	17.74	0.020			0.106	0.226	0.098
				(0.000)			(0.017)	(0.019)	(0.016)
6	UKIND	9.50	9.99	0.149	0.162	0.162			
				(0.015)	(0.015)	(0.015)			
7	UKUTIL	6.51	9.52		0.000		0.188	0.196	0.317
					(0.000)		(0.015)	(0.011)	(0.025)
8	UKCD	2.69	7.81			0.000	0.000	0.000	0.002
						(0.000)	(0.012)	(0.005)	(0.019)
9	UKSHIP	5.75	11.81				0.006	0.000	0.005
							(0.003)	(0.000)	(0.009)
10	UKTT	6.83	9.03	0.069	0.064	0.064	0.350	0.463	
				(0.009)	(0.009)	(0.009)	(0.013)	(0.020)	
11	UKTO	11.77	27.83	0.039	0.038	0.038		0.114	0.101
				(0.005)	(0.005)	(0.005)		(0.010)	(0.009)

Table IX. UK equity: Selecting 7 out of 11 asset classes (continued)

Panel B: No Short-Sale Constraints Optimization									
				Top 3 Portfolios			Worst 3 Portfolios		
				# 1	# 2	# 3	# 328	# 329	# 330
Market: Sharpe				1.372	1.370	1.351	0.849	0.813	0.749
				(0.03)	(0.03)	(0.03)	(0.03)	(0.05)	(0.05)
Market: Mean, %				12.38	13.60	12.94	10.27	8.73	12.79
				(0.17)	(0.26)	(0.23)	(0.18)	(0.08)	(0.17)
Market: St.Dev, %				7.13	8.03	7.65	9.03	7.54	12.84
				(0.13)	(0.26)	(0.25)	(0.34)	(0.24)	(0.49)
Asset No.	Asset Class	Mean (%)	St.Dev. (%)	Portfolio Weights					
				# 1	# 2	# 3	# 328	# 329	# 330
1	UKRAIL	4.66	8.77	−0.786	−0.675	−0.718	−0.018	−0.255	0.066
				(0.047)	(0.043)	(0.037)	(0.012)	(0.025)	(0.007)
2	UKFIN	7.48	6.31	0.856	0.869	0.945			
				(0.026)	(0.041)	(0.037)			
3	UKTXTL	7.69	9.32	0.415	0.439	0.460	0.543	0.384	0.787
				(0.013)	(0.016)	(0.016)	(0.012)	(0.018)	(0.021)
4	UKFD	13.73	15.77	0.165	0.179	0.215			
				(0.014)	(0.010)	(0.009)			
5	UKIRN	9.68	17.74				0.067	0.183	0.149
							(0.019)	(0.024)	(0.020)
6	UKIND	9.50	9.99	0.536	0.470	0.478			
				(0.037)	(0.032)	(0.029)			
7	UKUTIL	6.51	9.52	−0.244		−0.207	0.479	0.221	0.814
				(0.012)		(0.008)	(0.026)	(0.015)	(0.042)
8	UKCD	2.69	7.81		−0.359	−0.172	−0.717		−1.011
					(0.043)	(0.041)	(0.065)		(0.067)
9	UKSHIP	5.75	11.81				0.065	−0.061	−0.019
							(0.018)	(0.014)	(0.015)
10	UKTT	6.83	9.03				0.581	0.426	
							(0.033)	(0.020)	
11	UKTO	11.77	27.83	0.057	0.078			0.101	0.214
				(0.011)	(0.008)			(0.007)	(0.007)

sets that produce market portfolios with the highest Sharpe ratio are given in Table XI. When short-sale constraints are imposed (Panel A) the best portfolio invests in three foreign asset classes and produces a Sharpe ratio of 1.278. This may be compared to the best sub-set of 7 assets drawn from 11 UK-only asset classes that produces a market portfolio with an expected return of 7.84%, a standard deviation of 4.77%, and a lower Sharpe ratio of 1.099 (not shown in the table).[40]

[40] Benefits from using foreign asset classes are seen not only in the best 3 sub-sets, but also in the best one thousand. In the case of short-sale constraints when groups of 7 assets are ranked by Sharpe ratio of their market portfolio, all top 1,000 groups contain at least one foreign asset class. They all beat the UK-only best case.

Table X. UK equity (11) and world-wide equity (4): Selecting 7 out of 15 asset classes

We consider all 6,435 possible sub-sets of seven asset classes drawn from fifteen UK and foreign equity asset classes. For each sub-set we construct the optimal market portfolio (with the short sale constraint, reported in Panel A and without the constraint, reported in Panel B). We rank the sub-sets by the Sharpe ratio and report results for the three best cases and three worst cases. UK Equity Asset Classes: (1) UKRAIL - UK. Railways; (2) UKFIN - UK Finance: Banks and Insurance; (3) UKTXTL - UK Textiles; (4) UKFD - UK Food and Drink; (5) UKIRN - UK Iron, Steel, Coal and Heavy Industry; (6) UKIND - UK Industrial, including Mechanical Equipment, Electrical Equipment, Building and Construction Materials, and Chemicals; (7) UKUTIL - UK Utilities; (8) UKCD - UK Canals and Docks; (9) UKSHIP - UK Shipping; (10) UKTT - UK Telegraph and Telephone; (11) UKTO - UK Tramway and Omnibuses. Foreign equity: (12) WRAIL - World Rail Equity; (13) WBANK - World Banking Equity; (14) WINFR - World Infrastructure Equity; (15) WTEA - World Tea and Coffee Equity. Bootstrap standard errors are in parentheses (10,000 draws for Panel A, and 50,000 draws for Panel B).

Panel A: Constrained Optimization

				Top 3 Portfolios			Worst 3 Portfolios		
				# 1	# 2	# 3	# 6433	# 6434	# 6435
Market: Sharpe				1.149	1.147	1.147	0.679	0.678	0.669
				(0.04)	(0.04)	(0.05)	(0.03)	(0.04)	(0.05)
Market: Mean, %				9.28	9.35	9.35	7.50	8.70	9.13
				(0.22)	(0.22)	(0.22)	(0.17)	(0.44)	(0.11)
Market: St.Dev, %				5.81	5.88	5.88	7.21	9.00	9.76
				(0.09)	(0.07)	(0.07)	(0.33)	(0.52)	(0.48)
Asset	Asset	Mean	St.Dev.	Portfolio Weights					
No.	Class	(%)	(%)	# 1	# 2	# 3	# 6433	# 6434	# 6435
1	UKRAIL	4.66	8.77				0.000	0.000	0.000
							(0.003)	(0.028)	(0.020)
2	UKFIN	7.48	6.31	0.140	0.160	0.160			
				(0.010)	(0.009)	(0.009)			
3	UKTXTL	7.69	9.32	0.222	0.229	0.229	0.341		0.503
				(0.010)	(0.011)	(0.011)	(0.030)		(0.024)
4	UKFD	13.73	15.77	0.144	0.149	0.149			
				(0.009)	(0.008)	(0.008)			
5	UKIRN	9.68	17.74		0.000		0.059	0.246	0.209
					(0.000)		(0.015)	(0.021)	(0.017)
6	UKIND	9.50	9.99	0.050	0.049	0.049			
				(0.000)	(0.000)	(0.000)			
7	UKUTIL	6.51	9.52			0.000	0.292	0.403	
						(0.000)	(0.038)	(0.086)	
8	UKCD	2.69	7.81				0.009	0.000	0.000
							(0.061)	(0.095)	(0.045)
9	UKSHIP	5.75	11.81				0.168	0.035	0.000
							(0.034)	(0.030)	(0.001)
10	UKTT	6.83	9.03	0.039					
				(0.009)					
11	UKTO	11.77	27.83	0.028	0.028	0.028		0.079	0.130
				(0.005)	(0.004)	(0.004)		(0.025)	(0.008)
	Foreign Equity								
12	WRAIL	6.85	7.46						
13	WBANK	9.21	8.12	0.377	0.385	0.385			
				(0.018)	(0.017)	(0.017)			
14	WINFR	8.32	8.32						
15	WTEA	8.28	18.45				0.130	0.236	0.158
							(0.014)	(0.028)	(0.015)

Table X. UK equity (11) and world-wide equity (4): Selecting 7 out of 15 asset classes (continued)

Panel B: No Short-Sale Constraints									
				Top 3 Portfolios			Worst 3 Portfolios		
				# 1	# 2	# 3	# 6433	# 6434	# 6435
Market: Sharpe				1.50	1.50	1.50	0.761	0.742	0.699
				(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	(0.05)
Market: Mean, %				13.49	13.77	12.88	9.80	14.21	13.65
				(0.13)	(0.19)	(0.13)	(0.11)	(0.22)	(0.20)
Market: St.Dev, %				7.24	7.43	6.85	9.47	15.65	15.82
				(0.11)	(0.20)	(0.11)	(0.39)	(0.53)	(0.61)
Asset No.	Asset Class	Mean (%)	St.Dev. (%)	Portfolio Weights					
				# 1	# 2	# 3	# 6433	# 6434	# 6435
1	UKRAIL	4.66	8.77	−0.912	−0.738	−0.811	−0.506	−0.222	0.183
				(0.051)	(0.041)	(0.046)	(0.056)	(0.045)	(0.028)
2	UKFIN	7.48	6.31	0.377	0.419	0.456			
				(0.013)	(0.021)	(0.014)			
3	UKTXTL	7.69	9.32	0.492	0.473	0.449	0.435		0.928
				(0.013)	(0.015)	(0.012)	(0.018)		(0.020)
4	UKFD	13.73	15.77	0.179	0.213	0.195			
				(0.011)	(0.006)	(0.010)			
5	UKIRN	9.68	17.74				0.190	0.431	0.350
							(0.026)	(0.024)	(0.029)
6	UKIND	9.50	9.99	0.401	0.298	0.368			
				(0.037)	(0.029)	(0.034)			
7	UKUTIL	6.51	9.52			−0.171	0.531	1.041	
						(0.009)	(0.032)	(0.048)	
8	UKCD	2.69	7.81		−0.246			−0.815	−0.733
					(0.033)			(0.063)	(0.039)
9	UKSHIP	5.75	11.81				0.067	−0.031	−0.201
							(0.011)	(0.012)	(0.024)
10	UKTT	6.83	9.03						
11	UKTO	11.77	27.83				0.073	0.221	0.297
							(0.014)	(0.010)	(0.009)
Foreign Equity									
12	WRAIL	6.85	7.46	−0.259					
				(0.010)					
13	WBANK	9.21	8.12	0.721	0.580	0.513			
				(0.017)	(0.022)	(0.017)			
14	WINFR	8.32	8.32						
15	WTEA	8.28	18.45				0.211	0.376	0.176
							(0.029)	(0.033)	(0.027)

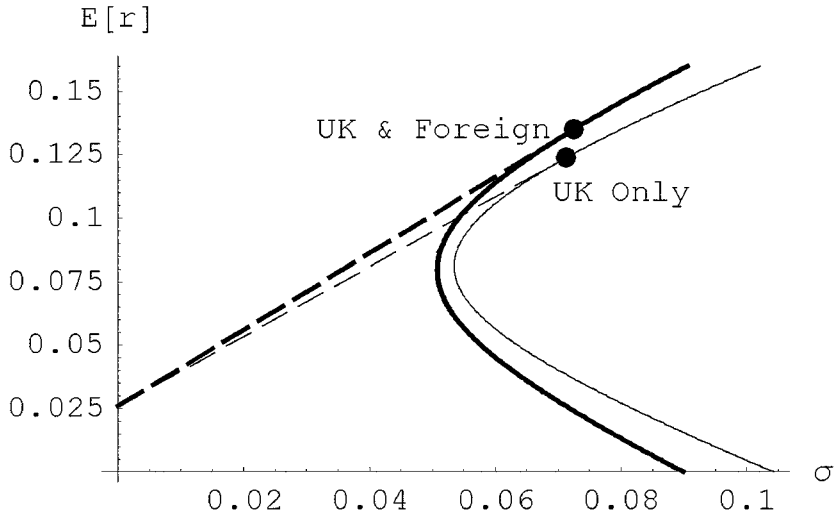


Figure 3. UK Equity and worldwide equity best sub-sets. The plot displays two minimum-variance frontiers constructed without short-sale restrictions (unconstrained optimization), lines tangent to the frontiers with origin at the risk-free rate, and two tangency portfolios. The "UK Only" frontier is constructed with the best sub-set of seven asset classes selected from 11 UK Equity asset classes. The "UK & Foreign" frontier is constructed with the best sub-set of seven asset classes selected from eleven UK Equity asset classes and four foreign equity asset classes. The best subsets are found by selecting the sub-set of 7 out of 11 assets (and 7 out of 15 assets) that results in the highest Sharpe ratio for the market portfolio.

An examination of recommended portfolio weights shows that the constrained optimization procedure suggests that in the best cases, 48 to 52 percent of wealth should be invested in world railway debt securities. This finding is particularly remarkable in light of the fact that between 1865 and 1941, at least 41 percent of total new overseas issues raised on British exchanges went solely for railway plant and equipment.[41]

In the unconstrained case the best subset of 7 assets from 11 UK-only asset classes produces a market portfolio with a Sharpe ratio of 1.46. When overseas asset classes are available, the best subset of 7 from 19 includes 4 foreign asset classes and produces market portfolio with a significantly higher Sharpe ratio of 1.95. Figure 4 shows mean-variance frontiers and capital allocation lines constructed with the best sub-sets of seven asset classes. When foreign assets are included in the opportunity set, the Capital Allocation Line has a higher slope, indicating that a higher expected return can be obtained for the same level of risk.

We now take our analysis one step further. For the 19 UK and overseas asset classes we once again maintain the correlations and the standard deviations of all assets, but set the expected return on each foreign asset class equal to that of the corresponding UK asset class. As before, this effectively penalizes investment

[41] Edelstein (1982, p. 37).

Table XI. Debt and equity: Selecting 7 out of 19 asset classes

We consider all 50,388 possible sub-sets of seven asset classes drawn from nineteen UK and foreign equity and debt asset classes. For each sub-set we construct the optimal market portfolio (with the short sale constraint, reported in Panel A and without the constraint, reported in Panel B). We rank the sub-sets by the Sharpe ratio and report results for the three best cases and three worst cases. Asset Classes: (1) UKRAIL – UK Railways; (2) UKFIN – UK Banks and Insurance; (3) UKLIND – UK Light Industry and Commerce: (a) Textiles, (b) Oldham cotton spinners; (c) Food, (d) Drink, (e) Retail stores; (4) UKHVIND – UK Heavy Industry: (a) Iron, coal, steel, and heavy fabrication, (b) Mechanical equipment, (c) Electrical equipment, (d) Building and Construction materials, (e) Chemicals; (5) UKINFRA – UK Infrastructure (Social overhead): (a) Electricity, (b) Gas, (c) Water, (d) Canals and Docs, (e) Shipping, (f) Telephone and Telegraph, (g) Tramways and Omnibuses; (6) UKRAILP – UK Railways, Preferred Shares; (7) UKINDP – UK Manufacturing and Commerce preferred shares; (8) UKMUNIDB – UK Municipals; (9) UKRAILDB – UK Railways; (10) UKINDDB – Manufacturing and Commerce debt; (11) UKINFRDB – UK Infrastructure (Social overhead) debt; (12) WRAIL – World railways: (a) Indian, (b) Western European, (c) Eastern European, (d) U.S. Railways, (e) Latin American Railways; (13) WBANK – World Banks equity: (a) Asia and Australasia, (b) South Africa, (c) Canada, (d) Eastern Mediterranean, (e) Latin America; (14) WINFR – World Infrastructure (Social Overhead): (a) India and China, (b) Western Europe, (c) North America, (d) Latin America; (15) WTEA – World Tea and Coffee; (16) CLGVDB – Debt of Colonial and Provisional Governments: (a) Australia, (b) Canada, (c) India, (d) Jamaica, (e) New Zealand, (f) South Africa; (17) CLMUNIDB – Debt of Colonial municipals; (18) WRAILDB – Debt of World Railways: (a) Indian railways, (b) Canadian Railways, (c) W. European railways, (d) E. European railways, (e) U.S. railways, (f) Latin American Railways; (19) WINFRDB - Debt, World infrastructure (Social Overhead). Bootstrap standard errors are in parentheses (10,000 draws for Panel A, and 50,000 draws for Panel B).

Panel A: Constrained Optimization

				Top 3 Portfolios			Worst 3 Portfolios		
				# 1	# 2	# 3	# 3	# 2	# 1
Market: Sharpe				1.278	1.277	1.276	0.612	0.597	0.588
				(0.05)	(0.06)	(0.05)	(0.08)	(0.07)	(0.07)
Market: Mean, %				6.52	6.49	6.34	4.88	5.32	3.96
				(0.11)	(0.09)	(0.10)	(0.16)	(0.10)	(0.07)
Market: St.Dev, %				3.07	3.04	2.94	3.73	4.56	2.31
				(0.14)	(0.13)	(0.13)	(0.18)	(0.15)	(0.09)
Asset	Asset	Mean	St.Dev.	Portfolio Weights					
No.	Class	(%)	(%)	# 1	# 2	# 3	# 3	# 2	# 1
UK Equity									
1	UKRAIL	4.66	8.77				0.000	0.000	0.000
							(0.001)	(0.000)	(0.000)
2	UKFIN	7.48	6.31	0.062	0.076				
				(0.005)	(0.004)				
3	UKLIND	10.64	8.84	0.174	0.174	0.157			
				(0.010)	(0.009)	(0.007)			
4	UKHVIND	9.56	9.95						
5	UKINFRA	6.74	8.07				0.266		
							(0.023)		

Table XI. Debt and equity: Selecting 7 out of 19 asset classes (continued)

Panel A: Constrained Optimization (continued)									
Asset	Asset	Mean	St.Dev.	Portfolio Weights					
No.	Class	(%)	(%)	# 1	# 2	# 3	# 3	# 2	# 15
UK Preferred									
6	UKRAILP	4.56	3.96				0.432	0.745	0.237
							(0.067)	(0.051)	(0.020)
7	UKINDP	5.70	4.75	0.054		0.079			
				(0.000)		(0.008)			
UK Debt									
8	UKMUNIDB	3.71	2.37				0.301	0.083	0.303
							(0.076)	(0.076)	(0.048)
9	UKRAILDB	3.79	3.32				0.001	0.000	0.066
							(0.031)	(0.059)	(0.017)
10	UKINDDB	3.83	3.35	0.114	0.118	0.118			0.368
				(0.040)	(0.035)	(0.035)			(0.032)
11	UKINFRDB	3.55	3.25				0.000	0.022	0.027
							(0.015)	(0.012)	(0.005)
Foreign Equity									
12	WRAIL	6.85	7.46						
13	WBANK	9.21	8.12	0.049	0.041	0.062			
				(0.007)	(0.006)	(0.008)			
14	WINFR	8.32	8.32						
15	WTEA	10.83	18.45	0.024	0.024	0.024		0.143	
				(0.000)	(0.001)	(0.003)		(0.008)	
Foreign Debt									
16	CLGVDB	4.15	2.24						
17	CLMUNIDB	5.25	3.22		0.068	0.080			
					(0.015)	(0.021)			
18	WRAILDB	5.25	2.89	0.521	0.499	0.479			
				(0.027)	(0.027)	(0.027)			
19	WINFRDB	−1.68	27.14				0.000	0.007	0.000
							(0.002)	(0.002)	(0.001)

abroad and highlights the role of diversification. The results are presented in Table XII. In the constrained case (Panel A) the best market portfolio has a Sharpe ratio of 1.15, compared to the best UK-only market portfolio with Sharpe ratio of 1.099. The market portfolio that uses penalized overseas indices has both a higher return (7.99% vs. 7.84%) and lower risk (4.69% vs. 4.77%) than the UK-only portfolio. Three out of seven asset classes in the top performing portfolios are foreign assets and the total fraction of wealth invested overseas is just above 20%. Similar results are obtained when short sales are allowed. The Sharpe ratio of the penalized foreign portfolio equals 1.700, higher than the Sharpe ratio of the UK-only portfolio of

Table XI. Debt and equity: Selecting 7 out of 19 asset classes (continued)

Panel B: No Short-Sale Constraints

				Top 3 Portfolios			Worst 3 Portfolios		
				# 1	# 2	# 3	# 3	# 2	# 1
Market: Sharpe				1.945	1.930	1.920	0.731	0.727	0.720
				(0.08)	(0.05)	(0.08)	(0.08)	(0.08)	(0.08)
Market: Mean, %				11.86	13.30	13.75	5.01	4.32	4.17
				(0.19)	(0.34)	(0.42)	(0.09)	(0.06)	(0.08)
Market: St.Dev, %				4.76	5.55	5.81	3.29	2.37	2.17
				(0.16)	(0.22)	(0.27)	(0.10)	(0.08)	(0.07)
Asset	Asset	Mean	St.Dev.	Portfolio Weights					
No.	Class	(%)	(%)	# 1	# 2	# 3	# 3	# 2	# 1
UK Equity									
1	UKRAIL	4.66	8.77	−0.460	−0.295	−0.312	−0.309		−0.096
				(0.025)	(0.015)	(0.012)	(0.012)		(0.005)
2	UKFIN	7.48	6.31	0.391	0.616	0.733			
				(0.008)	(0.024)	(0.036)			
3	UKLIND	10.64	8.84	0.535	0.668	0.755			
				(0.013)	(0.028)	(0.035)			
4	UKHVIND	9.56	9.95						
5	UKINFRA	6.74	8.07						
UK Preferred									
6	UKRAILP	4.56	3.96				1.030	0.287	0.525
							(0.038)	(0.011)	(0.017)
7	UKINDP	5.70	4.75						
UK Debt									
8	UKMUNIDB	3.71	2.37				0.654	1.012	0.962
							(0.042)	(0.031)	(0.038)
9	UKRAILDB	3.79	3.32		−1.719	−1.259	−0.424	−0.605	−0.635
					(0.110)	(0.116)	(0.059)	(0.037)	(0.053)
10	UKINDDB	3.83	3.35					0.331	0.327
								(0.021)	(0.020)
11	UKINFRDB	3.55	3.25	−1.341		−0.853	−0.070	−0.047	−0.064
				(0.060)		(0.048)	(0.018)	(0.009)	(0.011)
Foreign Equity									
12	WRAIL	6.85	7.46	−0.536	−0.584	−0.412			
				(0.012)	(0.018)	(0.019)			
13	WBANK	9.21	8.12		0.338				
					(0.021)				
14	WINFR	8.32	8.32	0.381					
				(0.041)					
15	WTEA	10.83	18.45				0.110	0.039	
							(0.007)	(0.004)	
Foreign Debt									
16	CLGVDB	4.15	2.24						
17	CLMUNIDB	5.25	3.22						
18	WRAILDB	5.25	2.89	2.030	1.976	2.349			
				(0.049)	(0.066)	(0.099)			
19	WINFRDB	−1.68	27.14				0.008	−0.017	−0.019
							(0.002)	(0.001)	(0.001)

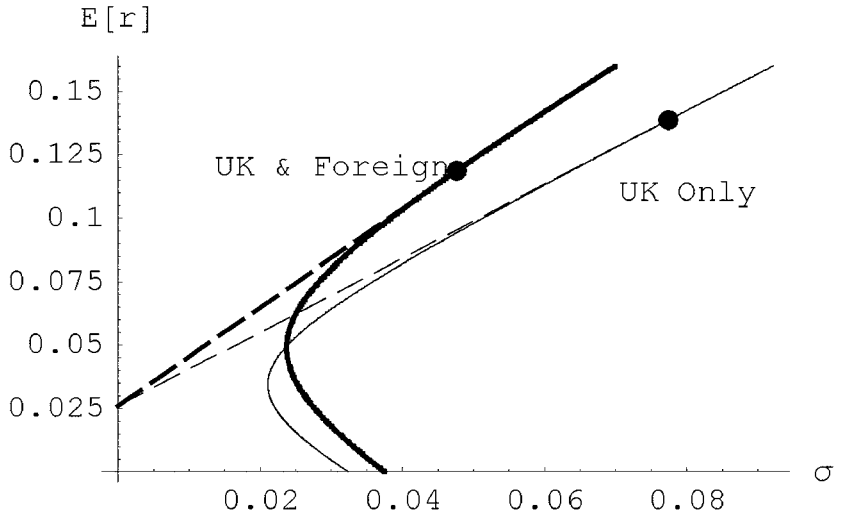


Figure 4. Equity and debt best sub-sets. The plot displays two minimum-variance frontiers constructed without short-sale restrictions (unconstrained optimization), lines tangent to the frontiers with origin at the risk-free rate, and two tangency portfolios. The "UK Only" frontier is constructed with the best sub-set of seven asset classes selected from 11 UK asset classes (5 UK Equity, 2 UK Preferred, and 4 UK Debt asset classes). The "UK & Foreign" frontier is constructed with the best sub-set of seven asset classes selected from 19 UK and foreign asset classes (11 UK, 4 foreign equity and 4 foreign debt asset classes). The best subsets are found by selecting the sub-set of 7 out of 11 assets for the UK-only case (and 7 out of 19 assets for the UK and Foreign case) that results in the highest Sharpe ratio for the market portfolio. There are 50,388 possible ways of selecting 7 different asset classes from 19.

1.46. Even when foreign assets are penalized with lower expected returns, they provide substantial improvement to the risk-return trade-off and should be included in the optimal portfolio.

4.5. ROBUSTNESS AND SENSITIVITY: BOOTSTRAPPING TESTS

One of the limitations of mean variance optimization is its sensitivity to small differences in expected returns. A natural question is whether the portfolio weights we obtain in our analysis are sensitive to variation in statistical inputs to the optimization model. To address this issue we perform bootstrapping tests about the robustness of portfolio weights. We draw from the set of returns, estimate the vector of expected returns and the variance-covariance matrix and use these inputs to compute optimal portfolio weights. Performing this procedure repeatedly provides a distribution of weights for the optimal portfolio from which we construct standard errors. The basic approach is similar to Jorion (1985).

Table XII. Debt and equity: Selecting 7 out of 19 asset classes, with equal expected returns

The rate of return on foreign equity is set equal to the rate of return on UK equity, and the rates of return on UK debt is set equal to the return on foreign debt. Expected returns in **boldface** are the returns on UK investments that are used in the calculations; the numbers in square brackets are the true returns on the overseas investments. We consider all 50,388 possible sub-sets of seven asset classes drawn from nineteen UK and foreign equity and debt asset classes. For each sub-set we construct the optimal market portfolio (with the short sale constraint, reported in Panel A and without the constraint, reported in Panel B). We rank the sub-sets by the Sharpe ratio and report results for the three best cases and three worst cases (Panel A) and six best cases (Panel B). Asset Classes: (1) UKRAIL – UK Railways; (2) UKFIN – UK Banks and Insurance; (3) UKLIND – UK Light Industry and Commerce: (a) Textiles, (b) Oldham cotton spinners; (c) Food, (d) Drink, (e) Retail stores; (4) UKHVIND – UK Heavy Industry: (a) Iron, coal, steel, and heavy fabrication, (b) Mechanical equipment, (c) Electrical equipment, (d) Building and Construction materials, (e) Chemicals; (5) UKINFRA – UK Infrastructure (Social overhead): (a) Electricity, (b) Gas, (c) Water, (d) Canals and Docs, (e) Shipping, (f) Telephone and Telegraph, (g) Tramways and Omnibuses; (6) UKRAILP – UK Railways, Preferred Shares; (7) UKINDP – UK Manufacturing and Commerce preferred shares; (8) UKMUNIDB – UK Municipals; (9) UKRAILDB – UK Railways; (10) UKINDDB – Manufacturing and Commerce debt; (11) UKINFRDB – UK Infrastructure (Social overhead) debt; (12) WRAIL – World railways: (a) Indian, (b) Western European, (c) Eastern European, (d) U.S. Railways, (e) Latin American Railways; (13) WBANK – World Banks equity: (a) Asia and Australasia, (b) South Africa, (c) Canada, (d) Eastern Mediterranean, (e) Latin America; (14) WINFR – World Infrastructure (Social Overhead): (a) India and China, (b) Western Europe, (c) North America, (d) Latin America; (15) WTEA – World Tea and Coffee; (16) CLGVDB – Debt of Colonial and Provisional Governments: (a) Australia, (b) Canada, (c) India, (d) Jamaica, (e) New Zealand, (f) South Africa; (17) CLMUNIDB – Debt of Colonial municipals; (18) WRAILDB – Debt of World Railways: (a) Indian railways, (b) Canadian Railways, (c) W. European railways, (d) E. European railways, (e) U.S. railways, (f) Latin American Railways; (19) WINFRDB – Debt, World infrastructure (Social Overhead). Bootstrap standard errors are in parentheses (10,000 draws for Panel A, and 50,000 draws for Panel B).

Panel A: Constrained Optimization

				Top 3 Portfolios			Worst 3 Portfolios		
				# 1	# 2	# 3	# 3	# 2	# 1
Market: Sharpe				1.149	1.147	1.147	0.456	0.445	0.425
				(0.04)	(0.04)	(0.04)	(0.06)	(0.06)	(0.07)
Market: Mean, %				7.99	7.92	7.99	3.75	3.79	3.84
				(0.29)	(0.26)	(0.26)	(0.13)	(0.12)	(0.11)
Market: St.Dev, %				4.69	4.64	4.70	2.53	2.67	2.92
				(0.31)	(0.29)	(0.29)	(0.09)	(0.08)	(0.10)
Asset No.	Asset Class	Mean (%)	St.Dev. (%)	Portfolio Weights					
				# 1	# 2	# 3	# 3	# 2	# 1
UK Equity									
1	UKRAIL	4.66	8.77				0.000	0.003	0.000
							(0.001)	(0.003)	(0.002)
2	UKFIN	7.48	6.31	0.242	0.237	0.254			
				(0.021)	(0.015)	(0.015)			
3	UKLIND	10.64	8.84	0.340	0.350	0.360			
				(0.026)	(0.025)	(0.025)			
4	UKHVIND	9.56	9.95	0.041					
				(0.009)					
5	UKINFRA	6.74	8.07			0.000			
						(0.000)			

Table XII. Debt and equity: Selecting 7 out of 19 asset classes, with equal expected returns (continued)

Panel A: Constrained Optimization (continued)									
Asset No.	Asset Class	Mean (%)	St.Dev. (%)	Portfolio Weights # 1	# 2	# 3	# 3	# 2	# 1
UK Preferred									
6	UKRAILP	4.56	3.96						
7	UKINDP	5.70	4.75		0.032				
					(0.000)				
UK Debt									
8	UKMUNIDB	3.71	2.37						
9	UKRAILDB	3.79	3.32				0.231	0.350	0.456
							(0.056)	(0.057)	(0.038)
10	UKINDDB	3.83	3.35	0.162	0.156	0.160			
				(0.057)	(0.054)	(0.055)			
11	UKINFRDB	3.55	3.25				0.000	0.000	0.015
							(0.011)	(0.021)	(0.017)
Foreign Equity									
12	WRAIL	**4.66**	7.46	0.123			0.000	0.000	0.104
		[6.85]		(0.000)			(0.018)	(0.024)	(0.019)
13	WBANK	**7.48**	8.12		0.136	0.136			
		[9.21]			(0.011)	(0.011)			
14	WINFR	**6.74**	8.32						
		[8.32]							
15	WTEA	**10.64**	18.45	0.044	0.043	0.044			
		[10.83]		(0.005)	(0.003)	(0.003)			
Foreign Debt									
16	CLGVDB	**2.06**	2.24				0.017	0.000	0.000
		[4.15]					(0.005)	(0.013)	(0.014)
17	CLMUNIDB	**3.71**	3.22				0.227		0.416
		[5.25]					(0.059)		(0.044)
18	WRAILDB	**3.79**	2.89				0.525	0.634	
		[5.25]					(0.043)	(0.073)	
19	WINFRDB	**6.74**	27.14	0.049	0.045	0.046		0.012	0.008
		[−1.68]		(0.004)	(0.004)	(0.004)		(0.003)	(0.003)

5. Interpretation

Figure 5 displays the proportion of different domestic and foreign securities listed on the London Stock Exchange with the proportions (weights) in the optimal portfolio. The weights for the optimal portfolio in this case are taken as the average across the weights for the three best portfolios in Table XII. The proportion of foreign assets on the LSE appears fairly similar to the proportion implied by an optimal portfolio. Optimal allocation to all foreign securities equals 63.4%, while

Table XII. Debt and equity: Selecting 7 out of 19 asset classes, with equal expected returns (continued)

Panel B: No Short-Sale Constraints									
				Top 3 Portfolios			Worst 3 Portfolios		
				# 1	# 2	# 3	# 3	# 2	# 1
Market: Sharpe				1.700	1.622	1.620	1.615	1.611	1.610
				(0.06)	(0.04)	(0.04)	(0.06)	(0.06)	(0.08)
Market: Mean, %				50.86	18.02	15.69	46.72	50.94	86.20
				(3.06)	(0.52)	(0.42)	(2.96)	(2.83)	(3.90)
Market: St.Dev, %				28.40	9.50	8.08	27.31	29.99	51.92
				(1.75)	(0.39)	(0.32)	(1.73)	(1.68)	(2.24)
Asset No.	Asset Class	Mean (%)	St.Dev. (%)	Portfolio Weights					
				# 1	# 2	# 3	# 3	# 2	# 1
UK Equity									
1	UKRAIL	4.66	8.77	−1.445		−0.46	−1.12	−1.49	−2.40
				(0.077)		(0.020)	(0.060)	(0.062)	(0.086)
2	UKFIN	7.48	6.31		1.00	1.05			
					(0.042)	(0.045)			
3	UKLIND	10.64	8.84		1.23	1.04			
					(0.052)	(0.044)			
4	UKHVIND	9.56	9.95	2.609			2.07	2.41	4.09
				(0.153)			(0.127)	(0.129)	(0.163)
5	UKINFRA	6.74	8.07				1.02		
							(0.040)		
UK Preferred									
6	UKRAILP	4.56	3.96						
7	UKINDP	5.70	4.75				1.55		
							(0.076)		
UK Debt									
8	UKMUNIDB	3.71	2.37	13.843			11.20	12.53	27.31
				(0.833)			(0.733)	(0.747)	(1.188)
9	UKRAILDB	3.79	3.32		−2.99	−2.16			
					(0.162)	(0.134)			
10	UKINDDB	3.83	3.35	2.818			2.31	3.10	5.38
				(0.166)			(0.119)	(0.131)	(0.222)
11	UKINFRDB	3.55	3.25						
Foreign Equity									
12	WRAIL	**4.66**	7.46	−2.227	−1.37	−0.94			
		[6.85]		(0.112)	(0.052)	(0.035)			
13	WBANK	**7.48**	8.12	3.859	0.91	0.57	2.45	2.61	4.84
		[9.21]		(0.224)	(0.043)	(0.028)	(0.156)	(0.152)	(0.207)
14	WINFR	**6.74**	8.32						
		[8.32]							
15	WTEA	10.64	18.45						
		[10.83]							
Foreign Debt									
16	CLGVDB	**2.06**	2.24	−18.46		−17.5	−19.16	−37.7	
		[4.15]		(1.189)		(1.148)	(1.120)	(1.673)	
17	CLMUNIDB	**3.71**	3.22						
		[5.25]							
18	WRAILDB	**3.79**	2.89		2.07	1.89			
		[5.25]			(0.073)	(0.070)			
19	WINFRDB	**6.74**	27.14		0.15				−0.54
		[−1.68]			(0.007)				(0.023)

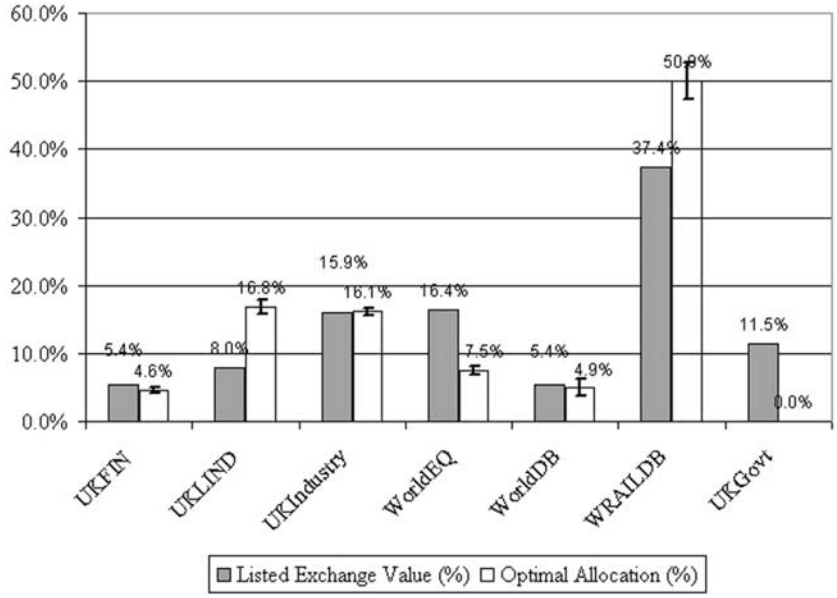


Figure 5. Optimal Allocation vs. Proportion Listed on the London Stock Exchange. The figure displays proportion of different domestic and foreign securities listed on the London Stock Exchange with the proportions (weights) in the optimal portfolio. Proportions of securities listed on the LSE are computed from the data for 1913 (Table V). UKFIN is UK Finance: Banks and Insurance; UKLIND is UK Light Industry and Commerce; UKIndustry is UK Heavy Industry; WorldEQ includes worldwide equity; WorldDB is worldwide debt, excluding railways shown separately; WRAILDB – Debt of World Railways: (a) Indian railways, (b) Canadian Railways, (c) W. European railways, (d) E. European railways, (e) U.S. railways, (f) Latin American Railways; UKGovt is UK Government debt. Standard error bars are shown for the optimal weights.

the proportion of all foreign securities quoted on the LSE is 59.3%. Although the particular weight on a given asset class may differ from the average of the optimal weights, there is certainly little evidence to reject the hypothesis that the supply and demand for export capital were out of equilibrium, given data available for estimation of risk and return at the time.

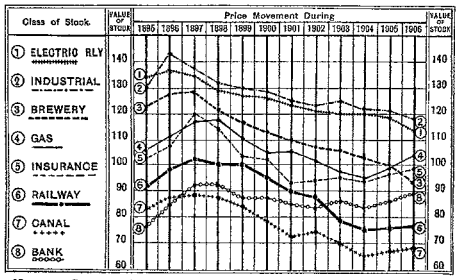
There are other strong similarities. For example, securities of UK financial industry, including banks and insurance companies, accounted for 5.4% of all securities listed on the LSE, a figure comparable to the 4.6% portfolio weight for this asset class in the optimal portfolio. UK heavy industry securities accounted for 15.9% of the total on the LSE, while optimal allocation to this asset class is 16.1%. Worldwide debt securities (excluding railroads) represented 5.4% of the London market, similar to the optimal allocation of 4.9%. Interestingly, the allocation to UK debt was lower than extant capitalization. This might have been due to the perceived benefits of domestic bonds not captured by historical performance.

6. Conclusion

Our findings suggest that diversification played an important role in the decision of British investors to allocate a significant fraction of their portfolio to overseas securities. Even when – by setting expected return on each foreign asset class equal to that of the corresponding UK asset class – we put foreign assets at a disadvantage, we find that it was rational for an investor to include a non-trivial proportion of foreign debt and equity in the portfolio. British investors had access to securities from all over the world. They also had access to news concerning political and economic events world-wide. Investors understood the notion of diversification, albeit in a manner slightly less formally developed at the time, and followed this principle by allocating a significant portion of their investments abroad. Our analysis shows that this behavior was consistent with the recommendations obtained by applying modern portfolio theory to the return series of securities available to the UK investors.

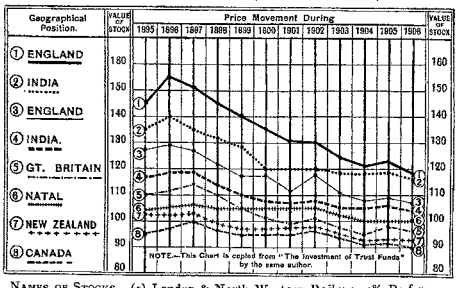
Appendix A: Charts of Security Prices from Lowenfeld (1907)

I.—GREAT BRITAIN (General Investments).



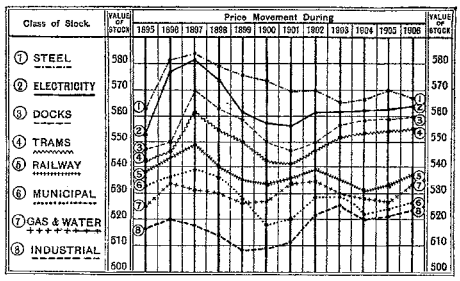
Names of Stocks.—(1) Liverpool Overhead Railway 4% Deb.; (2) J. & P. Coats 6% Cum. Pref.; (3) Bass, Ratcliff & Gretton 5% Cum. Pref ; (4) Brentford Gas Consolidated Stock; (5) Guardian Assurance Company; (6) London & North Western Railway Company Consolidated Stock; (7) Grand Junction Canal Original Shares; (8) Parr's Bank Shares.

II.—GREAT BRITAIN (Trustee Stocks).



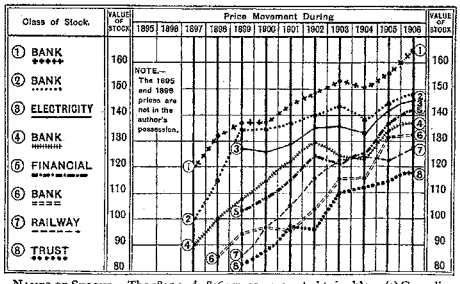
Names of Stocks.—(1) London & North Western Railway 4% Preference; (2) Southern Mahratta 4% Debenture; (3) Birmingham Corporation 3½%; (4) India 3½%; (5) British Local Loans 3%; (6) Natal 3½%; (7) New Zealand 3½%; (8) Canada 3%.

FRANCE.



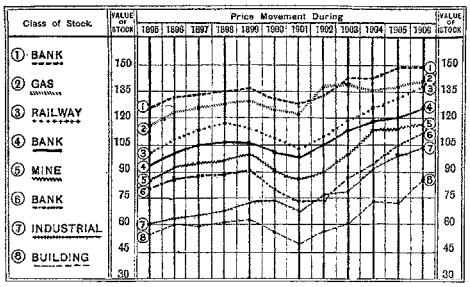
Names of Stocks.—(1) Acieries de France; (2) Thomson Houston (procédés); (3) Docks du Havre; (4) Lyon Omnibus & Tramway Company; (5) Lyon 5%; (6) Ville de Besançon; (7) Gaz et Eaux; (8) Soc. Lyonn. de Teinture Apprêt et Gaufrage.

CANADA.



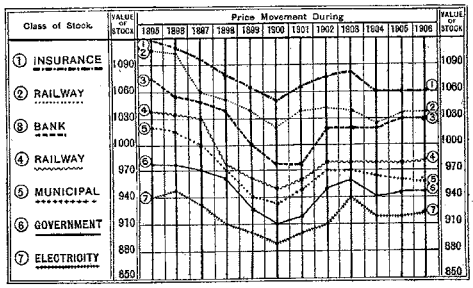
Names of Stocks.—The 1895 and 1896 prices were not obtainable.—(1) Canadian Bank of Commerce; (2) The Ontario Bank; (3) Toronto Electric Light Company; (4) The Standard Bank of Canada; (5) Toronto Mortgage Company; (6) The Traders' Bank of Canada; (7) Grand Trunk 1st Pref.; (8) Real Estate Loan Company.

GERMANY.



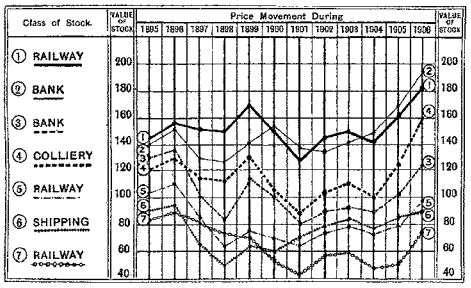
NAMES OF STOCKS.—(1) Frankfort Mortgage Bank Shares; (2) General Gas Company of Magdeburg; (3) Lübeck-Büchen-Hamburg Railway; (4) Deutsche Bank; (5) Gelsenkircher Mine; (6) Schaafhausen Bankverein; (7) Westphalia Wireworks; (8) Passage Building Society of Berlin.

SWITZERLAND.



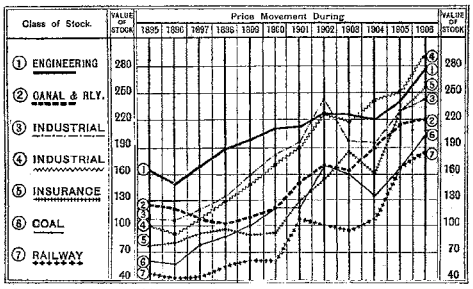
NAMES OF STOCKS.—(1) La Genevoise Assurance Company; (2) Jura Simplon; (3) Banque du Commerce; (4) Central Swiss Debenture, 1894; (5) Ville de Genève; (6) 3% Rentes; (7) Industrie Electrique de Genève Debentures.

JAPAN



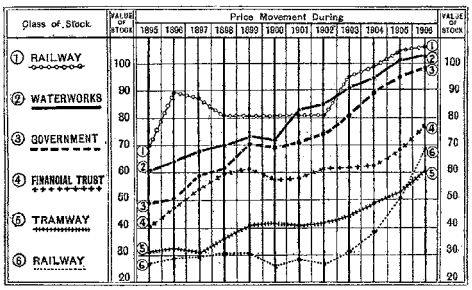
NAMES OF STOCKS.—(1) Sanyō Railway; (2) Bank of Japan; (3) Yokohama Specie Bank; (4) Hokkaido Colliery; (5) Japan Railway; (6) Japan Steamship Company; (7) Kwansai Railway.

UNITED STATES OF AMERICA.



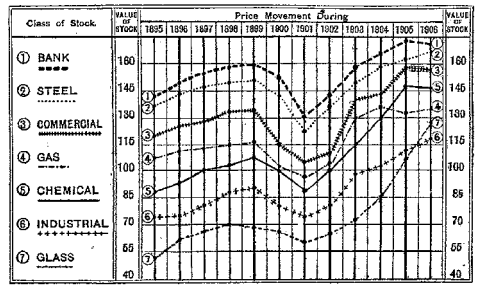
NAMES OF STOCKS.—(1) The Pullman Company; (2) Delaware & Hudson Company; (3) American Express Company; (4) Wells, Fargo & Company; (5) Home Fire Assurance Company; (6) Consolidation Coal Company; (7) New York, Chicago & St. Louis Railroad Company.

ARGENTINE REPUBLIC.



NAMES OF STOCKS.—(1) Buenos Ayres Western Railway Ord.; (2) Buenos Ayres 5% Water Works Loan; (3) 4½% Sterling Loan 1888; (4) River Plate Trust Loan & Agency Company; (5) Anglo-Argentine Trams; (6) Argentine North Eastern Railway Ord.

BELGIUM.



NAMES OF STOCKS.—(1) Banque d'Anvers; (2) Athus; (3) Société Immobilière de Belgique; (4) Société d'Eclairage du Bassin Houiller de Mons; (5) Produits Chimiques de Droogenbosch; (6) Prayon; (7) Glaces de Charleroi.

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