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Abstract:

Why did Victorian Britain invest so much capital abroad? We collect over 500,000 monthly returns of British and foreign securities trading in London and the United States between 1866 and 1907. These heretofore-unknown data allow us to better quantify the historical benefits of international diversification and revisit the question of whether British Victorian investor bias starved new domestic industries of capital. We find no evidence of bias. A British investor who increased his investment in new British industry at the expense of foreign diversification would have been worse off. The addition of foreign assets significantly expanded the mean-variance frontier and resulted in utility gains equivalent to a meaningful increase in lifetime consumption.

Key Words: Capital markets, Home bias, History, Victorian overseas investment
JEL codes: E44, F22, G11, G15, N21, N23, O16

*Never before or since has one nation committed so much of its national income and savings to capital formation abroad.* –Michael Edelstein[1]

It is estimated that between 1865 and 1914 Great Britain invested more than £4.1 billion nominal pounds abroad.[2] For a nation that until 1850 had exported less than two percent of its gross domestic product, this was a prodigious sum that represented 5.4 percent of GDP.[3] At the same time that British capital was leaving the island at unprecedented levels, British industry began a decline that signaled the beginning of Britain's transformation from world's workshop to banker. While it was no surprise that a nation would eventually surpass Britain in industrial might, the speed of the reversal caused much consternation among the British elite. The city of London, with its perceived propensity to funnel capital overseas rather than into domestic industry, was widely suspected of hastening the decline of British industry. According to this view, London's capital markets systematically discriminated against domestic industry by ignoring potentially profitable domestic investments, preferring instead to invest in inferior projects overseas.[4]

C.K. Hobson, writing in 1914, commented on the hysteria:

*A few years ago the British public was startled by a new cry--the cry that capital was being driven abroad...Foreign investment was regarded as a new and portentous phenomenon, without precedent in the history of the country, as a running sore, sapping the life blood of British industry...The matter was discussed in Parliament. A well-known statesman made the discovery that all the great ships going westward across the Atlantic were carrying bonds and stocks in ballast...Other speakers lamented the increase in unemployment and the stagnation of trade, which they attributed to the unparalleled outflow of capital*—C.K. Hobson (1914), *The Export of Capital,* p.i

Hobson was engaging in hyperbole, but the feeling that "*the city of London and its financial institutions were the single greatest threat to the prosperity of England*" was

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[1]Edelstein (1981 p.70)

[2]Cottrell (1975, p. 27) and Stone (1999, p.6) both estimate £4.1B was raised on the London stock exchange. These estimates amount to a lower bound as total overseas investment includes the £4.1B raised on the LSE plus foreign direct investment and the purchase of foreign securities trading outside of London.

[3]The pre 1850 overseas investment estimate is from Edelstein (1982, Table 2.1 p.21). The aggregate nominal U.K. GDP estimate is from Lawrence H. Officer, "What Was the U.K. GDP Then?" MeasuringWorth, 2008. URL: http://www.measuringworth.org/ukgdp/

[4]See O'Rourke and Williamson (1999) Chapter 12 for an excellent review of the capital market failure view of British industrial decline. Work by Crafts, et al, (1989) and Broadberry (1997) provide evidence that counters the conclusion of outright British industrial decline prior to the First World War.

widespread.[5] By 1931 John Maynard Keynes and his colleagues on the Macmillian Committee had formerly accused the London capital markets of ignoring domestic industry.

*It is all-important to the community that its savings should be invested in the most fruitful and generally useful enterprises at home...our financial machinery is definitely weak in that it fails to give clear guidance to the investor when appeals are made to him on the behalf of home industry—* Committee on Finance and Industry (Macmillian Committee) *1931.*

Since the Macmillian Report, the charge of foreign bias has resonated throughout the literature. Proponents of the view that British capital markets failed argued that domestic investors sent capital abroad due to bias or ignorance.[6]

*There is strong evidence that it [the London capital market] was not perfect, that there was virtually total ignorance among financial institutions and advisors about investment opportunities in home industry, and that banks and other institutional lenders operated with traditional and irrational prejudices as to which type of investments they should support and which they should not.*—Pollard (1987, p.460)

Proponents of rational markets responded with an appeal to revealed preferences. British investors who sent capital abroad must have believed that this was the optimal use of their funds. To proponents of rational markets, this was strong evidence that the returns offered by the forgone domestic investments must have been inferior to their international counterparts.[7]

It is important to note that both sides of this debate framed their arguments in the context of which investment (domestic or foreign) had a higher expected return. The focus on return is appealing. If Victorian investors expected to earn higher returns overseas, this could explain capital flows abroad without having to resort to claims of bias. On the other hand, if British investors discriminated against domestic securities, the price of these securities would be lower (and their returns higher) than would otherwise be the case.

Given the focus on returns, one would think that the debate about capital market bias would have ended in 1982 when Michael Edelstein published *Overseas Investment in*

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[5]Rosenstein-Rodan (1967) *Capital Movements and Economic Developement* p.68.
[6]For instance Crafts (1979), Pollard (1985) and Kennedy (1974, 1987).
[7]For example, McCloskey (1970,1979), Temin (1987, 1989), Michie (1988) and O'Rourke and Williamson

*the Age of High Imperialism.* In this impressive work, Edelstein computed the realized annual return of 566 foreign and domestic assets listed on the London stock exchange between 1870 and 1913. He concluded that the return on foreign assets was, on average, slightly higher than domestic assets and this difference was statistically insignificant after controlling for risk via the capital asset pricing model.

Rather than end the debate, Edelstein's work simply revitalized the antagonists. The proponents of efficient markets cited the absence of higher returns on domestic assets as evidence of market efficiency. The proponents of market failure responded by questioning Edelstein's sample selection and noting that the relative spread between foreign and domestic returns fluctuated with long periods of higher domestic returns. In short, the difference between Edelstien's domestic and foreign returns was too similar and the data too noisy to convince either side their position was wrong.[8]

Much of the disagreement in the literature can be traced to the focus on returns and the faulty premise that Victorian investors had to choose between investing either at home or abroad. In their 1999 text, O'Rourke and Williamson reviewed the literature to date

> *The claim is that the City of London systematically discriminated against domestic borrowers, preferring instead to channel funds into overseas ventures. The result was that domestic British industry, starved of capital, grew more slowly than it would otherwise have done. An obvious implication of the hypothesis is that domestic (British) rates of return must have exceeded those available on foreign investments*—O'Rourke and Williamson (1999, p.226)

The implication that domestic rates of return must have exceeded those available on foreign investments is *not* the obvious implication of capital market bias. If British investors were biased against domestic assets this bias would manifest itself in a higher domestic rate of return then would otherwise be the case. Whether the effect of bias was sufficient to make domestic rates of return exceed foreign depends upon the magnitude of the bias and other factors that influence asset returns such as risk and diversification.

Comparing the magnitude of domestic and foreign returns is a valid test of capital market bias if, *and only if*, domestic returns have equal or lesser risk *and* investors are forced to choose between investing all of their savings either at home or abroad. When

(1999).

[8] O'Rourke and Williamson (1999) provide an excellent summery of the debate. Pollard (1985) and Kennedy (1987 p.146-147) are prominent examples of critics who were unconvinced by Edelstein's work.

investors are given the opportunity to divide their money between home *and* foreign assets, the expected rate of return on domestic assets can exceed the expected rate of return on foreign assets and an unbiased, rational investor will still choose to invest a portion of her wealth overseas if the diversification benefits of foreign investment outweigh the loss of return.

In our opinion, diversification is a likely explanation for the high level of Victorian overseas investment. Foreign asset returns had a low correlation with domestic asset returns. Nineteenth century investors were certainly sophisticated enough to realize the benefits of international diversification. C.K. Hobson, writing in 1914, suggested that Victorian investors sent capital abroad due to their desire to "spread risks by investing in various countries or in diverse industries."[9] Turn of the century investment guides encouraged overseas investment as a form of insurance against domestic market declines. As early as 1907, Holt Schooling published a remarkable article that drew upon historical returns to document the low correlation between Victorian-era British and foreign asset returns. Schooling concluded, "the safe and profitable investment of capital, as distinct from speculative finance, depends upon the sagacious distribution of the investment of capital in different parts of the world."[10] Two years later, in 1909, Henry Lowenfield published one of the first investment guides, *Investment: an Exact Science.* Lowenfield's work included detailed graphs of 19th century ex-post returns. His graphs showed the large yet uncorrelated movements of British and foreign securities during the Victorian and Edwardian eras. The magnitude and independence of the movements led Lowenfield to advise, "it is impossible for any investor safely to invest his capital in any one country."[11]

Diversification seems like a plausible explanation for Victorian overseas investment. It is therefore surprising that the dominant explanation for the high level of British overseas investment ignores diversification and relies upon a market failure (irrational bias) to explain Victorian investment. The reliance on bias is surprising because economists who study modern portfolio choice lament the refusal of modern investors to hold more foreign assets. Ironically, the same market failures (bias, transaction costs, or information asymmetries) that are used to explain the *low* levels of international

[9]Hobson (1914) .xiii.
[10]Schooling (1907) p. 137

diversification observed in modern portfolios are also cited as explanations for the *high* level of Victorian investment abroad. If we are to seriously take the view that modern home bias can be explained by these market failures, a logical extension is that the high levels of international investment observed in the 19th Century is evidence of market efficiency, not failure.

Why isn't the high level of international investment present in 19th Century portfolios viewed as a sign of rationality and efficiency? In a word, covariance. When economists assert that modern investors should invest a higher percentage of their wealth in foreign assets, they are basing this conclusion on the diversification benefits of holding foreign assets with a low covariance with domestic assets. Economists studying Victorian portfolio choice have largely ignored covariance (and hence diversification). There are two reasons for this omission. First, the debate was framed in the years before mean-variance analysis of portfolio decisions became standard. At the time that Rostow (1949) and Cairncross (1953) literally wrote the books on Victorian overseas investment, an investment was evaluated by its return, not its effect on the return *and* risk of one's portfolio. Despite advances in our understanding of portfolio choice under uncertainty, the optimality of Victorian foreign investment continues to be framed as a decision about asset return rather then risk.

The second, and probably more important, reason that diversification has been ignored is the practical problem of a lack of data. Before we can hope to evaluate the diversification benefits of foreign investment we must be able to measure the covariance between domestic and foreign assets. Prior to our data, the available security returns were too sparse to apply the statistical tests and consumption comparisons we utilize.

Recent work by Goetzmann and Ukhov (2007) use Edelstein's annual data to contribute to the debate on Victorian capital market bias. The authors describe the investment technology of the 19th century Victorians, particularly communication advances. Similar to this paper, Goetzmann and Ukhov employ modern portfolio theory to compute optimal portfolios and compare the risk and return characteristics of domestic and internationally diversified investments. This paper differs in methodology and most importantly the scope of available data. Edlestein's sample was limited to the annual

[11] Lowenfield (1909) p.43

returns of 566 securities trading in London, while our new data contains the monthly returns of 4,059 securities trading in London and the United States. The Monthly frequency allows us to employ the statistical tests and compute the consumption gains common in the portfolio choice literature.

Beyond methodological differences, the breadth our data permit us to construct portfolios that better reflect the underlying debate on Victorian capital market failure. For example, Kennedy (1987) argues that the British capital market discriminated against domestic high tech firms such as electric utilities. Edelstein's data contains only three domestic and six foreign electric companies. This is too few to confidently draw conclusions about the risk and return of investment in British versus foreign electrical firms. By contrast, our data set contains twenty-eight British and twenty-one foreign electric firms. More importantly, our data set is more representative of the investment opportunities available to Victorian Investors. For example, nearly a quarter of the total capital raised on the London Stock Exchange and roughly half of all capital invested abroad was placed in foreign government securities.[12] We observe 213 non-colonial foreign bonds, by contrast only one non-colonial foreign bond can be found in Edelstein's data.[13]

### Victorian Investment Data

We address the lack of data by collecting asset returns from 1866 to 1907 trading in both London and the United States.[14] The data were hand entered from 19th and early 20th century financial publications. London price data were collected from the Friday official lists published in the *Money Market Review*, while the London dividend and share data source from the *Investor's Monthly Manual* and *The Economist*. The United States' price, dividend, and share data were collected from the *Commercial and Financial Chronicle's* price lists and investor's supplements, the *Mining Record*, and the hand written

[12] Michie (1988) Table 3.3

[13] Edelstein (1982) Table 5.1. Edelstein does include 52 colonial government bonds in his sample. We observe 110 colonial bonds in addition to the 213 non-colonial bonds. Colonial bonds traded as if they had a implicit guarantee from the British crown. They therefore provided little diversification for a British investor who held domestic sovereign debt.

[14] United States exchanges include New York, Baltimore, Boston, Cincinnati, Charleston, Louisville, Philadelphia, St. Louis, and San Francisco.

ledgers *Records of Stock Brokers and Stock Exchanges*.[15]

The data were selected by collecting all securities listed in both the *Money Market Review* and the *Commercial and Financial Chronicle* in the December of each sample year. This process might introduce a survivorship bias, albeit small, in that stocks listed in January and de-listed in November will not enter into our sample. Also, in order to make it into the final dataset, each security must be matched with corresponding dividends and shares. Lastly, to eliminate errors, all data were double entered and compared.

Prices were sampled every 28-days between January 1866 and December 1907, roughly 86 percent of the Victorian overseas investment boom. Importantly, our sample includes the 1893 and 1907 panics, both of which severely affected foreign markets, and hence diversification opportunities.

Our data consists of closing bid and ask prices, shares, and dividends of 2,242 stocks and 1,817 bonds, that traded in London or the United States.[16] Gross returns are calculated for two consecutive non-missing time periods by equally weighting the bid and ask prices at each point in time, adding any paid dividends. After correcting for capital calls and stock splits, the panel contains 518,224 individual 28-day stock and bond returns. Financial data tends to display a high rate of attrition, with many companies trading for a fraction of the entire time frame. The amount of entry and exit within our panel is heightened by bonds reaching maturity (few are perpetuities), and the substitution of new stock for old. The average life of an individual security within our data set is 9.8 years.[17]

We sort securities by geographic region and industry and compute value-weighted indexes. Each asset is determined to be British, U.S., foreign, or British colonial/protectorate.[18] As markets thickened throughout 1866-1907, financial publications sorted securities into industrial categories such as foreign government bonds, foreign

[15] The *Records of Stock Brokers and Stock Exchanges* is located at Harvard's Baker Library.

[16] The London and U.S. Stock Exchanges were the most liquid exchanges during the Victorian Investment Boom. For excellent history of the size and efficiency of these exchanges see Michie (1988).

[17] With 4,059 securities spanning a 42 year period our dataset could be populated with over 2.2 million observations. A balanced panel of this sort is unlikely due to entry, exit, and the maturation of securities. A similar result can be found in modern data, as the population of CRSP data over the past 21 years yields 65 percent of the data missing. In addition, Little's (1988) MCAR test fails to reject the null hypothesis that the missing data within our sample is missing completely at random.

[18] Information regarding whether a company was foreign or domestic was determined by the company name, e.g., "South African Breweries," or from various web-based resources, such as the UK National Archives, www.nationalarchives.gov.uk.

railroads, electric, gas companies, etc. We use this information to further divide the data into value-weighted indexes that reflect specific types of investment opportunities.

We employ these heretofore-unknown data to investigate the effects of international diversification on the portfolios of Victorian investors. This is the first study to use 19th century data that is both broad enough and sampled at a high enough frequency to apply the mean-variance spanning tests common in the modern portfolio choice literature. This is also the first study of Victorian investment to include assets trading on the exchanges of the United States as well as London. There is considerable evidence that British investors held a large number of assets listed on the exchanges of the United States.[19] By adding U.S. assets to the choice set, we hope to better reflect the true set of investment opportunities available to Victorian investors.

**Test Portfolios**

We sort assets into portfolios corresponding to type and geographic location. For the purpose of this study we define a company as foreign if it is located outside of the United Kingdom or if it exists to raise capital for overseas ventures. Thus in addition to companies located abroad we classify investment trusts and banks as foreign if they are headquartered in London but invest their capital abroad. Details of the portfolio compositions, and the average 28-day gross returns, standard deviations and correlation coefficients can be found in Tables 1-2.

The ex-post returns and correlations provide *prima facie* evidence of the diversification benefit of international investing. The foreign government bond portfolio had both a high return and a low correlation with domestic assets.[20] Likewise, foreign corporate bonds had higher returns than their domestic counterparts with slightly higher risk.

The ex-post diversification benefits apparent in Tables 1 and 2 cry out for a formal test. Were these benefits real or simply a reflection of sampling error? Even if the

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[19]See Wilkins (1989) Chapters 4-5

[20] Both Temin (1987) and Kennedy (1987) have suggested that British investors had a "fear of equities" and preferred to invest in foreign government bonds. Ex-post, this seemed to be a wise decision as foreign government bonds simultaneously delivered high returns and diversification benefits.

differences are statistically significant, were the apparent benefits from international diversification meaningful enough to explain the Victorian penchant for overseas investments? To answer these questions we require a method to evaluate the mean-variance trade-offs available to 19th century British investors.

**Evaluating the Benefits of International Investing**

We utilize a method that encompasses both risk and return to evaluate the affect of the addition of foreign assets into the portfolios of British Victorian-era investors. We present three measures of the benefits of international diversification. The first is a straightforward statistical evaluation of the null hypothesis that the addition of foreign assets provided no diversification benefits. The second is an estimation of the wealth gain a British investor would demand before willingly refraining from international investment. The third measure estimates the optimal weights on the global efficient portfolio and compares the estimated weights to actual market weights at the time. Together these three methods ask if the addition of foreign assets expanded the mean-variance investment frontier available to 19th century British investors, what was the extent of the utility gain, and were the actual holdings during the period optimal?

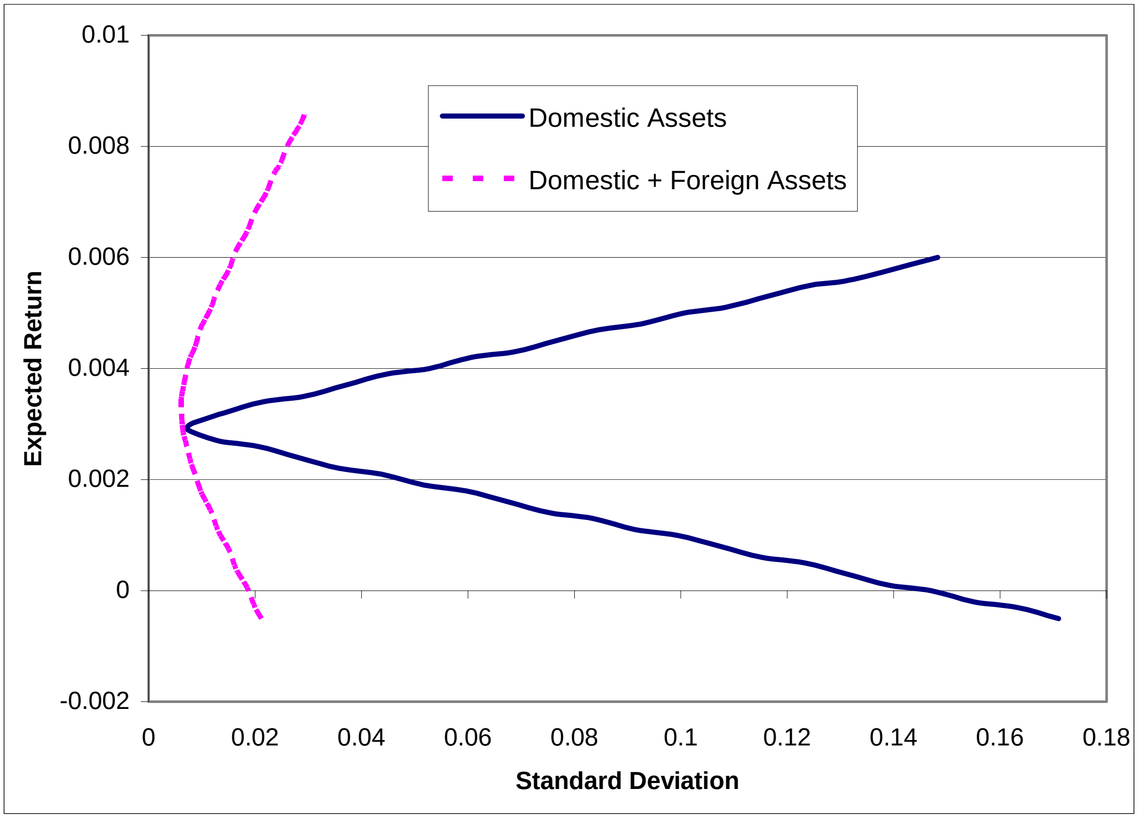
**The Mean-Variance Frontier**

Given a set of assets with expected return vector $\boldsymbol{\mu}$, and covariance matrix $\boldsymbol{\Sigma}$, the mean-variance frontier is the boundary set of means and minimum variance portfolios. One can trace the mean-variance frontier by choosing a vector of weights to minimize portfolio variance for different values of $k$.

$$\begin{gathered}\min_{w} \mathbf{w}'\boldsymbol{\Sigma}\mathbf{w} \\ s.t.\ \mathbf{w}'\boldsymbol{\mu} = k \text{ and } \mathbf{w}'\mathbf{1} = 1\end{gathered} \tag{1}$$

A graph of two mean-standard deviation frontiers formed by domestic and internationally diversified portfolios can be found in Figure 1.

**Figure I**
**Mean-Standard Deviation Frontiers**




Domestic Assets = British Gov. Bonds, British Corp Stocks & British Corp. Bonds
Domestic + Foreign Assets = Domestic Assets + Foreign Gov. Bonds, Foreign Corp. Bonds and Foreign Corp Stocks.

Figure 1 appears to confirm the diversification benefits of international investing. A word of caution is in order. Ex-post estimates of the mean-variance frontier are formed by replacing $\mu$ and $\Sigma$ with their sample estimates $\hat{\mu}$ and $\hat{\Sigma}$. Even if the ex-anti domestic portfolios were mean-variance efficient, an ex-post frontier constructed from the finite sample estimate $\hat{\mu}$ and $\hat{\Sigma}$ will lie to the left of the domestic portfolios.

Did the addition of foreign securities actually expand the ex-ante mean-variance frontier or are the observed ex-post differences the result of sampling error? To answer this question we require a test of the likelihood that an observed expansion of the ex-post mean-variance frontier was the result of sampling error. If the addition of foreign assets actually expanded the mean-variance frontier of Victorian investors, we should be able to reject the hypothesis that the observed benefit is the result of sampling error.

## A Spanning Test

Under what conditions would the inclusion of a foreign asset *fail* to expand the mean-variance set of potential investments? Huberman and Kandel (1987) show that the vector of L domestic assets, $\mathbf{R}_t$, span a foreign asset, $\mathbf{r}_t$, if

$$\begin{gathered} \mathbf{r}_t = \mathbf{a} + \boldsymbol{\delta}\mathbf{R}_t + \boldsymbol{\varepsilon}_t \\ E[\boldsymbol{\varepsilon}] = E[\mathbf{a}] = 0,\ \boldsymbol{\delta}\mathbf{1}_{\mathrm{L}} = 1 \end{gathered} \tag{2}$$

If (2) holds, one can replicate the expected return of the foreign asset with a portfolio of domestic assets. If this is the case, the foreign asset is redundant and its inclusion had no effect on the ex-ante mean-variance frontier. If $\mathbf{R}_t$ does not span $\mathbf{r}_t$, however, then the inclusion of the foreign asset expands the mean-variance frontier. Thus one can test for spanning by estimating (2) via OLS and evaluating the joint restrictions on the coefficients.

## A Spanning Test with Short Restrictions

The Huberman-Kandel spanning test may not be restrictive enough to capture the real-world constraints faced by Victorian investors. The spanning test in (2) does not rule out short positions. Although it was often easier to short stocks in the 19th century than it is today, for many investors short restrictions were a realistic constraint when choosing their optimal portfolios.[21] Therefore, whenever we reject the null hypothesis of spanning, we should ask if the apparent diversification benefits of international investing rely upon the ability to sell assets short and form highly leveraged portfolios. If the results depend upon short sales, we should question whether the apparent gains from diversification are consistent with the general equilibrium market clearing condition that all assets must be held.

DeRoon, Nijman, and Werkers (2001) show how to manipulate the minimization problem in (1) to derive a spanning test with short-sale constraints. Consider an investor

[21] Short selling based on reputation-based forward contracts was widespread during the period of Victorian overseas investment. Not only were short sales prolific, there is evidence that the value of derivative contracts was sometimes larger than spot trades (Harrison, 2004, 2004a, and Dickson 1967). More evidence of the prevalence of short sales comes from the fact that multiple laws attempted to restrict such trades. Such

who maximizes the following utility subject to a short sales constraint[22]

$$\max_{\mathbf{w}\geq\mathbf{0}} \mathbf{w}'\boldsymbol{\mu} - \frac{1}{2}\gamma\mathbf{w}'\Sigma\mathbf{w} \text{ subject to } \mathbf{w}'\mathbf{1} = 1 \tag{3}$$

$\gamma$ is a coefficient of risk aversion. By altering $\gamma$, we can trace the upward sloping portion of the short-sale constrained mean-variance frontier. The resulting short-sale constrained frontier consists of a finite number of unconstrained frontiers formed from subsets of the assets in (3).[23] By altering $\gamma$, we can identify the various subsets. For example, given the choice of investing in the British domestic portfolios and the foreign government bonds portfolios, Figure 2 graphs the optimal weights for different values of $\gamma$.

**Figure 2**
**Solutions to equation (3)**

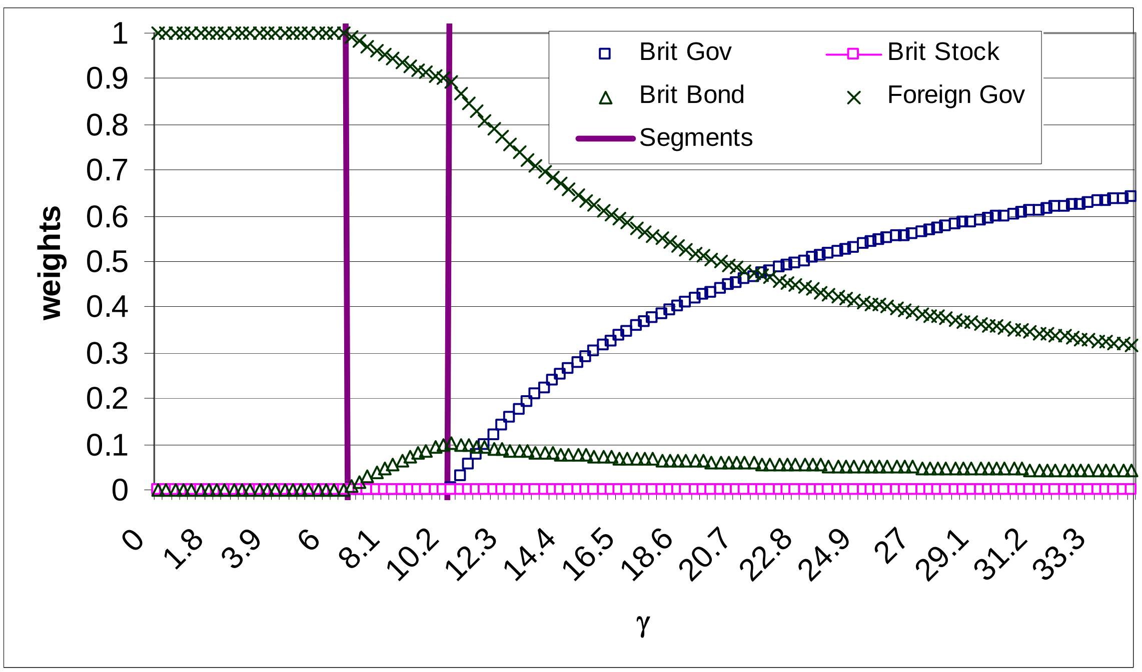



Figure 2 illustrates the risk and return trade-off as one alters $\gamma$. The vertical lines mark the endpoints of the three subsets of **R**. A risk neutral investor ($\gamma = 0$) will choose to place all of her wealth in the portfolio with the highest expected return (the foreign

laws were eventually rescinded. The first law attempting to curtail short sales was enacted in 1697, with further attempts made in 1720, 1734, 1746, 1756, and 1771 (Harrison, 2004).

[22] This utility specification provides a convenient illustration of the derivation of the short-sale constrained spanning test. The resulting test does not depend upon a specific utility function.

[23] Markowitz (1991) and DeRoon, Nijman, and Werkers (2001)

government bond portfolio). As we increase $\gamma$ and re-solve (3), the optimal weights continue to consist of all wealth in the foreign government bond portfolio until the coefficient of risk aversion reaches 6.8.

An investor with $6.8 < \gamma < 10.5$ prefers to forgo some expected return in favor of the diversification benefit from splitting her money between the foreign government bond portfolio and the British corporate bond portfolio. Recall the expected returns and standard deviations from Table 1. The British corporate bond portfolio had a smaller return *and* a greater standard deviation then the British government bond portfolio. Nonetheless, due to the negative correlation between British corporate bonds and foreign government bonds, an investor who holds foreign government bonds would rather diversify her holdings with the British corporate bonds instead of British Government bonds. This decision would be deemed irrational if we neglect covariance and only focused on returns and variances.

Investors with $\gamma < 10.5$ choose to further diversify their portfolios by splitting their wealth between foreign government bonds, British corporate and British government bonds.

Figure 2 also illustrates how the short-sale constrained mean-variance frontier can be decomposed into different subsets. For small values of $\gamma$ the frontier consists of a single point defined by the mean and variance of the foreign government bond portfolio. For $6.8 < \gamma < 10.5$ the frontier consists of a convex combination of the foreign government and British corporate bond portfolios. For $\gamma > 10.5$ the frontier is comprised of a convex combination of the foreign government bond, British corporate bond and British government bond portfolios.

Let $\mathbf{w}(\gamma)^*$ denote the solution to (3) for a given $\gamma$. Let $\nu$ denote the inverse of the Lagrange multiplier for the restriction in (3) that $\mathbf{w}(\gamma)^{*\prime}\mathbf{1} = 1$. Define $\mathbf{R}_t^{(\gamma)}$ as the subvector of $\mathbf{R}_t$ that contains only those assets with non-zero weights in $\mathbf{w}(\gamma)^*$. DeRoon, Nijman, and Werkers (2001) show that the short-sale restricted frontier comprised of the assets in $[\mathbf{R}_t \;\; \mathbf{r}_t]$ and short-sale restricted frontier comprised of the assets in $\mathbf{R}_t$ alone, intersect at the point $\mathbf{w}(\gamma)^*$ if the restriction in (5) holds for the regression in (4)

$$\mathbf{r}_t = \mathbf{a} + \boldsymbol{\delta}\mathbf{R}_t^{(\gamma)} + \boldsymbol{\varepsilon}_t \qquad (4)$$

$$\nu\mathbf{a} + \boldsymbol{\delta}\mathbf{1} \leq 1 \qquad (5)$$

To test for mean-variance spanning, subject to short restrictions, solve (3) for increasing values of $\gamma$ until the P finite subsets of $\mathbf{R}_t$ are identified. Let $\mathbf{R}_t^{[p]}$ denote the $p$-th subset and $\nu^{[p]\max}$ and $\nu^{[p]\min}$ denote the maximum and minimum values of $\nu$ that correspond to the end points of the $p$-th subset. $\mathbf{R}_t$ spans $\mathbf{r}_t$ with short constraints if (6)-(7) hold for all $p$

$$\mathbf{r}_t = \mathbf{a} + \boldsymbol{\delta}\mathbf{R}_t^{[p]} + \boldsymbol{\varepsilon}_t \qquad (6)$$

$$\begin{aligned} \nu^{[p]\max}\hat{\mathbf{a}} + \hat{\boldsymbol{\delta}}\mathbf{1} &\leq 1 \\ \nu^{[p]\min}\hat{\mathbf{a}} + \hat{\boldsymbol{\delta}}\mathbf{1} &\leq 1 \end{aligned} \qquad (7)$$

We estimate (6) for each subset simultaneously via seemingly unrelated regression. Let $\hat{\alpha}$ denote the 2P x 1 vector equal to the difference between the left and right hand side of (7). Under the null hypothesis that $\mathbf{R_t}$ spans $\mathbf{r}_t$ the test statistic in (8) is asymptotically distributed as a mixture of $\chi^2$ distributions

$$\xi(p) = \min_{\alpha \leq 0}(\hat{\alpha} - \alpha)Var[\hat{\alpha}]^{-1}(\hat{\alpha} - \alpha) \qquad (8)$$

Kodde and Palm (1986) show that under the null $\xi(p)$ is asymptotically distributed as a mixture of $\chi^2$ distributions with p-value

$$\Pr(\xi(p) > c)) = \sum_{i=0}^{N} \Pr\left\{\chi^2 \geq c\right\} w(N, i, Var[\hat{\alpha}]), \qquad (9)$$

where $\mathbf{w}(N, i, Var[\hat{\boldsymbol{\alpha}}])$ is a probability weight equal to the probability that N-i of the N elements of a vector distributed $N(\mathbf{0}, Var[\hat{\boldsymbol{\alpha}}])$ are strictly negative.

### Measuring Utility Gains from International Diversification

The spanning tests above suffer from the well-known problem of statistical versus economic significance. The spanning tests ask a simple question: If domestic assets span foreign assets, what is the probability of observing the given expansion in the ex-post mean-variance efficient frontier. Failure to reject the null of spanning suggests that foreign assets made British investors better-off but the tests offers no guidance as to the magnitude of these welfare gains. To give the shift in ex-post frontiers an economic interpretation we employ the methodology of Cole and Obstfeld (1991), Lewis (2000), and Rowland and Tesar (2004) to measure the utility gain associated with a shift in the mean-variance frontier.

Following Lewis (2000), we evaluate the utility gain for an investor with a Epstein-Zin-Weil expected utility[24]

$$U_t = [C_t^{(1-\theta)} + \beta[E_t(U_{t+1}^{1-\gamma})]^{\frac{(1-\theta)}{(1-\gamma)}}]^{\frac{1}{(1-\theta)}}, \quad \text{for } \gamma, \theta > 0; \gamma, \theta \neq 1 \tag{10}$$

where $\gamma$ and $\theta$ are the coefficients of risk aversion and inverse of the elasticity of intertemporal substitution respectively. $\beta$ is the 28-day discount rate which we set equal to .999 .

Both foreign and domestic asset returns are assumed to be jointly log normally distributed. Under these conditions, the expected utility of consumption for an investor who holds the optimal domestic portfolio is[25]

$$E_t U(C_t) = W_t \{1 - \beta \exp[(1-\theta)(\mu_D - \frac{1}{2}\gamma\sigma_D^2)]\}^{\frac{-1}{(1-\theta)}}, \tag{11}$$

where $W_t$ is wealth at time t and $\mu_D$ and $\sigma_D^2$ are the expected return and variance of the optimal portfolio comprised of domestic securities alone. Likewise, the expected utility of the investor who holds the optimal combination of foreign and domestic assets is

$$E_t U(C_t) = W_t \{1 - \beta \exp[(1-\theta)(\mu_{DF} - \frac{1}{2}\gamma\sigma_{DF}^2)]\}^{\frac{-1}{(1-\theta)}}, \tag{12}$$

where $\mu_{DF}$ and $\sigma_{DF}^2$ are the expected return and variance of the optimal portfolio formed with domestic and foreign stocks.

Given the set of domestic and foreign assets, $[\mathbf{R}_t \;\; \mathbf{r}_t]$, the utility gain from diversification can be computed by choosing portfolio weights to maximizing (11)-(12). The ratio of the optimal utility with all assets to the optimal utility when the investor is constrained to hold domestic assets alone forms our measure of the gains from

[24] It is customary to use the Epstein-Zin-Weil utility function because this specification allow the risk-aversion parameter, $\gamma$, to differ from the inverse of the elasticity of intertemporal substitution, $\theta$ .

[25] The utility is only defined if the discount rate is less then 1. This is equivalent to the restriction that $\beta \exp[(1-\theta)(\mu - \frac{1}{2}\gamma\sigma^2) < 1$ .

diversification.

$$\Phi = \{\frac{1-\beta \exp[(1-\theta)(\mu_D^* - \frac{1}{2}\gamma\sigma_D^{*2})]}{1-\beta \exp[(1-\theta)(\mu_{DF}^* - \frac{1}{2}\gamma\sigma_{DF}^{*2})]}\}^{\frac{1}{(1-\theta)}} - 1 \qquad (13)$$

$\Phi$ is the percentage increase in wealth required to compensate an investor for the removal of foreign assets.

The diversification benefit in (13) depends upon investors' risk aversion and elasticity of intertemporal substitution. Unfortunately there is no consensus about the true magnitude of risk aversion and intertemporal substitution. Therefore, we report values of $\Phi$ for a range of risk aversion and intertemporal substitution.

**Testing Portfolio Weights**

In addition to testing the ability of domestic assets to span foreign securities and measuring the utility gains provided by overseas investment, financial publications from the period allow us to test the optimality of investment allocations. Given the actual market weights from the period we use the Britten-Jones (1999) methodology to test their optimality.

Britten-Jones (1999) formulate a procedure to estimate optimal portfolio weights based on an linear regression of excess returns on the unit vector. Regression t and F-statistics can be used to calculate confidence intervals and test for the optimality of observed Victorian-era portfolio weights. A common drawback to this procedure is extraordinary low power. Confidence intervals around the point estimates for the optimal weights are invariably large. Many papers using Britten-Jones methodology find optimal portfolio weight confidence intervals that are sufficiently wide that one cannot reject the null hypothesis that home bias is rational in modern data.[26] Although the spanning methodology of Huberman-Kandel (1987) provides a more powerful test of the null that the addition of foreign assets expand the mean-variance frontier the Britten-Jones methodology allows us to draw inference about individual asset allocations across industries and geography.

**Results**

[26] Ahearne ,Griever & Warnock (2004). See Lewis (1999) for a review of the home bias literature.

We use each of the three methodologies outlined above to measure the gains from international diversification for a Victorian British investor. The gains are quantified through the spanning tests, utility gains, and weights tests using different means of separating asset classes. First, we sort the portfolios into six benchmark asset classes. The combination of portfolios that comprise the benchmark sets can be found in the first column of Table 3. Each set represents a different level of international diversification or asset type. We then separate the asset classes further by categorizing stocks and bonds into separate industries. And finally, we attempt to test whether Victorian investors actually held "optimal" portfolios by aggregating our asset classes according to the market values of different security allocations found in historical financial publications.

**Benchmarks 1 through 6:**

Table 3 reports the short- and non-short restricted results from the spanning tests and Table 4 reports the utility gain from international diversification. The first set, which we call Benchmark 1, contains portfolios comprised of British domestic assets. A test of the hypothesis that Benchmark 1 portfolios spanned the foreign portfolios is equivalent to asking if British investors who held domestic assets could have expanded their mean-variance frontier by adding foreign portfolios.

We can reject the hypothesis that British assets spanned foreign government bonds, foreign corporate stocks, and U.S. bond portfolios. We can not reject the hypothesis that British assets spanned the foreign corporate bonds or U.S. stock portfolios. Looking at the gains in utility from Table 4, the addition of foreign securities resulted in utility gains of 10 to 89 percent when investors were able to take short positions and 8 to 33 percent when short sales were restricted. The magnitude of short-restricted gains available to Victorian investors was similar to estimates of the short-restricted utility gains available to modern U.S. investors.[27]

With the exception of British Government bonds, foreign government bonds were the most popular investment among Victorian-era British investors. By 1883, foreign government bonds accounted for 23 percent of the par value of all securities trading on the

London Stock Exchange.[28] When one considers the diversification benefits apparent from the high returns and low correlations in Tables 1 and 2, the British appetite for foreign government bonds is easy to understand.[29]

Did Victorian investors need to diversify beyond foreign government bonds? The second set of assets, which we call Benchmark 2, consists of all the domestic portfolios contained in the first benchmark plus the foreign government bond portfolio. Tables 3 and 4 therefore contain the results of the spanning tests and the utility gains from international diversification beyond foreign government bonds.

If short sales were allowed, the inclusion of foreign corporate stock and US bonds expanded the mean-variance frontier while the inclusion of foreign corporate bonds and US stocks does not. On the other hand, a British investor who was constrained to long positions was able to expand their mean-variance frontier by adding foreign debt or equity. This expansion was also economically significant, as the addition of foreign debt or equity to benchmark 2 allowed for consumption gains up to 40 percent, with utility gains much smaller for the short-restricted investor. While the diversification gains to a British investor appear measurably less than the benchmark 1 case, individuals already holding foreign sovereign debt and a domestic portfolio could diversify further through investing in private debt and equity abroad.

Was it possible to replicate the return of foreign government bonds with any other assets? Benchmark 3 includes every portfolio *except* the foreign government bond portfolio. A test of the hypothesis that the assets in Benchmark 3 span the remaining portfolio of foreign government bonds is therefore equivalent to a test of the hypothesis that foreign government bonds provided no diversification benefit to a Victorian investor who had already diversified across all other domestic and foreign assets.

The addition of foreign government bonds expanded the mean-variance frontier of Victorian investors only when inventors were restricted to long positions. This expansion, while statistically significant, offered very small utility gains of no more than 1 percent of

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[27] Lewis (2000) Table I reports utility gains for risk aversion and IES ranges of 2-5. Her estimates of modern gains from diversification range from 12%-52%.

[28] British Government bonds accounted for 24% of the par value of traded securities. By comparison, foreign government bonds accounted for 23%, British railway stocks and bonds accounted for 18%, foreign railway stocks and bonds 19% and all other securities 16%. Michie (1999, Table 3.3)

[29]Temin (1987) provides an alternative liquidity based explanation of demand for foreign government bonds.

consumption without short sales.

Benchmarks 4 and 5 are designed to evaluate the effect of investing in only debt or equities. Critics of Victorian-era capital markets have criticized the reluctance of investors to hold equity investments. This "fear of equities may have caused the British stock market to perform poorly as a social capital allocation mechanism before World War I and may have played a role in British industrial decline."[30]

Benchmark 4 is comprised of every bond portfolio regardless of geographic location while benchmark 5 is comprised of every stock portfolio regardless of geographic location. The results of the spanning tests and the utility gains from diversification outside of simply holding all stocks or all bonds can also be found in Tables 3 and 4. For both sets of spanning tests, the results imply that an investor that held all bonds or all stocks, for both foreign and domestic assets, could claim diversification benefits by shifting a fraction of their portfolio into both debt and equity. The Victorian's fear of equities appears irrational until we take the utility gains into account, after which the Victorian preference for debt becomes clear. For investors holding a portfolio of bonds, the addition of equity investments negligibly affect the utility gain from diversification. On the other hand, adding debt to equity only portfolios resulted in utility gains of 10 to 120 percent when investors could short and 2 to 120 percent when investors were short restricted. In light of these consumption gains, Victorian investors' choice of debt rather than equity appears to reflect rational calculation rather than a "fear of equities."

So far, we have treated all foreign investments the same. However, Victorian investors had the opportunity to invest abroad without risking their capital in a land beyond British rule. Great Britain's vast 19th Century Empire provided British investors with ample opportunity to diversify their holdings and invest in the high return infrastructure projects of the developing world. Was the British Empire so vast that it provided British investors with the ability to diversify their holdings without leaving the relative safety of British legal protections? Or, was there something unique about investment in the United States, Latin America or elsewhere that could not be replicated by the British Empire? To answer these questions, we sort all corporate assets into value-weighted British Empire and non-empire stock and bond portfolios. Benchmark 6 consists

[30] De Long and Grossman (1992 p.1)

of the British government bond portfolio and two new portfolios consisting of all British Empire corporate stocks and all British Empire corporate bonds respectively. A test of the hypothesis that the assets in benchmark 6 span the remaining assets is equivalent to a test of the hypothesis that once Victorian investors had diversified their portfolios throughout the empire the addition of non-empire securities had no effect on the mean and variance of their optimal portfolios.

The results again point towards the diversification benefits of foreign fixed-income securities. We only fail to reject the hypothesis of spanning in the case of non-empire stocks. Both foreign government bonds and non-empire bonds expanded the mean-variance frontiers of Victorian investors. The gains from investing outside the empire were considerable. These gains ranged from 11 to 84 and 6 to 36 percent of wealth depending on investors' preferences and ability to short assets.

Benchmarks 1 through 3 provide convincing evidence that British Victorian-era investors had to look abroad in order to maximize their mean-variance tradeoffs. The measurement of utility gains from diversification with Benchmarks 4 and 5 lends credence to the popular explanation that the high level of Victorian overseas investment was due to British investors' preference of debt over equity, particularly foreign government and U.S. railroad bonds.[31] Benchmark 6 shows why Victorian investors choose to look outside the British Empire to find suitable investments.

**Industry Spanning Tests and "New" British Industries**

While the tests on the above benchmarks highlight the overall benefits of foreign investment, our data permit a more refined test of the theory that Britain's capital markets failed to sufficiently fund specific industry. In particular, we are able to value weight at the industry level to test whether investors in a particular industry could diversify further by investing in the foreign analog of that industry. Furthermore, industry-level data will allow us to test the argument that capital market failure was partially responsible for the decline of British industry. We create a set of value-weighted indexes of stocks and bonds from "new growth" industries that dominate trade and development in the 20$^{th}$ century.

[31]See Kennedy (1987) for a discussion of the Victorian's preference for foreign debt.

We then test for diversification benefits when investors held a portfolio comprised of "new growth" industries. Tables 5 and 6 contain the results of spanning tests and measures of utility gains for the industry and "new" industry indexes, respectively.

For the basic industry analysis, each stock or bond return is grouped according to the categories outlined in the *Investors Monthly Manual*. This approach, while useful for the delineation of securities within our dataset also follows the common industry-grouping characterization of the Victorian period.[32] The industries include railroads, finance, electric and petroleum, telephone and telegraph, miscellaneous, iron coal and steel, mines, and steamship and shipping. The spanning test evaluates if a British investor who held British government bonds and domestic securities from a single industry could expand their mean-variance frontier by investing in foreign securities from the same industry.

Overall, the spanning tests and the measures of the utility gains from diversification presented in Table 5 are consistent with our earlier findings. Outside of the electric and petroleum and the iron, coal, and steel industries, we reject that short restricted investors could span the foreign securities with the risk free asset and domestic holdings. When short sales are allowed the rejection rate decreases, and the British investors mean-variance frontier was expanded with overseas investment in railroads, financial, telephone and telegraph, and the miscellaneous industries. In terms of utility gains, investors in particular British industries see the highest utility gains from holding foreign railroads, financial companies, and steamship and ship building industries. Together, these two sets of results provide additional evidence that there were significant gains to be had by investing outside of British industry, particularly when Victorian investors funneled their wealth into foreign railroads, financial companies, and steamship and shipping companies.

British investors gained significantly by holding broad value-weighted portfolios of foreign securities or foreign portfolios for a particular industry. It is argued that a capital market failure, caused by a lack of sufficient funding for the continued development of domestic industry, contributed to the relative decline of British industry. To test this we construct a set of domestic holdings of "new" industries, comprised of value-weighted portfolios of securities from developing industries. We define "new" industries as electricity, petroleum, telephone, telegraph, iron, coal, steel, and miscellaneous commercial and industrial companies. If the portfolios of new industries dominate foreign investment, either through spanning foreign securities or through foreign stocks and bonds providing little additional utility gain to investors, than the case can be made that financing was misappropriated. The tests in particular examine whether a mean-variance investor holding 5 value-weighted portfolios of "new" industries (electricity and petroleum, telephone and telegraph, iron, coal, and steel, miscellaneous commercial and industrial companies, and the risk-free asset) could expand his or her mean-variance frontier or increase their utility by investing in foreign government bonds, foreign corporate stocks, foreign corporate bonds, or US stocks or Bonds. The results of the "new" British industry spanning and utility gains tests can be found in Table 6.

The tests in Table 6 provide evidence that even when British investors held a broad array of "new" industry securities the addition of foreign securities significantly expanded their risk return tradeoffs. Only when short sales were allowed did foreign corporate stocks and US stocks not significantly expand the mean-variance frontier; the addition of foreign bonds expanded the frontier even when short sales were allowed. Particularly large utility gains result from investing in foreign government bonds, foreign corporate bonds, and US bonds. Foreign corporate bonds offered up to 238 percent utility gain over our "new growth" industries, followed by the possibility of 130 percent gain with U.S. Bonds, and an 84 percent gain for foreign government bonds. A British investor who increased his funding of new industry at the expense of foreign diversification would have been worse off.

## Were the Holdings of British Investors Optimal?

Ronald Michie's 1999 work *The London Stock Exchange: A History* tabulates the composition of securities listed on London Stock Exchange in ten year intervals starting in 1853. Michie's Table 3.3 reports the value weights of portfolios of British sovereign debt, foreign sovereign debt, domestic and foreign railways, financial securities, and three

[32] Normal market turnover, brought about by stocks and bonds being delisted or reaching maturity, respectively, creates several thin periods of time within our data series, restricting us from further disaggregation below level of *IMM* industrial categories.

categories of miscellaneous stocks listed on the London Stock Exchange.[33]

Using Britten-Jones' (1999) methodology, we test whether the actual weights at a specific point in time are statistically different from the optimal weights. We calculate for the optimal portfolio weights of a mean-variance investor for three points in time: 1883, 1893, and for 1903. The optimal portfolio weights are estimated from returns over a 10-year interval centered on the dates for which Michie reports actual portfolio weights. We estimate the optimal weights for varying levels of risk aversion ($\gamma$).[34] Table 7 contains the true market weights and the results of Britten-Jones' hypothesis test that the true weights are statistically indistinguishable from the optimal weights.

Table 7 re-affirms the low power common in tests of the optimality of a set of market weights. For 1883 and 1893, except for one case, regardless of the level of risk aversion or how much an optimal investor might short, we cannot reject that the optimal weights are statistically different from the market weights. Simple ocular econometrics would lead one to believe that the market weights for every year are very different from the estimated optimal weights. However, we can only reject the null hypothesis that the 1903 weights are equal to optimal weights. The rejection in 1903 results from the large deviations of the optimal weights from the market weights as mean-variance investors attempt to significantly short domestic bonds while simultaneously placing a large positive weight on financial stocks. Given the magnitude of the differences between actual and optimal weights, our failure to reject in 1883 and 1893 is almost surely due to the low power of the test methodology, and where the markets weights are rejected as sub-optimal, we learn very little.

## Conclusion

[33]The miscellaneous categories in Michie mirror the miscellaneous commercial companies discussed earlier, but we can further aggregate these securities into three categories in order to closely fit the market weights from the Stock Exchange Official Intelligence. The three miscellaneous categories are social infrastructure, commercial and industrial, and tea, coffee and raw materials. Social Infrastructure contains canals, docks, gas, electric, telegraph, telephone, tramways, omnibus, and waterworks companies. Commercial and Industrial contains commercial and industrial, breweries, distilleries, iron, coal, steel, and shipping companies. Tea, Coffee, and Raw Materials contains mines, nitrate, oil, tea, coffee, and rubber companies.

[34] The results are robust to alternative interval lengths used to estimate the optimal weights. Although Michie reports market weights for 1873, which is included in our panel, we cannot test if those weights were optimal due to data limitations. The miscellaneous sectors were not reported separately in the Investors Monthly Manual until 1872.

Why did British investors send so much of their capital abroad? Because that's where the returns were. The benefits of overseas investments were not limited to competitive returns, however. The real benefit of international investing was the diversification benefit of holding foreign assets that had a low correlation with their domestic counterparts.

Proponents of the view that Victorian capital markets failed have argued that the high level of Victorian foreign investment and any evidence of domestic returns commensurate with foreign returns must be proof of bias. When one considers the low correlation between domestic and foreign investments, however, it becomes obvious that a proper test of market failure is far more stringent. Before we can deem Victorian investors irrational, we must not only show that domestic assets had commensurately high returns but also that it was possible to form a domestic portfolio with the low variance of an internationally diversified portfolio.

What about the claim that British investors and the British economy could have done better by investing at home? These counter-factual investments never occurred, so we cannot evaluate their benefits directly. Given the assets that did exist, we can reject the claim that British Victorian-era investors acted irrationally when purchasing foreign assets. A British investor who increased his investment in new British industry at the expense of foreign diversification would have been worse off.

In light of the observed benefits of international diversification, it is no surprise that British Victorian-era investors' sent capital overseas. By sending a portion of their capital abroad, Victorian investors were able to increase their returns while simultaneously decreasing the risk of their portfolios. Victorians did not invest overseas due to bias or ignorance. Instead, the Victorians sent capital overseas in search of both the high returns and diversification that rational investors crave.

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## Table 1: Value Weighted Portfolios 1866-1907

| Portfolio | Assets | 28-Day Mean Return | Std. Dev. |
|---|---|---|---|
| British Government Bonds | All British Sovereign Assets | 1.0022 | 0.0119 |
| British Corporate Stocks | All Domestic British Corporate Stocks | 1.0035 | 0.0142 |
| British Corporate Bonds | All Domestic British Corporate Bonds | 1.003 | 0.0106 |
| Foreign Government Bonds | All non-British Sovereign Bonds | 1.0044 | 0.0177 |
| Foreign Corporate Stocks | All non-British Corporate Stocks | 1.0053 | 0.0291 |
| Foreign Corporate Bonds | All non-British Corporate Bonds | 1.0045 | 0.0125 |
| U.S. Stocks | All United States Corporate Stocks | 1.0062 | 0.0384 |
| U.S. Bonds | All United States Corporate Bonds | 1.0051 | 0.0144 |

Note: Foreign corporate stocks and bonds include U.S. securities

## Table 2: Correlation Coefficients 1866-1907

| | British Govt. Bonds | British Corp. Stocks | British Corp. Bonds | Foreign Govt. Bonds | Foreign Corp. Stocks | Foreign Corp. Bonds | U.S. Stocks | U.S. Bonds |
|---|---|---|---|---|---|---|---|---|
| British Govt. Bonds | 1 | 0.3539 | 0.2897 | 0.2995 | 0.2206 | 0.241 | 0.167 | 0.2378 |
| British Corp. Stocks | 0.3539 | 1 | 0.4267 | 0.3992 | 0.3865 | 0.3776 | 0.2914 | 0.3347 |
| British Corp. Bonds | 0.2897 | 0.4267 | 1 | 0.2774 | 0.1722 | 0.2221 | 0.119 | 0.2175 |
| Foreign Govt. Bonds | 0.2995 | 0.3992 | 0.2774 | 1 | 0.3866 | 0.4113 | 0.2713 | 0.3535 |
| Foreign Corp. Stocks | 0.2206 | 0.3865 | 0.1722 | 0.3866 | 1 | 0.5502 | 0.9658 | 0.5624 |
| Foreign Corp. Bonds | 0.241 | 0.3776 | 0.2221 | 0.4113 | 0.5502 | 1 | 0.4984 | 0.7668 |
| U.S. Stocks | 0.167 | 0.2914 | 0.119 | 0.2713 | 0.9658 | 0.4984 | 1 | 0.5441 |
| U.S. Bonds | 0.2378 | 0.3347 | 0.2175 | 0.3535 | 0.5624 | 0.7668 | 0.5441 | 1 |

Note: Foreign corporate stocks and bonds include U.S. securities

## Table 3: Do Domestic Assets Span Foreign Assets?

**The tabulated p-values correspond to the test of the hypothesis that the benchmark assets 1-6 span the test assets when investors can or cannot short portfolios.**

| Test Assets: | | Foreign Govt. Bonds | Foreign Corp. Stocks | Foreign Corp. Bonds | U.S. Stocks | U.S. Bonds | British Govt. Bonds | British Corp. Bonds | British Corp. Stocks | Non-Empire Stocks | Non-Empire Bonds |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Benchmark 1** | | | | | | | | | | | |
| British Govt. Bonds | short sales p-values | 0.002 | 0.000 | 0.178 | 0.134 | 0.000 | | | | | |
| British Corp. Stocks | | | | | | | | | | | |
| British Corp. Bonds | short restricted p-values | 0.000 | 0.000 | 0.127 | 0.205 | 0.000 | | | | | |
| **Benchmark 2** | | | | | | | | | | | |
| British Govt. Bonds | short sales p-values | | 0.000 | 0.411 | 0.278 | 0.000 | | | | | |
| British Corp. Stocks | | | | | | | | | | | |
| British Corp. Bonds | short restricted p-values | | 0.000 | 0.000 | 0.003 | 0.000 | | | | | |
| ForeignGovt. Bonds | | | | | | | | | | | |
| **Benchmark 3** | | | | | | | | | | | |
| British Govt. Bonds | short sales p-values | 0.393 | | | | | | | | | |
| British Corp. Stocks | | | | | | | | | | | |
| British Corp. Bonds | short restricted p-values | 0.000 | | | | | | | | | |
| Foreign Corp. Stocks | | | | | | | | | | | |
| Foreign Corp. Bonds | | | | | | | | | | | |
| **Benchmark 4** | | | | | | | | | | | |
| British Govt. Bonds | short sales p-values | | 0.000 | | 0.000 | | | | 0.700 | | |
| British Corp. Bonds | | | | | | | | | | | |
| Foreign Govt. Bonds | short restricted p-values | | 0.000 | | 0.000 | | | | 0.000 | | |
| Foreign Corp. Bonds | | | | | | | | | | | |
| **Benchmark 5** | | | | | | | | | | | |
| British Corp. Stocks | short sales p-values | 0.000 | | 0.000 | | 0.000 | 0.000 | 0.000 | | | |
| Foreign Corp. Stocks | | | | | | | | | | | |
| | short restricted p-values | 0.000 | | 0.000 | | 0.000 | 0.000 | 0.000 | | | |
| **Benchmark 6** | | | | | | | | | | | |
| Empire Stocks | short sales p-values | 0.003 | | | | | | | | 0.339 | 0 |
| Empire Bonds | | | | | | | | | | | |
| | short restricted p-values | 0.000 | | | | | | | | 0.469 | 0 |

Note: Each benchmark above is composed of several value-weighted portfolios; each test asset is one value-weighted portfolio.

## Table 4: Measuring Utility Gains from Diversification

**Utility gain measured as the percentage increase in wealth required to compensate an investor for the removal of foreign assets for different values of risk aversion (γ) and the elasticity of intertemporal substitution (θ).**

| | | Gain with Short Sales | | | Gain w/o Short Sales | | |
|---|---|---|---|---|---|---|---|
| **Benchmark 1** | | θ=2 | θ=3 | θ=5 | θ=2 | θ=3 | θ=5 |
| | γ=2 | 0.89 | 0.40 | 0.19 | 0.25 | 0.13 | 0.07 |
| British Govt. Bonds | γ=3 | 0.70 | 0.33 | 0.16 | 0.26 | 0.14 | 0.07 |
| British Corp. Stocks | γ=5 | 0.53 | 0.26 | 0.13 | 0.27 | 0.15 | 0.08 |
| British Corp. Bonds | γ=10 | 0.37 | 0.20 | 0.10 | 0.28 | 0.15 | 0.08 |
| | γ=30 | 0.33 | 0.19 | 0.10 | 0.33 | 0.19 | 0.10 |
| **Benchmark 2** | | | | | | | |
| | γ=2 | 0.40 | 0.20 | 0.10 | 0.07 | 0.04 | 0.02 |
| British Govt. Bonds | γ=3 | 0.35 | 0.17 | 0.09 | 0.09 | 0.05 | 0.03 |
| British Corp. Stocks | γ=5 | 0.28 | 0.14 | 0.07 | 0.12 | 0.07 | 0.03 |
| British Corp. Bonds | γ=10 | 0.22 | 0.12 | 0.06 | 0.17 | 0.09 | 0.05 |
| ForeignGovt. Bonds | γ=30 | 0.24 | 0.14 | 0.07 | 0.23 | 0.13 | 0.07 |
| **Benchmark 3** | | | | | | | |
| British Govt. Bonds | γ=2 | 0.06 | 0.03 | 0.02 | 0.00 | 0.00 | 0.00 |
| British Corp. Stocks | γ=3 | 0.05 | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 |
| British Corp. Bonds | γ=5 | 0.04 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 |
| Foreign Corp. Stocks | γ=10 | 0.03 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 |
| Foreign Corp. Bonds | γ=30 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 |
| **Benchmark 4** | | | | | | | |
| | γ=2 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| British Govt. Bonds | γ=3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| British Corp. Bonds | γ=5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Foreign Govt. Bonds | γ=10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Foreign Corp. Bonds | γ=30 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Benchmark 5** | | | | | | | |
| | γ=2 | 1.12 | 0.50 | 0.23 | 0.06 | 0.04 | 0.02 |
| British Corp. Stocks | γ=3 | 0.79 | 0.37 | 0.18 | 0.12 | 0.06 | 0.03 |
| Foreign Corp. Stocks | γ=5 | 0.53 | 0.26 | 0.13 | 0.18 | 0.10 | 0.05 |
| | γ=10 | 0.40 | 0.21 | 0.11 | 0.28 | 0.15 | 0.08 |
| | γ=30 | 1.25 | 0.68 | 0.35 | 1.23 | 0.67 | 0.35 |
| **Benchmark 6** | | | | | | | |
| | γ=2 | 0.84 | 0.38 | 0.18 | 0.22 | 0.12 | 0.06 |
| Empire Stocks | γ=3 | 0.69 | 0.33 | 0.16 | 0.23 | 0.12 | 0.06 |
| Empire Bonds | γ=5 | 0.53 | 0.26 | 0.13 | 0.25 | 0.13 | 0.07 |
| | γ=10 | 0.40 | 0.21 | 0.11 | 0.29 | 0.16 | 0.08 |
| | γ=30 | 0.38 | 0.21 | 0.11 | 0.36 | 0.20 | 0.11 |

Note: Foreign securities included for the measurement of utility gain, unless specified within the benchmark, are value-weighted portfolios of: foreign government bonds, foreign stocks, foreign corporate bonds, and non-empire stocks and bonds. For benchmark 6, the foreign securities are indexes of non-empire bonds and non-empire stocks.

## Table 5: Industry Spanning Tests and Utility Gains

**The tabulated p-values result from a test of the hypothesis that the risk-free asset and a value-weighted index of stocks in a particular domestic industry span a value weighted index of foreign stocks in the same industry. Utility gain is the percentage increase in wealth required to compensate an investor for the removal of the foreign industry from a portfolio including the foreign industry, a risk free asset, and the domestic industry for different values of risk aversion (γ) and the elasticity of intertemporal substitution (θ).**

### Spanning p-values

| Industry | Short Sales | Short Restricted | Industry | Short Sales | Short Restricted |
|---|---|---|---|---|---|
| **Railroads** | 0.02 | 0.00 | **Miscellaneous** | 0.02 | 0.00 |
| **Finance** | 0.08 | 0.00 | **Iron, Coal, & Steel** | 0.40 | 0.28 |
| **Electric & Petroleum** | 0.48 | 1.00 | **Mines** | 0.31 | 0.00 |
| **Telephone & Telegraph** | 0.01 | 0.00 | **Steamship & Shipping** | 0.20 | 0.00 |

### Utility Gain

| **Railroads** | Short Sales | | | Short Restricted | | | **Miscellaneous** | Short Sales | | | Short Restricted | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | θ=2 | θ=3 | θ=5 | θ=2 | θ=3 | θ=5 | | θ=2 | θ=3 | θ=5 | θ=2 | θ=3 | θ=5 |
| γ=2 | 0.50 | 0.26 | 0.13 | 0.49 | 0.26 | 0.13 | γ=2 | 0.03 | 0.02 | 0.01 | 0.03 | 0.02 | 0.01 |
| γ=3 | 0.37 | 0.20 | 0.10 | 0.37 | 0.20 | 0.10 | γ=3 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 |
| γ=5 | 0.26 | 0.15 | 0.08 | 0.26 | 0.15 | 0.08 | γ=5 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 |
| γ=10 | 0.18 | 0.11 | 0.06 | 0.18 | 0.11 | 0.06 | γ=10 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 |
| γ=30 | 0.26 | 0.24 | 0.20 | 0.26 | 0.24 | 0.20 | γ=30 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 |
| **Finance** | | | | | | | **Iron, Coal, & Steel** | | | | | | |
| γ=2 | 0.36 | 0.19 | 0.10 | 0.30 | 0.16 | 0.08 | γ=2 | 0.10 | 0.06 | 0.03 | 0.10 | 0.06 | 0.03 |
| γ=3 | 0.27 | 0.14 | 0.07 | 0.23 | 0.13 | 0.07 | γ=3 | 0.08 | 0.04 | 0.02 | 0.08 | 0.04 | 0.02 |
| γ=5 | 0.18 | 0.10 | 0.05 | 0.18 | 0.10 | 0.05 | γ=5 | 0.05 | 0.03 | 0.02 | 0.05 | 0.03 | 0.02 |
| γ=10 | 0.12 | 0.07 | 0.04 | 0.12 | 0.07 | 0.04 | γ=10 | 0.04 | 0.03 | 0.02 | 0.04 | 0.03 | 0.02 |
| γ=30 | 0.11 | 0.08 | 0.05 | 0.11 | 0.08 | 0.05 | γ=30 | 0.07 | 0.06 | 0.05 | 0.07 | 0.06 | 0.05 |
| **Electric & Petroleum** | | | | | | | **Mines** | | | | | | |
| γ=2 | 0.26 | 0.14 | 0.07 | 0.14 | 0.08 | 0.04 | γ=2 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 |
| γ=3 | 0.20 | 0.11 | 0.06 | 0.13 | 0.07 | 0.04 | γ=3 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 |
| γ=5 | 0.14 | 0.08 | 0.04 | 0.13 | 0.07 | 0.04 | γ=5 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 |
| γ=10 | 0.09 | 0.05 | 0.03 | 0.09 | 0.05 | 0.03 | γ=10 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 |
| γ=30 | 0.07 | 0.05 | 0.03 | 0.07 | 0.05 | 0.03 | γ=30 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.02 |
| **Telephone & Telegraph** | | | | | | | **Steamship & Shipping** | | | | | | |
| γ=2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | γ=2 | 0.30 | 0.17 | 0.09 | 0.28 | 0.16 | 0.08 |
| γ=3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | γ=3 | 0.20 | 0.12 | 0.06 | 0.19 | 0.11 | 0.06 |
| γ=5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | γ=5 | 0.13 | 0.08 | 0.04 | 0.13 | 0.08 | 0.04 |
| γ=10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | γ=10 | 0.08 | 0.05 | 0.03 | 0.08 | 0.05 | 0.03 |
| γ=30 | 0.00 | n.a. | n.a. | 0.00 | n.a. | n.a. | γ=30 | 0.07 | 0.07 | 0.08 | 0.07 | 0.07 | 0.08 |

Note: n.a. denotes that expected utility is not defined.

## Table 6: New British Industry Spanning Tests and Utility Gains

**The tabulated p-values result from a test of the hypothesis that the risk-free asset and value-weighted indexes of "new industry" assets span foreign test assets. Utility gain is the percentage increase in wealth required to compensate an investor for the removal of the foreign assets from the domestic "new industry" portfolio for different values of risk aversion (γ) and the elasticity of intertemporal substitution (θ).**

**Spanning p-values**

| Industry | Short Sales | Short Restricted |
|---|---|---|
| Foreign Govt. Bonds | 0.00 | 0.00 |
| Foreign Corp. Bonds | 0.00 | 0.00 |
| Foreign Corp. Stocks | 0.56 | 0.00 |
| U.S. Stocks | 0.71 | 0.00 |
| U.S. Bonds | 0.00 | 0.00 |

**Utility Gain**

| Industry | Short Sales | | | Short Restricted | | |
|---|---|---|---|---|---|---|
| | θ=2 | θ=3 | θ=5 | θ=2 | θ=3 | θ=5 |
| Foreign Govt. Bonds | | | | | | |
| γ=2 | 0.30 | 0.15 | 0.07 | 0.00 | 0.00 | 0.00 |
| γ=3 | 0.29 | 0.15 | 0.07 | 0.00 | 0.00 | 0.00 |
| γ=5 | 0.29 | 0.15 | 0.08 | 0.03 | 0.02 | 0.01 |
| γ=10 | 0.32 | 0.18 | 0.09 | 0.24 | 0.13 | 0.07 |
| γ=30 | 0.84 | 0.59 | 0.38 | 0.83 | 0.59 | 0.38 |
| Foreign Corp. Bonds | | | | | | |
| γ=2 | 0.98 | 0.43 | 0.20 | 0.00 | 0.00 | 0.00 |
| γ=3 | 0.95 | 0.42 | 0.20 | 0.00 | 0.00 | 0.00 |
| γ=5 | 0.93 | 0.43 | 0.20 | 0.06 | 0.04 | 0.02 |
| γ=10 | 0.98 | 0.48 | 0.23 | 0.39 | 0.21 | 0.11 |
| γ=30 | 2.38 | 1.32 | 0.71 | 2.08 | 1.19 | 0.66 |
| Foreign Corp. Stocks | | | | | | |
| γ=2 | 0.04 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 |
| γ=3 | 0.03 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 |
| γ=5 | 0.03 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 |
| γ=10 | 0.03 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 |
| γ=30 | 0.04 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 |
| U.S. Stocks | | | | | | |
| γ=2 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| γ=3 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| γ=5 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| γ=10 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 |
| γ=30 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 |
| U.S. Bonds | | | | | | |
| γ=2 | 0.58 | 0.27 | 0.13 | 0.00 | 0.00 | 0.00 |
| γ=3 | 0.56 | 0.27 | 0.13 | 0.00 | 0.00 | 0.00 |
| γ=5 | 0.54 | 0.27 | 0.13 | 0.05 | 0.03 | 0.02 |
| γ=10 | 0.56 | 0.29 | 0.15 | 0.31 | 0.17 | 0.09 |
| γ=30 | 1.29 | 0.84 | 0.50 | 1.27 | 0.83 | 0.50 |

Note: New British industry is a combination of secveral value-weighted portfolio of stocks from developing industries, including electric, petroleum, telephone, telegraph, iron, coal, and steel, and miscellaneous commercial and industrial companies.

## Table 7: Weights Tests

The following table presents the actual market weights, the optimal portfolio weights evaluated for a given level of risk aversion (γ), and the p-value for null hypothesis that the optimal weights are equal to the true market weights.

| **1883** | **Market Weights** | **Optimal Weights for gamma =** | | | | |
|---|---|---|---|---|---|---|
| | | **2** | **3** | **5** | **10** | **30** |
| **British government bond index** | 0.25 | -2.89 | -1.85 | -0.89 | -0.11 | 0.40 |
| **foreign government bond index** | 0.27 | 4.55 | 3.02 | 1.80 | 0.90 | 0.31 |
| **British Railroad index** | 0.18 | -0.56 | -0.36 | -0.21 | -0.10 | -0.02 |
| **Foreign Railroad index** | 0.23 | 1.69 | 1.15 | 0.70 | 0.35 | 0.12 |
| **Financial stocks** | 0.03 | 1.20 | 0.91 | 0.62 | 0.39 | 0.23 |
| **Social Infrastructure** | 0.03 | 0.16 | 0.16 | 0.11 | 0.05 | 0.00 |
| **Commercial and Industrial** | 0.01 | -2.84 | -1.78 | -0.98 | -0.40 | -0.02 |
| **Tea, Coffee, and Raw Materials** | 0.01 | -0.32 | -0.25 | -0.16 | -0.08 | -0.03 |
| **p-value for rejecting null** | | 0.20 | 0.20 | 0.19 | 0.14 | 0.01 |

| **1893** | **Market Weights** | **Optimal Weights for gamma =** | | | | |
|---|---|---|---|---|---|---|
| | | **2** | **3** | **5** | **10** | **30** |
| **British government bond index** | 0.18 | -6.59 | -4.33 | -2.47 | -1.02 | -0.06 |
| **foreign government bond index** | 0.21 | 1.49 | 0.93 | 0.72 | 0.52 | 0.32 |
| **British Railroad index** | 0.17 | 2.69 | 1.66 | 1.06 | 0.51 | 0.14 |
| **Foreign Railroad index** | 0.32 | -1.27 | -0.82 | -0.48 | -0.25 | -0.12 |
| **Financial stocks** | 0.04 | -2.86 | -1.57 | -0.94 | -0.44 | 0.02 |
| **Social Infrastructure** | 0.03 | 4.03 | 2.86 | 1.73 | 0.93 | 0.42 |
| **Commercial and Industrial** | 0.04 | 3.55 | 2.37 | 1.47 | 0.81 | 0.33 |
| **Tea, Coffee, and Raw Materials** | 0.01 | -0.03 | -0.10 | -0.08 | -0.07 | -0.05 |
| **p-value for rejecting null** | | 0.64 | 0.64 | 0.62 | 0.57 | 0.19 |

| **1903** | **Market Weights** | **Optimal Weights for gamma =** | | | | |
|---|---|---|---|---|---|---|
| | | **2** | **3** | **5** | **10** | **30** |
| **British government bond index** | 0.16 | -12.80 | -8.47 | -4.93 | -2.27 | -0.43 |
| **foreign government bond index** | 0.20 | -1.26 | -0.63 | -0.30 | -0.06 | 0.07 |
| **British Railroad index** | 0.16 | -1.61 | -1.04 | -0.59 | -0.26 | -0.02 |
| **Foreign Railroad index** | 0.28 | 3.92 | 2.64 | 1.58 | 0.78 | 0.27 |
| **Financial stocks** | 0.06 | 14.26 | 9.57 | 5.92 | 3.18 | 1.32 |
| **Social Infrastructure** | 0.03 | 2.14 | 1.44 | 0.88 | 0.46 | 0.17 |
| **Commercial and Industrial** | 0.10 | -3.81 | -2.53 | -1.51 | -0.75 | -0.25 |
| **Tea, Coffee, and Raw Materials** | 0.01 | 0.17 | 0.02 | -0.05 | -0.10 | -0.13 |
| **p-value for rejecting null** | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Note: Optimal weights from Stock Exchange Official Intelligence as cited in Michie (Table 3.3, 1999)

Social Infrastructure contains canals, docks, gas, electric, telegraph, telephone, tramways, omnibus, and waterworks companies

Commercial and Industrial contains commercial and industrial, breweries, distilleries, iron, coal, steel, and shipping companies

Tea, Coffee, and Raw Materials contains mines, nitrate, oil, tea, coffee, and rubber companies