



RESEARCH ARTICLES

Risk and Behavioral Regional Investment: A Case Study of Speculation in the Nineteenth-Century Oil Industry of Pennsylvania

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“There is no alternative to human judgment in understanding human behavior.”¹

Introduction

With the benefit of hindsight, it is tempting to view the nineteenth-century development of natural resources in the United States as a straightforward by-product of the overall westward expansion of settlement and extension of the transportation network. However, a simplistic overview of this kind conceals a myriad of research questions about the timing, location, and exploitation rate of specific resources at the regional level. To these must be added further empirical questions about sources of capital and labor and the relative importance of each, especially in the early stages of development. From a more theoretical perspective, Clark et al.² have argued that capital investment tends to precede labor in-migration in rapidly growing regions and the reverse is the case where development is slow. Likewise Alonso³, in terms of sources of capital, would expect new regional investment to be largely exogenous, although endogenous local entrepreneurial initiative may also be significant. In the present context, exogenous could mean either from the financial centers of the eastern seaboard, other previously industrialized regions, or overseas. The latter source was particularly important in relation to railroad investments.⁴ In a similar way, transatlantic immigration provided a bountiful, if fluctuating, source of new labor

power, complemented by westward-biased streams of internal migrants.⁵

This paper focuses on a specific subset of these possible development processes. In particular, it examines the problems faced by potential investors and speculators trying to choose between a multitude of investment opportunities in their quest for handsome profits. These opportunities varied widely in terms of timing, type of natural resource (e.g. coal or oil), and location. Some resources were regionally concentrated, others widely dispersed, and most were remote from the eastern seaboard. Almost all were poorly understood in geological terms at the outset. Hence investment decisions, especially for those seeking “first mover advantage,” were necessarily made under conditions of considerable uncertainty, owing to imperfect information both about present circumstances, and future exploitation potential.

Every component of overall uncertainty added its own element of risk. For the individual investor, the sum total of these risk factors would find expression over time in progressive or sudden financial loss, patient capital gain, or windfall profit. Strategies to manage risk were therefore needed, perhaps by diversifying a portfolio across different companies, sectors, or locations. For specific regions, the aggregate of numerous investment decisions by individual and corporate investors would have a significant impact on the pace of regional development or decline, the articulation of the transportation network, and the growth or contraction of settlements.

Given the importance of these investment processes in regional economic growth, it is perhaps surprising that they have not received more attention in the literature. The present aim is therefore to identify a more systematic approach to the analysis of such processes, focusing on the problem of risk. Initially, I identify broad types of nineteenth-century investor, followed by enumeration of the different categories of risk that they faced. I then use these categories in a structured case study of speculation in the early oil industry of western Pennsylvania, from its beginnings in 1859 up to the 1873 banking panic and its immediate aftermath. This case study has been specifically selected because of the extraordinary regional economic dynamics and rampant speculation associated with its development. Since it is an extreme case, a number of key investment related processes can be seen in relatively stark relief. I assess the applicability of available theoretical frameworks, especially behavioral finance theory, prior to proposing a new theoretical formulation termed “behavioral regional investment.”

The Behavioral Environment and Types of Nineteenth-Century Investor

If we are to be concerned with the thoughts and actions of investors, we must also appreciate the milieu in which they operated, since investment

risk in the broadest sense was not entirely independent of such factors as prevailing levels of knowledge and technology, banking practices, types of corporate organization, business cycle changes, and even the extent of settlements and the transportation network. To these must be added questions of personal motivation for investment by different types of investor and a range of interaction effects. The latter include well-known effects such as speculative manias, herd behavior, and the "madness of crowds,"⁶ where the behavior of multiple investors produces positive feedback effects in the marketplace. Such speculative episodes could be either stock market-based, where the geographical location of the companies involved was immaterial, or regionally based, when funds were pouring into similar types of industrial activity in specific geographical areas. Within this broader context, it is possible to identify a range of investor groupings because of the potentially different motivations for investment, especially in relation to targeting funds to specific regions.

Based on levels of access to capital, the highest flyers would be Wall Street operators, such as Jay Gould, and leading eastern seaboard bankers.⁷ The latter would be expected to manage risk through portfolio diversification, which might or might not have a regional, as opposed to sectoral, component. Wall Street operators were necessarily involved with railroad shares, the growth stocks of their day.

A second group would include individuals of wealth and influence, such as politicians and leading merchants, with access to hot tips from professional stockbrokers, but no direct involvement in the money markets themselves. A greater tendency to follow investment fashions rather than a disciplined approach to portfolio diversification would be characteristic of this group. Where a regional concentration of investment corresponded to a sectoral fad, e.g. copper mining in the Great Lakes region during the 1840s,⁸ a geographical focus might be an incidental result. In contrast, investment in railroad securities, by county or municipal governments, had a well-defined geographical motivation, to bring improved transportation facilities to their home regions, thereby attracting new industries to enhance the tax base.⁹

A similar geographical motivation can be attributed on a much smaller financial scale to both local landowning elites and senior officials of large railroad or mining companies. Local wealthy individuals stood to benefit indirectly from transportation improvements through increased land values. Many urban 'boosters' fell into this category.¹⁰ In a slightly different way, corporate managers often took a financial stake in ancillary local companies, such as water companies or street railway companies, that benefited from overall local population growth.¹¹

The entrepreneurial group would be a mix of local individuals who perceived investment opportunities in their area, generally in the extractive

industries, or energetic individuals from other areas with limited capital, and possibly wealthy backers, who were attracted by the possibility of quick returns. The degree of commitment to a specific area would therefore be a function, not only of local knowledge, but also relative success in terms of returns on capital invested.

Overall, therefore, the relative extent of participation by these different groups in any kind of regionally focused investment, if known, would tell us something about the likelihood of capital retention in the region, depending on the degree of “geographical commitment” involved. However, complex interrelationships between groups might also arise, as Pudup has shown in southeast Kentucky, where local elites were neither followers nor leaders of outside capitalist investors, but rather adopted the role of a local commercial and service class.¹² Dunaway has described similar examples of local Appalachian elites acting as agents for Eastern Seaboard capital.¹³

Local Knowledge and Investment Choices

One of the problems already identified for investors in a nineteenth-century emerging economy was the proliferation of alluring, but poorly understood opportunities for natural resource development, characterised by numerous uncertainties, whose impact on potential income streams was very hard to estimate. An early priority therefore was to find ways of reducing the level of uncertainty about the location and extent of mineral resource deposits, especially coal, iron ore, and copper. While the Geological Surveys of Pennsylvania and Kentucky, for example, were state-funded, demand for investigations of specific lands by mining and improvement companies also led to the establishment of a cadre of consulting geologists, such as J. P. Lesley and Professor Silliman of Yale.¹⁴ Scientific reports were frequently appended to company prospectuses, to help convince the distant investor, unfamiliar with the locality, that share purchases would quickly provide handsome dividends.¹⁵ Viewed from this perspective, local knowledge of coal outcrops or oil seepages was equivalent to “insider” knowledge in stock market terms, since it gave potential local investors an important head start over distant financiers. The combination of state-wide surveys and specialist investigative reports was therefore the means by which remote investors seeking portfolio diversification could combat the hazards of decision-making based on very imperfect information and weigh the comparative merits of different geographically constrained opportunities, in competition with groups of more localized investors. The latter, however, would still enjoy a timing advantage even when the ‘knowledge’ playing field was levelled, given the delays inherent in the conduct of specialist surveys, and the publication of the resultant findings.

Risk Components in Regionally Targeted Natural Resource Investment

While financial economists acknowledge that measuring the risk of a particular investment strategy is difficult and controversial, at least in contemporary stock market terms there are a number of possible measures of stock price volatility, from the simple standard deviation to index-specific measures of relative volatility such as the beta.¹⁶ Since fundamentally new developments, such as the opening of new natural resource deposits, would have had no such readily available comparative yardsticks, any measure of risk must necessarily have been more qualitative, based on a number of major components.¹⁷ These would have included the following: *resource quality and quantity risk; technology related risks, in terms of adequacy and substitutability; transportation risk; corporate organization risk; competitive/speculative risk; timing risk; and institutional risk.*

Resource risk relates back to the question of local knowledge considered above, but even surveys by eminent scientists were not a substitute for test mining or exploratory drilling.¹⁸ Mineral seams could peter out or go into fault, greatly increasing the potential cost of exploitation. Access to existing workings or drilling logs would greatly reduce uncertainty, but this would be equally reflected in higher prices to secure the necessary leasing or extraction rights.

Adequacy of technology risk would depend on specific geological and topographic circumstances. In general, the deeper the resource deposit below ground, the more challenging the technological problems to be overcome, such as providing support for super-incumbent strata or ventilating deep mines.¹⁹ Hence, shallower workings might be lower risk, although they could be prone to other problems such as cave-ins or flooding. At least two types of substitution risks can be identified. Firstly, a new energy resource might prove more abundant or more cost effective than previously available fuels, thereby rapidly replacing them in the marketplace. The adverse impacts of nineteenth-century crude oil discoveries on the whale oil industry of New England fit this category.²⁰ Secondly, changing fuel utilization technologies could progressively alter demand for one fuel versus another, for example the twentieth-century shift away from steam power to the gasoline engine. In the present context, such risk factors clearly acted to favor rather than impede the nascent oil industry.

Unless investors were geological or mining experts, their appraisal of the magnitude of the above risks might be rather inaccurate. Arguably, transportation risk and corporate organization risk would be assessed more adequately, as the information required was more accessible and interpretable. Given the importance of the railroads to the development of the U.S. econ-

omy in the nineteenth-century,²¹ the transportation sector was very closely followed by the investment community.²² So there was a growing body of previous examples/experience with this kind of economic activity, on which judgments and assessments of future project viability could be made.

Similarly, the organizational basis of firms set up to exploit the new commercial opportunities was readily available from inspection. In the case of co-partnerships, the ability to attract financial backing would depend heavily on the business standing of the principals. For other forms of corporate organization, a range of factors would influence investment decision-making. One of these was variation in state laws governing whether stockholders were liable for debts incurred by companies in which they had invested. A second was whether or not the company was established under general incorporation laws or had special charter privileges that enabled it, for example, to engage in railroad construction as well as mineral extraction.²³

The term “speculative risk” as used here means the problem of deciding at what point to invest in the development of a specific regional resource. “Early movers” potentially gained considerable price advantages in the acquisition of mineral rights, due to a lesser degree of competition from other genuine investors or pure speculators. At the same time, this might be offset by resource and transportation risks to produce a high probability of capital loss. Late arrivals experienced lower risk, but higher prices and reduced scope for speculative gain.

Timing risk is the problem of when to invest in relation to wider fluctuations in the national economy. The concept of the business cycle, as now understood, was not widely recognized in the nineteenth century, despite publication of Clement Juglar’s book in the early 1860s.²⁴ While it was obviously understood that the level of economic activity varied in its intensity, this was quite different from being able to forecast the timing of future booms and slumps and arrange investment activity accordingly, as experience during the 1857 banking panic demonstrated.²⁵ Buoyant business conditions encouraged investment in new plant and increased productive capacity, yet this new capacity frequently came on stream just as trade conditions worsened and the additional output was not required. At this point, the capital was sunk in the ventures, but the anticipated cash flow did not materialize, leading a steady stream of budding entrepreneurs to the sheriff’s sale and leaving their backers nursing major losses.²⁶

Apart from the legislative interventions already discussed under the corporate organization heading, other institutional risks might include government restrictions on monopolistic practices, regulation of environmental degradation, or windfall taxes on large profits. Stock market institutions could also decline to list stocks or de-list them following evidence of financial irregularities.²⁷

This discussion of multi-dimensional risk has focused on the decision to invest in a specific region at a specific time. However, in actuality, the decision is more complex still, because investing in one region has an opportunity cost in relation to another possible investment in a different region. Hence comparative risk profiles across space at any given time also have to enter the assessment process. Unfortunately, in the nineteenth century investment opportunities could easily be lost because of delays in securing the reliable information needed to evaluate them effectively. Faced with such complexity, many investors eschewed meticulous research and regional portfolio selection/diversification. For the impatient or incautious, it was easier to participate in the latest investment fashion or speculative bubble, hoping against hope to exit the market before the bubble collapsed. The more prudent might seek out financiers such as J. P. Morgan to be their fund managers.²⁸

To give specific empirical substance to this initial broad discussion of investment risk factors in a regional context, I next present a case study of the early development of the Pennsylvanian oil regions. This case effectively illustrates the problems of risk assessment, the possibility of total capital loss, and unusually, a realistic probability of capital gain beyond one's wildest dreams! The case study has two main parts. The first is a qualitative assessment of the early development of the industry. It necessarily relies on earlier studies for factual information, as opposed to interpretation, so details will not be individually referenced.²⁹ The second part is a more quantitative analysis of comparative investment returns using manufacturing census data and Pennsylvania Industrial Statistics Reports.

Local Knowledge, Scientific Investigation, and Investor Sentiment

Although surface seepages had long provided evidence of the existence of oil in northwest Pennsylvania, especially along Oil Creek, it was not until July 1853 that the first oil lease in the United States was executed. The lessee was Brewer, Watson and Company, a local firm from Titusville in Venango County (see Figure 1). The choice of lands was made by Dr. Brewer, a Dartmouth-trained physician and recent recruit to the local elite, based on his detailed investigations of seepages along the length of Oil Creek. Rudimentary machinery was installed and modest output was achieved, before Brewer realised that "first mover advantage" in this fledgling industry needed to be complemented by scientific assessment of the commercial properties of the new resource. Analyses undertaken in the Chemistry Department at Dartmouth confirmed its value, but only if it could be obtained in paying quantities. Following this initial appraisal, interest in the oil deposits was expressed, firstly by the entrepreneurial partnership of Bissell and Eveleth, both men of

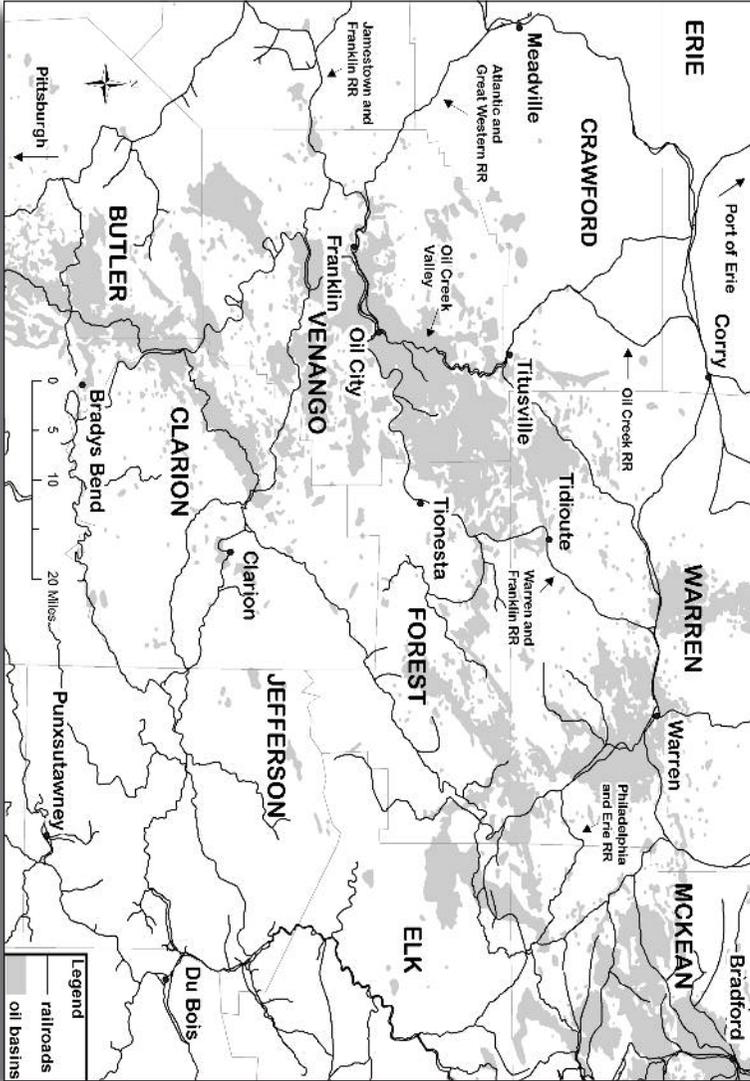


Figure 1. The Oil Regions of N.W. Pennsylvania (oil basin boundaries courtesy of the Pennsylvania Geological Survey).

limited means, and subsequently by capitalists associated with James Townsend, energetic President of the City Savings Bank of New Haven. However, these potential investors would not risk their funds in such a speculative venture without further reports from agents despatched to the Oil Creek region and additional scientific analyses by the eminent Professor Benjamin Siliman, whose findings were eventually published in May 1855.

Organizational Risk and Timing Risk

Despite their growing enthusiasm for rock oil and its scientifically proven value for illuminating purposes, the New Haven investors found a critical stumbling block in the New York State incorporation laws, which would have left stockholders liable for any debts incurred by such a risky enterprise. At their insistence, the recently established Pennsylvania Rock Oil Company had to be reorganized under Connecticut laws, which gave protection from such liability, before they would subscribe for stock. Even after this was done in September 1855, subsequent disagreements between groups of investors and the impact of the 1857 panic paralyzed the operation of the company until December 1857. At that time James Townsend, by then President of the Company, persuaded the firm of Drake and Bowditch to lease the property for a royalty of 12 cents per gallon raised. Townsend and his New Haven colleagues then organized the Seneca Oil Company, with Drake as figurehead, and the Drake and Bowditch lease was transferred to the new company.

Drake quietly commenced drilling operations in 1858, basing his methods on those of the salt industry. Despite numerous setbacks and problems acquiring machinery and retaining skilled workmen, he persisted to ultimate success. Oil was struck at a depth of about 70 feet on 27 August 1859. Strangely, New Haven investors prevented newspapers reporting the find for some weeks, out of fear that the oil would rapidly run out.³⁰

Speculative Risk

While the conservative New Haven money-men hid their new source of illumination under a bushel, Titusville residents showed no such reticence. Hundreds thronged the vicinity of the Drake Well, eager for sight of the new discovery. Two of the original actors in the drama, Jonathan Watson and George Bissell, were immediately stirred into action, using their local knowledge to minimize any timing delay. Watson took to his horse and within 48 hours of the discovery had leased two important properties on Oil Creek. Bissell followed in September, leasing or purchasing lands to the tune of \$200,000, even though many had no surface indications of oil.

A speculative boom followed. The first leases were favorable to the

landowners, who secured a quarter to a half of the oil to be produced. Interestingly, as the scale of the oil resources became better understood, the proportions reduced to one-eighth or less. The same applied with increasing distance from the Drake Well, where the likelihood of future oil strikes seemed less and less certain, although betting on this particular distance decay function was to prove entirely false.

The actual discovery of oil instantly altered the 'landscape of risk' for the potential regional investor. The investment question had suddenly changed its geographical scale from "should my funds be allocated to this resource in this region?" to "where is the best location on Oil Creek to acquire an oil lease?" Also, success from shallow wells meant that there was a probability (as yet unknown) of a good return from an investment measured only in hundreds of dollars. In terms of cost of entry this was much lower than iron furnace construction or mine shaft sinking, where much larger capital sums were required. It also compared extremely favorably with blue chip railroad stocks on Wall Street yielding 6-8 percent in good times, at least when oil fetched \$20 per barrel, as it did initially. That said, a minimum investment of \$300-400 to drill a shallow hole without the help of a steam engine was still the annual income of a laborer, and it was a significant sum even for a middle class investor.³¹ Nevertheless it fell within the reach of a significant portion of the population and the desire to invest would rise with the perceived payoff, which, lottery-like, had the key benefit of being almost instant, if oil was struck.

Unfortunately, the speculative risk attached to any given oil lease proved to be multi-faceted. It had a number of components, including risks attributable to geological factors, price fluctuations, accident, and fraud. In terms of geological risk, even the most eminent of scientists could not reliably extrapolate from a handful of wells and surface indications to specify the best locations for oil drilling. So trial and error was essential, although the depth variable greatly complicated matters. The fledgling industry was initially driven by faulty exploration heuristics, such as "oil flows downhill towards Oil Creek," although it took five years for this particular error to be corrected.³² It is possible to get an estimate of geological risk by analyzing data on the relative proportions of producing and non-producing wells. The latter included both dry holes and abandoned wells.³³ For fifteen properties in the Oil Creek valley the proportions in question can be determined for 1862 and 1869. In 1862, only one in five wells previously sunk was in operation, whereas by 1869 the ratio had improved to one in every 3.22 wells. Interestingly, this improvement was entirely offset by higher costs of sinking deeper wells, so the average required investment for a successful well remained at about \$15,000.

That said, the potential payoff was almost inconceivably larger than

a small investor could hope for by playing the stock market. For example, prior to 1861, the largest wells were producing 300 barrels a day, but when the Empire Well struck oil it set a new record of 3,000 barrels a day, bringing instant riches to its owners and leading very quickly to the first oil millionaires. It is unsurprising therefore that fortune seekers made for Oil Creek in huge numbers. Leases spawned nested sub-leases, each group using the money from subsequent sub-leasing to drill their own wells, crowding the hillsides with makeshift derricks, each trying to secure the greatest output before the reservoir ran dry.

However, gushers such as the Empire spelled both instant wealth for their owners and lessees but also possible penury for less successful small operators, who faced sudden and severe price risk.³⁴ The yield from the second generation of wells was so large that prices collapsed in the latter part of 1861 to 10 cents a barrel (Figure 2). Output had suddenly exceeded demand and both available barrel-making and refining capacity. Although prices recovered during the Civil War, allowing for the temporary high inflation of the period, they never again reached the dizzy heights of 1859-60.

Aside from price risk, there were also other risks of accident. Prominent among these were the dangers of fire, quicksand, and water drowning, as happened at the Hammond well. Lastly, at the height of speculative fever, fraudulent misrepresentation of the oil bearing capacity of lands became commonplace.³⁶

Transportation Risk

Rather than a specifically speculative risk, transportation risk is perhaps best characterized as a kind of 'regional development' risk. In 1859-60 the nearest railroad stations (Garland and Corry) were 20 and 27 miles from Titusville, respectively. The roads became clogged with the wagons of 4,000 teamsters, charging extortionate rates. The only alternative was to utilize "pond freshets," synchronized releases of water from lumber ponds to float barges down Oil Creek into the Allegheny River. If the flow became obstructed, the effects could be disastrous, as happened on 31 May 1864.³⁷ Andrew Carnegie, himself an early oil investor, estimated that 1/3 of the oil originally shipped in such freshets was lost in boat smashes and another 1/3 from leaking barrels, before the surviving vessels reached Pittsburgh. In 1862 the Oil Creek Railroad finally reached Titusville and the Atlantic and Great Western was subsequently extended to Franklin, but Oil City did not have a direct railroad connection until 1864 (Figure 1). Shortly after this, in 1865, Samuel Van Syckel laid the first successful pipeline, despite repeated sabotage by teamsters, who saw their easy money about to vanish. At \$1 a barrel via the pipeline, they were significantly undercut and Van Syckel's income rose to

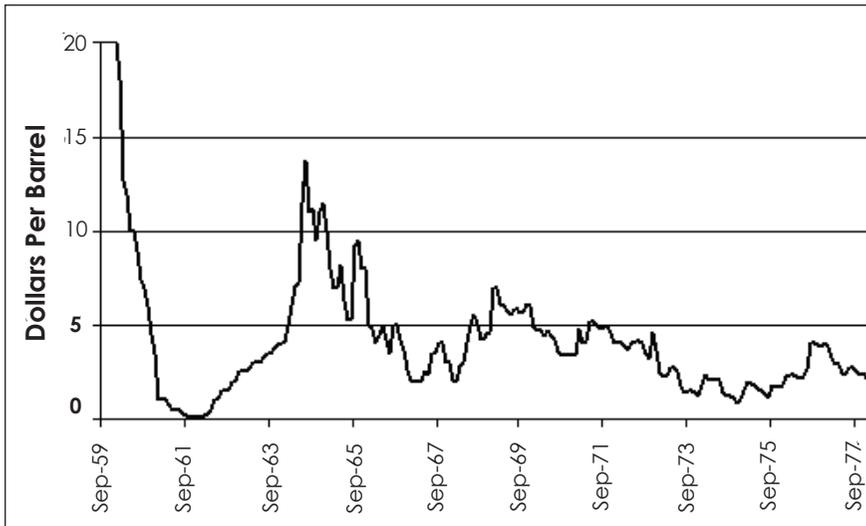


Figure 2. Monthly maximum prices of Pennsylvania crude oil 1859-1877.³⁵

\$2,000 a day, almost matching that of the most productive of well operators. Further pipelines followed and they proved so effective that a mass emigration of teamsters from the region quickly followed; reportedly as many as 1,500 left in a single week.³⁸

Institutional Risk

It might be imagined that a burgeoning new industry would immediately have attracted the attention of legislators, either to curb speculative excesses or to strengthen the Exchequer with new tax levies. In the heady days of the 1864 inflationary boom, neither of these institutional factors came into play to any significant extent. Booming oil exports helped fund the cost of the war at the federal level, and an explosion of oil company incorporation activity took place, primarily in Pennsylvania, but spilling over into adjoining states. The literature reports over 500 companies capitalized at \$356 million,³⁹ of which \$100 million was believed to have been actually paid in. However, further investigation has revealed that these are substantial underestimates, because the number of companies incorporated in Pennsylvania alone had reached almost 900 by the end of 1866.⁴⁰ Examination of a sample of surviving investment prospectuses and letters patent shows the incorporators, trustees and directors of these companies to have originated largely from New York and Philadelphia, with Pittsburgh, Baltimore, and Boston also represented. Sometimes a trustee was drawn from the Oil Regions, but rarely more than one. Evidence of officers domiciled in the Anthracite Coal Regions is

suggestive of re-investment of profits from one region in new developments farther west. As individuals, these officers ranged from the exalted status of bank/insurance company presidents and the occasional railroad president, down to commission merchants and minor luminaries from the New York wholesale fish market.⁴¹

Importantly, it was rare for a single institution's officers to dominate a specific oil company. This suggests perhaps a more individualized speculative motive, rather than an orchestrated attempt by large institutions, in the early days at least, to control investment in the fledgling industry. Oil stocks were not generally dealt at the Regular Board of the New York Stock Exchange, but there were several independent boards set up to handle such stocks from 1864-65 onwards, although no evidence of them exercising any regulatory functions has been uncovered.⁴² Within the Oil Regions themselves, the first Oil Exchange was established in Titusville in 1871,⁴³ but this was primarily a commodity rather than a stock exchange. It did, however, serve a key role in thwarting the activities of the South Improvement Company, a first attempt in 1872 by Standard Oil and the railroads to increase their control over the industry.⁴⁴ Allowing for the undeniable influence of the pre-existing financial structure in New York, the early development of the oil industry therefore seems to have been at least as much the product of unfettered and unregulated individual agency, as it was of the machinations of large institutions or corporate capital. Of course, this would change in later years as Standard Oil tightened its grip on the industry from its early Cleveland base, while simultaneously attracting government concern about its growing monopoly power.⁴⁵

Repeating the Cycle— Speculative Booms in Neighboring Areas

Several years after the first flush of excitement along Oil Creek, wildcat drillers began searching further afield for new strikes. Wells were put down near the junction of the Clarion and Allegheny rivers in 1863-64, but these attracted little attention.⁴⁶ However, in 1865, an oil strike at Pithole, east of Oil Creek, inaugurated a second wave of speculative mania. A boom town mushroomed almost overnight, and fortunes were made in real estate, never mind from oil, before the wells ran dry and the peak population of 12,000 dwindled away within a couple of years. During the boom, the drillers of Pithole aggressively adopted the new pipeline technology and rapidly constructed a 12-mile double track plank road to Titusville.⁴⁷

While Pithole captured the nation's imagination, from Civil War generals down to elevator boys, C.D. Angell was quietly developing oil property 25 miles below Oil City and elaborating his theory of the location of the main

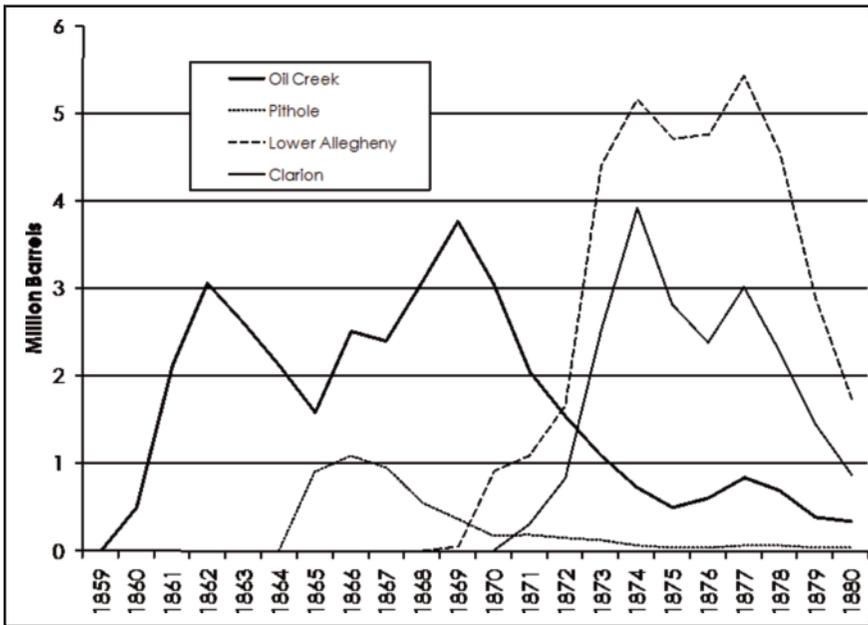


Figure 3. Pennsylvania annual oil production by district 1859-1880.⁴⁹

oil-producing belts in the region. This sparked further oil exploration and production in Clarion County and other parts of the lower Allegheny Basin.⁴⁸ These developments came on stream in earnest in the early 1870s, as can be seen from Figure 3. While more detailed data are not available, the graphs suggest the impact of each new oil region on investment and output in older areas. The short-lived surge of activity around Pithole certainly seems to have dented enthusiasm in the Oil Creek district, although the latter had already started its overall decline shortly before the Clarion and Lower Allegheny districts became major forces in the marketplace. However, the major new finds from deep wells in the Bradford district had to wait until the mid-1870s.

Thereafter this region ‘took off’ at astonishing speed (not shown in Figure 3). Its output rose from a mere 18,500 barrels in 1875 to more than 22 million by 1880, over 85 percent of the state’s entire production.⁵⁰ Although a regional breakdown is lacking, the temporal impact of these different developments can be seen in Figure 4. Initially, the impact of the 1873 Panic on exploration activity seemed marked, but as the importance of the Bradford district finds became known, the adverse impacts of the 1870s depression⁵² disappeared from the figures, since speculative drilling peaked when the depression was approaching its nadir in 1877. Such investment behavior may appear counter-intuitive until it is appreciated that once the depth of the oil-bearing strata was known, only 3 percent of wells were dry holes, leaving just the threat of fire as the main risk to capital.⁵³ Hence, for the fortunate few

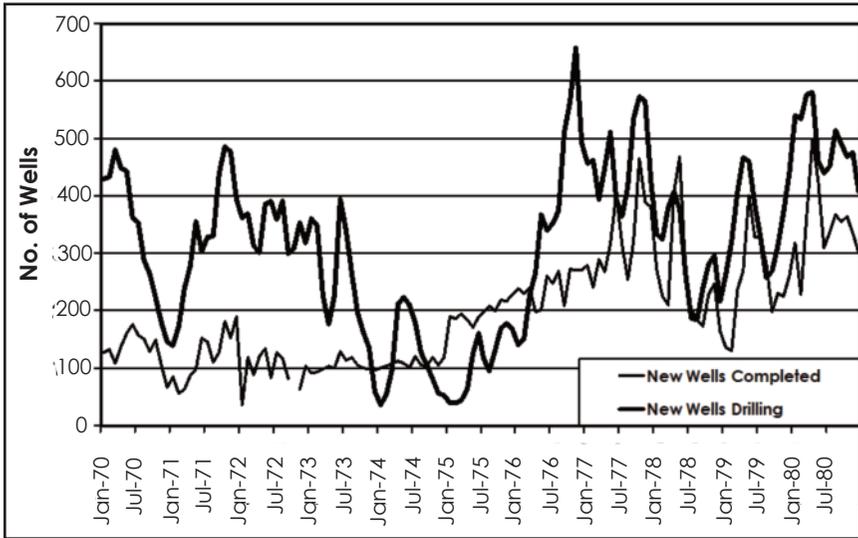


Figure 4. New wells completed and drilling in Pennsylvania 1870-1880.⁵¹

who still had funds to invest, this was as near to betting on a genuine certainty as any region was ever likely to offer.

Rewarding Risk – Returns on Oil Investments

Although the risk profile in the Bradford district proved to be extremely attractive, despite drilling depths of up to 2,000 ft.,⁵⁴ the profile in other districts was less favorable, although wells were shallower. Fortunately, 1870 manufacturing census tabulations allow indicative calculations to be performed on gross margins and returns on capital for the industry by county (Table 1). Minor producing counties have been excluded from the table individually, although their data are incorporated into the state averages given. In the absence of specific data, I used a high figure of 33.33 percent to cover estimated depreciation. Based on this assumption Venango County emerges as a clear winner with a healthy return on capital in excess of 100 percent. Only Beaver County's modest oil developments appear to be questionable investments.

Substantially greater investment per well was required in the oilfields outside Venango County, which raised the cost of entry and would have deterred the smaller independents and speculators. Thus a combination of relatively cheap drilling costs and high returns enabled the county to continue attracting investment, at least until the decline of the early 1870s set in. It is interesting to compare the level of capital directed towards Venango County in the space of a decade with that deployed in Schuylkill County, one of the

Table 1. Estimated Investment Returns in Oil Counties 1870⁵⁵

County	No. of establishments	Capital invested (million \$)	Costs + depreciation assumed at 33.33% (million \$)	Value of output (million \$)	Gross margin (million \$)	% Return on Capital
Armstrong	187	1.15	0.82	1.5	0.67	59
Beaver	95	0.58	0.22	0.17	-0.04	-8
Venango	1668	5.97	6.3	14.83	8.52	143
Warren	181	1.47	0.78	1.42	0.65	44
State total	2148	9.25	8.16	18.05	9.88	107

major anthracite mining counties of Eastern Pennsylvania.⁵⁶ According to the census, 91 mines were capitalized at \$17.15 million after more than 40 years of development of the coalfield, but using a more favorable depreciation rate of 10 percent, the return on capital was a mere 7.6 percent.

Alternative Theoretical Frameworks for the Analysis of Speculative Risk

It is abundantly clear in the foregoing case study that the Oil Regions represented an archetypal, if not extreme example of the risk factors inherent in natural resource development, and the problems of investment decision-making and regional asset allocation based on very imperfect information. A political economy approach has undeniable value in general theoretical terms, especially such concepts as Harvey's "spatial fix."⁵⁷ However, his reliance on Marx's argument that the motivation for overseas investment was simply a quest for higher returns, without close regard to the link between risk and return, for example, is now open to re-evaluation in the light of more recent work on international capital flows.⁵⁸ In addition, the spatial fix is currently too broadly defined to address adequately the detailed study of investment risk, as developed above. Also, given the absence of state/federal initiative or intervention in the early period and the five-year time lag between the start of the industry and the inauguration of the first petroleum stock exchange, it is difficult to argue here for a theoretical approach derived from the institutionalist tradition, where such governmental and financial organizations are deemed to provide bulwarks against market uncertainty and bounded knowledge.⁵⁹

Nor does endogenous growth theory as formulated by Krugman, with its emphasis on increasing returns to scale and external economies, appear to offer particular insight into the early stages of the natural resource investment process, although it clearly has value in relation to longer term, agglomeration processes of urbanization and industrialization.⁶⁰ Interestingly, part of Krugman's approach relied heavily on Meyer's classic study of the American manufacturing belt, within which the present case study region is situated.⁶¹ Similarly, some concepts from the new economic geography, such as industrial districts and embeddedness, may have explanatory value for aspects of early industrial development, as Meyer has demonstrated.⁶² However, other insights from this voluminous literature are clearly directed towards the post-Fordist regime of flexible accumulation⁶³ and their relevance, if any, to nineteenth-century economic circumstances have yet to be demonstrated, either theoretically or empirically.

It is therefore necessary to turn to perspectives which focus more specifically on the decision-making behavior of individuals, either in relation

to direct regional investment, such as acquisition of natural resource lands and leases, or indirect investment by means of the securities of companies engaged in the extraction, processing, or transporting of such resources in single or multiple locations. Three major alternatives can be considered very briefly. These include *neoclassical economics*, *behavioral geography*, and *behavioral finance*.

Neoclassical economics relies, amongst other things, on assumptions of perfect information and perfect rationality, which scarcely match to present requirements. It remains the dominant paradigm in contemporary economics,⁶⁴ despite being subject to trenchant criticism from different quarters.⁶⁵ The specific challenge from behavioral finance will be examined further below. Simon,⁶⁶ in particular, has rejected the process independent predictions of the neoclassical paradigm, insisting instead on the importance of analyzing real-world decision processes. His approach certainly seems more in keeping with the class of problem examined in the present case study, and conveniently also provides the theoretical basis for a second alternative theoretical framework, namely behavioral geography.

Behavioral geography⁶⁷ is based on Simon's concept of bounded rationality or satisficing behavior,⁶⁸ largely derived from his empirical work on organizations in the 1950s. It has a key interest in questions of risk and uncertainty, as exemplified by Wolpert's classic study of Swedish farmers.⁶⁹ However, the growing impact of social theory, and the structure-agency debate within geography⁷⁰ led to criticism that behavioral approaches privileged individual agency at the expense of structural and institutional factors.⁷¹ Evidence of this was easy to find in the relevant literature and the approach subsequently lost ground. This is unfortunate in the nineteenth-century context, since these same institutional factors, in the present case study at least, have been shown to be of very limited importance. That said, the behavioral geography literature has a dearth of studies relating to regional development and this greatly reduces its value in respect of the problem at hand.

A third alternative approach is that of behavioral finance, which Shefrin has defined very simply, as "the application of psychology to financial behavior."⁷² He divides the field into three main areas of focus, namely heuristic-driven bias, frame dependence, and inefficient markets.⁷³ The first of these addresses the fact that individual investors do not in general base decisions on an objective model of the relationship between risk and return,⁷⁴ but on subjective rules of thumb. These are often based on incorrect interpretation or extrapolation of partial available information. One example is the representativeness problem, where individuals incorrectly perceive patterns in short temporal samples of random price series. Another is the tendency to underreact to earnings announcements in the short-term, and overreact to consistent patterns of news trending in the same direction. This is known as the

problem of conservatism.⁷⁵

The second theme, frame dependence, is less readily appreciated by the casual observer. It relates to findings from psychological experiments,⁷⁶ that the form in which potential choices are presented to an investment decision maker, especially those involving objectively calculable risks, can cause one course of action to be preferentially chosen over others. This can be beneficial, but it can also lead to sub-optimal or erroneous decisions. For example, the experiments have demonstrated a tendency towards loss aversion, so the canny stockbroker, who advises clients to adjust their portfolios by “transferring some assets” rather than by “selling some stocks at a loss,”⁷⁷ is more likely to find his advice heeded. Another example is the problem of money illusion,⁷⁸ where choices framed in nominal monetary terms produce different outcomes than those presented in “real” inflation accounted terms.

The third theme concerns the claim of persistent inefficiency in securities markets, based on the working out of the kind of psychological factors just discussed. This is of crucial importance, because it contradicts the “efficient markets hypothesis” (EMH), a key tenet of neoclassical finance theory, that stock prices always fully reflect available information, representing a competitive market equilibrium under conditions of rational investment.⁷⁹ If this claim of inefficiency can be substantiated, it strikes at the heart of the dominant paradigm of neoclassical theory. Hence, this issue has attracted both the highest levels of theoretical debate as well as the lowest levels of academic name-calling, such as the characterization of empirical behavioral research as “anomalies dredging.”⁸⁰

Put another way, are anomalies in stock pricing simply investor errors that are quickly eradicated, or do inherent psychological factors generate an endless stream of new entrant irrational “noise” investors,⁸¹ most of whom either leave the market penniless, fleeced by skilled arbitrageurs, or enjoy miserable returns, while a minority learn from experience and graduate to join the “smart money” set,⁸² only to be replaced by another group of gullible novices? In the latter case, it could be argued that market anomalies are, in fact, the norm, while efficient market behavior is anomalous, because it is out of kilter with the known behavioral characteristics of the market’s participants. Well-known examples of persistent anomalies from the literature include the arguments that the representativeness heuristic causes pricing bias to develop, whereby past stock market losers become undervalued and past winners overvalued.⁸³ Eventually, over a period of several years, the mispricing anomalies are corrected in individual cases. However, if new candidates for mispricing continue to arise (and there is no obvious reason why they should not), a strong element of mispricing will be endemic to the market.

Another example is the phenomenon of momentum investing,⁸⁴ whereby investor demand and price increases are more dependent on prior in-

vestor demand, and perhaps broker recommendations of outperforming stocks, than on any change in value fundamentals. Additional theoretical support for behavioral finance comes from Stiglitz's emphasis on the key role of information in economic behavior and his arguments, based on information costs, against the validity of the EMH.⁸⁵

Further important aspects of behavioral finance theory include an emphasis on distinguishing different types of investors, such as noise investors, whose decision errors may or may not cancel each other out, professional fund managers and the more elusive and reclusive smart money set. It has also successfully addressed the role of government and financial institutions,⁸⁶ thereby avoiding some of the criticisms of behavioral geography made by social theorists. Thus, behavioral explanations are concerned with what "investors actually think and do,"⁸⁷ although the focus of both theoretical and empirical work has been on prices and returns in equity markets.

Although behavioral finance drew its initial inspiration from 1970s work on the experimental psychology of economic decision making, it did not trace its origins back to Simon's work (for example, Schiller's *Irrational Exuberance*⁸⁸ makes no mention of his papers). While both bodies of psychological work gained Nobel prizes for their originators, they therefore spawned very separate literatures, so there is virtually no overlap between behavioral geography and standard behavioral finance theory. It is therefore particularly interesting that in a recent reassessment of both neoclassical and behavioral finance, Lo has proposed a new approach, based on his adaptive markets hypothesis (AMH),⁸⁹ that draws heavily on Simon's work in conjunction with analogies from evolutionary biology about survival and adaptability as key strategies in financial markets. Lo's innovative work has yet to stimulate significant further research, but initial support for the AMH is beginning to emerge,⁹⁰ so the possibility of identifying adaptive investment or development strategies in future empirical work needs to be borne in mind.

Behavioral Regional Investment – A New Proposal

Despite occasional excursions into other asset classes outside the stock market, such as housing, literature searches indicate that behavioral finance approaches have not been previously utilized to examine investment decision-making on a regional basis. In relation to the impact of booms and panics on stock market investments, Schleifer does refer to the problem of collateral collapses of assets and hugely inefficient liquidations, which demonstrate the high costs of market inefficiency. However, he admits that this is a largely unexplored topic.⁹¹

A behavioral finance approach clearly meets some of the necessary criteria to address the class of problem of interest here, because of its focus

on types of investors, investment psychology under conditions of risk and uncertainty, and the wider role of psychology in relation to speculative activity, bubbles, and subsequent crashes. However, it is equally clear that it needs to be significantly extended if it is to investigate why or how investors choose to allocate capital to specific firms or sectoral developments in particular places/geographical regions at particular times. In the nineteenth century, information was much more imperfect than in the present day stock market, and perhaps even more prone to manipulation than at the present day⁹² with the investment risks correspondingly higher. Unsurprisingly the same problems of market inefficiency were apparent then as now. For example, the little known stock market bubble of early 1864 displayed exactly the same types of “irrational exuberance” that Shiller has documented for the twentieth century,⁹³ leading *The New York Times* of the day to warn its readers against stock prices that bore no relation to rational valuations “present or prospective.”⁹⁴

It is also apparent that Schleifer’s comments about the need for investigation of asset collapses following stock market panics will have important implications at the regional level, as well as on the national scale (which he had in mind). A hint of this importance can be seen in the differential impact of the 1857 Panic on bankruptcies in the Northeast and the Midwest.⁹⁵ Thus, there are good theoretical and empirical grounds for proposing a new research agenda, in terms of “behavioral regional investment.” A countervailing neoclassical formulation, analogous to the familiar efficient markets hypothesis, might be called the “efficient spatial investment hypothesis.” This would imply that scarce capital resources were efficiently allocated by market mechanisms among competing industrial sectors and geographical regions.⁹⁶ Efficiency would also mean that the cost of participating investment-wise in the development of specific areas at specific times accurately reflected the risk-adjusted discounted present value of the investments in question.⁹⁷ In the light of nineteenth-century levels of development of capital markets and the banking system,⁹⁸ the new approach proposed here would contend that departures from such normative conditions, as a result of behavioral regional investment processes, should be the focus of interest rather than postulated equilibrium states. Even in the long run, it would be argued that efficient allocation of the nation’s capital resources among competing regional sectors would not be achievable. As long as new opportunities of unknown future value were regularly being discovered, any fragile balance in flows of capital that might have pertained would immediately have been destabilized by the latest regional “get-rich-quick” scheme.

Full-scale analysis of behavioral regional investment will be a demanding undertaking. Questions such as the eventual scope of the analysis or how to measure the relative importance or effectiveness of different investment strategies in specific locations will figure prominently. In the pres-

ent case study, for example, only direct investment in wells was considered, but in a fuller analysis, other factors such as capital destruction by fire or flood, and capital gains and losses from speculation in both lands/leases and oil-related securities would need to be taken into account. Also, did momentum investing in the associated speculative bubbles bring wealth to a few well-placed eastern capitalists and losses to everyone else, or did local landowners derive most profit at the lowest risk? Or again, were some sectors consistently more profitable than others, such as pipelines or transportation? In this context, Miller hints that Rockefeller viewed control over the means of oil transportation as the route to ultimate control of oil supply, and hence stability of prices to ensure good return on investment.⁹⁹ This implies a more complex kind of long-run geographically mediated investment strategy than simply trying to pick sectors with promise of long-term out-performance. Such questions can only be addressed by means of detailed investigation of company records, newspapers, and personal correspondence, using the limited published statistics as background context. Preliminary work of this kind is now in progress, but much more needs to be done before our grasp of regionally-focused investment in nineteenth-century natural resource development can move beyond the anecdotal into systematic and geographically specific understanding.

Conclusions

This study has developed an initial approach to the analysis of factors affecting nineteenth-century behavioral regional investors. Sketching out the “landscape of risk” has indicated changing perceptions depending on local knowledge, personal experiences of areas, and availability of professional scientific opinion. The case study has shown that different categories of risk could assume markedly varying proportions in different geographical areas, such as in the case of the proportion of dry holes to productive strikes. Faulty rules-of-thumb for exploratory drilling were the wild-catters’ equivalent of heuristic-driven bias in behavioral finance, but they were more complex, because the search space was multidimensional, unlike the time series behavior of share prices. Nevertheless, over a period of time, investment capital gravitated progressively to locations perceived as yielding higher returns at lower risk, though not without riding several spatially distinct waves of speculation in the process. However, much more detailed investigation is required before any statements can be made about the extent of departure from a normative efficient allocation of capital resources between competing regions in the nineteenth century.

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