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How an Energy Transition Underlay the Great Depression

by

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ABSTRACT

This paper explains the mechanisms by which a major energy transition produced the US Great Depression. Stock market indices show the 1927–29 Wall Street Bubble was led by petroleum-based technologies—especially airplanes and agricultural machinery. The subsequent crash was triggered by oil discovery. Tractors replacing 32 percent of horses over the course of the 1920s led to a 26 percent increase in the net available farmland for domestic consumption. The oversupply of land lowered farm prices, causing deflation. The deflation was non-uniform, with prices of coal, metals, and building materials—essential for capital formation—rising in real terms. Railroads had hegemonic control over transportation and energy supply; their decline, complicated by technological lock-in, undermined the US financial system, contributing to bank failures. Several statistical tests corroborate the energy transition hypothesis.

KEYWORDS: Great Crash; Wall Street Bubble; Deflation; Coal; Petroleum; Tractors; Airplanes; Railroads

INTRODUCTION

In his introduction to *The Coal Question*, Jevons (1865) made a critical observation on the essential role of energy in economies. He noted, “[c]oal in truth stands not beside, but entirely above all other commodities. It is the material energy of the country—the universal aid—the factor in everything we do. With coal almost any feat is possible or easy; without it we are thrown back into the laborious poverty of early times” (Jevons 1865, 2).

Jevons (1865) proceeded to argue that the era in which he wrote should be known as the *Age of Coal*—rather than that of iron. In other words, coal was an epoch-defining energy carrier.

Anthropologists have subsequently recognized that fundamental societal change occurs when technology alters access to energy (White 1959; Morris 2013). Ecological economists and industrial ecologists also consider energy supply to have profound impacts on economies (Ayres and Warr 2005; Cleveland et al. 1984; Foxon 2017; Georgescu-Roegen 1971; Haberl et al. 2016; Hall and Klitgaard 2011), even though energy is rarely included in conventional macroeconomic theory (Mill 1848; Kennedy 2022).

This article provides a novel perspective explaining the Great Depression as a critical period during which Jevons’ *Coal Age* transformed into the *Oil Age*. Discovery of large oil reservoirs in the late 1920s led to heightened economic growth, after, paradoxically, a period of severe decline in the 1930s (Kennedy 2024). The objective here is to describe the mechanisms by which this major energy transition produced the Great Depression in the US.

Understanding the energy transition—and change in civilization—that occurred during the Great Depression is important for framing humanity’s response to climate change this century. A transformation of global energy systems is required to substantially reduce greenhouse gas emissions (Williams et al. 2012; Kennedy and Corfee-Morlot 2012; Dangelmann and Schnellhuber 2013; Rogelj et al. 2015). Estimates of the costs of addressing climate change are made, yet there is not a well-developed understanding of energy transitions in macroeconomics. Crucially, with rare, brief exception (Galbraith and Ferguson 1999; Galbraith and Chen 2025),

there is no recognition in economics that the Great Depression of the 1930s occurred at the time of the last fundamental energy transition.

Economists have undertaken numerous studies of the Great Depression; historiography of the economics literature suggests it has moved from monocausal to multi-causal explanations (Schiffman 2014). The novel physical perspective of this paper complements and deepens conventional understandings of the Great Depression.

This paper provides new interpretation of five central features of the Great Depression through an energy lens (Table 1). Examination of industry-level stock market indices provides enhanced comprehension of the Wall Street Bubble (1927–29) and the Great Crash. Deeper analysis of investments in key energy technologies—i.e., airplanes, tractors, steam locomotives and motor vehicles—reveals physical mechanisms underlying the deflation, collapse in industrial production, and bank failures that occurred. Statistical evidence corroborating the energy transition hypothesis is then reviewed. No mathematical representation of the Depression is given here due to the differing nature and timescales at which various energy-based technologies impact different markets and sectors.

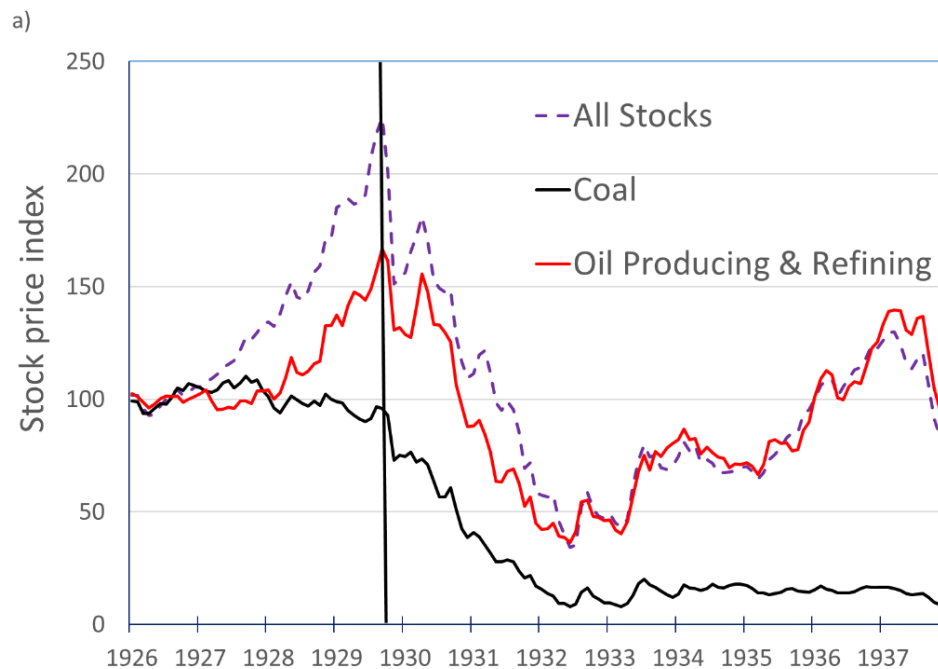
Table 1. Underlying Role of Energy in Five Aspects of the Great Depression, Including Impacts of Coal and Oil-Based Technologies

Aspect of the Depression	Explanation in physical terms
Wall Street Bubble (1927-29)	Led by petroleum-based technology sectors: aviation and agricultural machinery, plus utilities and other stocks
Deflation	Tractors replacing horses produced an oversupply of net farmland. Decline in farm product prices led the overall decline in prices.
Great Crash	Corresponds with oil discovery. Marks a tipping point from the Coal Age to the Oil Age.
Collapse in Industrial Production (& Jobs)	Rising real coal prices—resulting from highly non-uniform deflation—increased the real costs of materials necessary for producing capital assets and consumer durables (amongst other factors).
Bank Failures	Decline of the railroads, exhibited by collapses in railroad bonds and railroad bankruptcies, undermined the banking system (amongst other factors).

A TIPPING POINT FROM THE COAL AGE TO THE OIL AGE

Evidence that the Great Crash of October 1929 can be considered a tipping point into an oil-based age of civilization is first provided by Cowles monthly market indices for the New York stock exchange (Figure 1a). The index for the oil producing and refining sector rose similarly to the index for the overall market prior to October 1929, before collapsing. By 1936, however, the index for oil stocks recovered to its 1926 value, along with the overall market index. Behavior of the index for coal companies was distinctly different; it remained flat before the crash, then dropped by 90 percent with little recovery. The coal index curve resembles a change in phase, or change in state, as observed in the natural sciences.

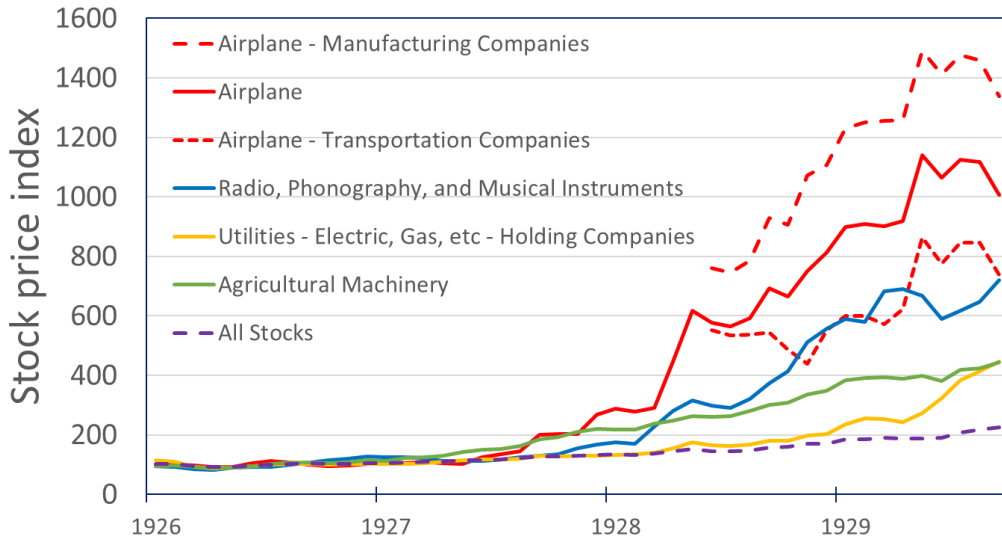
Figure 1a) Cowles' Monthly Stock Price Indices for Sectors of the New York Stock Exchange



Note: The performance of coal stocks and oil producing & refining stocks, 1926 to 1937, suggests the Great Crash of October 1929 was a tipping point from the Coal Age to the Oil Age. Source: data from Cowles (Cowles et al. 1938).

Figure 1b) Cowles' Monthly Stock Price Indices for Sectors of the New York Stock Exchange

b)



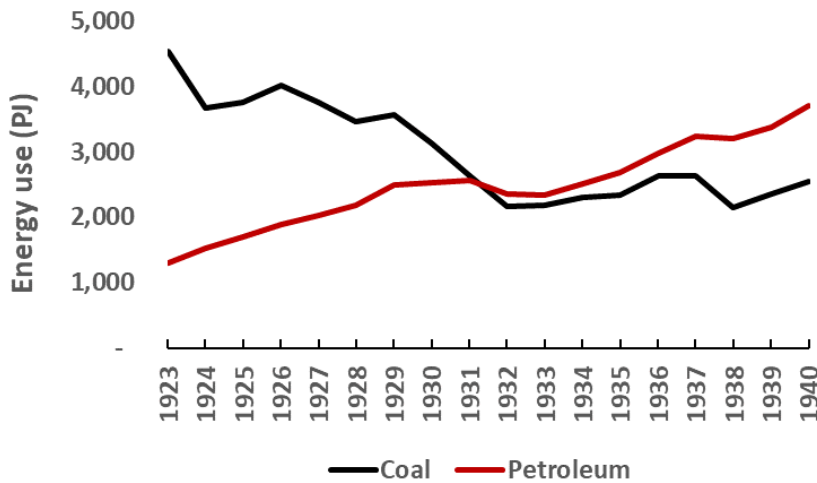
Note: The highest rising stocks, 1926 to September 1929, show a strong role for petroleum-based technologies – airplanes and agricultural machinery – in the ‘Wall Street Bubble.’ Source: data from Cowles (1938).

A close reading of historical newspapers further supports the observation that the Great Crash was a tipping point. In 1920, only 12 percent of US primary energy supply was provided by oil (Schurr et al. 1960). This share grew gradually through the 1920s, but there was a well-recognized shortage of supply, so oil companies stored oil as a hedge against supply shocks (US Geological Survey 1922; US DOI 1926; 1928; Dennis 1985; Olien and Olien 1993). There were major oil discoveries in 1929. Drilling of deeper wells in California led to overproduction, and announcements of oil price cuts averaging 55 percent were made on October 22 and 23 in the *New York Times*. The Great Crash began on October 24, and lasted several days. Moreover, on October 29—Black Tuesday—a further article in the *New York Times* noted that Standard Oil of New Jersey had reversed its long-term policy of storing of oil as a hedge against uncertain supplies. The reason given was that “*the future supply of crude oil was no longer an uncertainty.*” This evidence suggests that oil discovery triggered the crash.

The transition from coal to oil primarily occurred in the transportation sector. Use of petroleum for ground transportation surpassed coal use in petajoule terms in 1931 (Figure 2). The timing

was different in other sectors. Oil was discovered in the nineteenth century; military and industry were early adopters. Coal is still used in the twenty-first century, especially for power generation. The transition in agriculture was from biomass—used to feed horses—to oil.

Figure 2. Use of Petroleum for US Ground Transportation Surpassed Coal in 1931

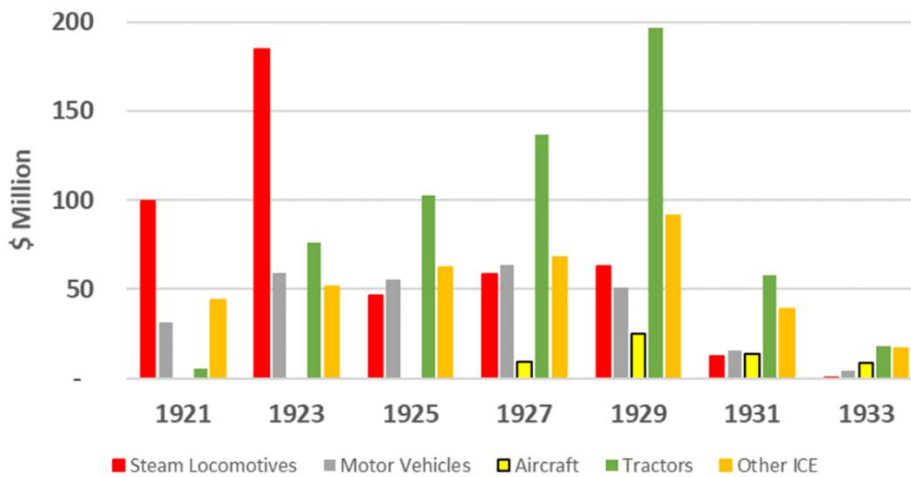


Note: Adapted from Figure 1b in Kennedy (2023)

MECHANISMS UNDERLYING THE DEPRESSION

Biennial data on capital investments in engines, vehicles, and tractors in the 1920s, are key to understanding the mechanisms by which the energy transition caused the Depression (Figure 3). The investment data capture multiple aspects of the transition to oil. In 1923, early in the decade, investment in coal-based steam locomotives exceeded those in petroleum-fueled motor vehicles, tractors, and other internal combustion engines. By the end of the decade, however, investments in steam locomotives had declined, falling below motor vehicles in 1925 and 1927. Notably, investments in tractors substantially grew throughout the decade, and aircraft first appear in the data in 1927. All of these technologies have a role in explaining different aspects of the Depression (Table 1), as we describe further below.

Figure 3. US Investments in Engines, Tractors and Locomotives, 1921 to 1933 (millions of current dollars; ICE = internal combustion engine)



Source: US Census Bureau (1930)

The role of airplanes is linked to the legendary flight of US airmail pilot Charles Lindbergh from New York to Paris on May 20–21, 1927. Lindbergh’s solo flight, winning the Orteig prize, made him an instant celebrity. He then spent the next two years, funded by the US Department of Commerce and Harry Guggenheim, promoting the growth of the US commercial aviation business (Kessner 2010). There was increasing investment in the US plane manufacturing and commercial airlines, from 1927 to 1929, known as the “Lindbergh Boom.” This was a major component of the “Wall Street Bubble.”

Closer inspection of the industrial sectors with the largest stock price increases up to October 1929, shows a dominance of petroleum-based technologies (Figure 1b). Amongst about 60 sectors tracked by Cowles’ (1938) indices, the sector that rose the most in the Wall Street bubble was airplane manufacturers, which went up by a factor of 13.38 from 1926 to September 1929. The next four greatest rising sectors were airplane transportation companies (factor of 7.37); radio, phonography, and musical instruments (factor of 7.21); electric and gas utility holding companies (factor of 4.46), and agricultural machinery (factor of 4.45). Four of the top five were energy-related, with three explicitly exploiting petroleum-based technologies. So, the Wall Street bubble was a technology bubble akin to the dot-com bubble of 1999, though larger.

The role of tractors in the Depression goes beyond their contribution to the Wall Street bubble. The 1920s was a period of rapid evolution in tractor technology (White 2000). Responding to the cost-competitive Fordson tractor, International Harvester developed the first general purpose tractor in 1925, with John Deere adding a power lift in 1927. Other developments in the late 1920s included the first combine harvesters and corn pickers, plus rubber tires. White (2000) showed that the size of farms necessary for tractors to compete with horses, declined from 3,545 acres in 1923, to 1.4 acres in 1930. By 1930, there were 920,000 tractors in the US (US Census Bureau 1960).

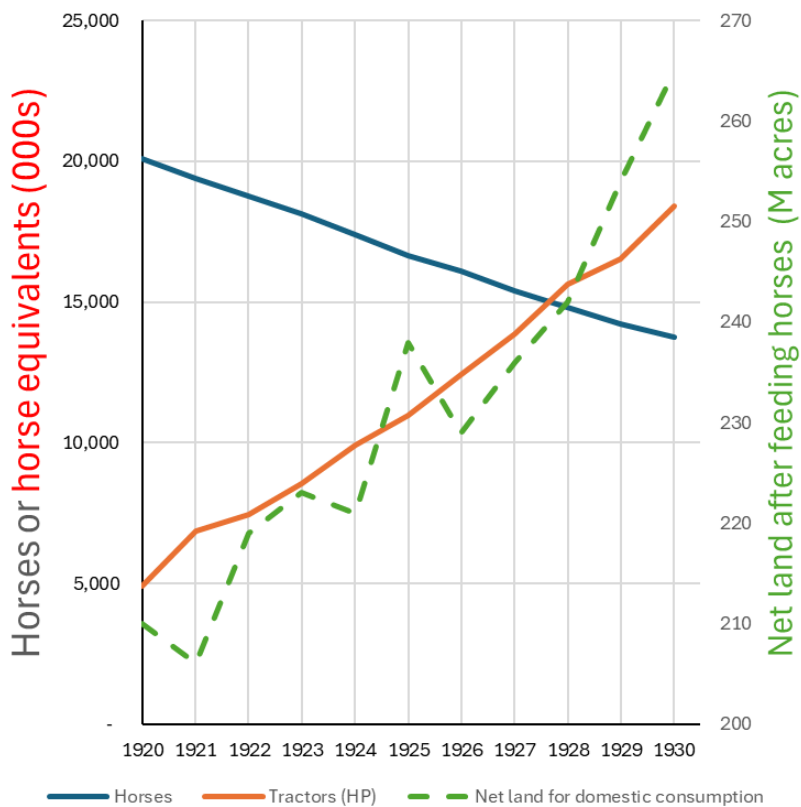
Economics literature has already linked a rapid decline in farm product prices to overall deflation and the wider depression (League of Nations 1931; Davis 1934; Kindleberger 1986; Madsen 2001; Hausman, Rhode, and Wieland 2021; Beaur and Chiapparino 2022). A collapse in global wheat markets, 1929–33, has been attributed to increased wheat acreages, and the accumulation of large wheat stocks following bumper yields in the late 1920s (Davis 1934). Some studies have associated declining consumption by farmers as a cause of reduced demand for industrial products (League of Nations 1931; Hausman, Rhode, and Wieland 2021). Using data from 16 countries, including the US, Madsen (2001) showed that falling agricultural prices explain declines in general prices and output, while substantially contributing to lower consumption and investment.

An important impact of tractors—not well recognized in the economics literature (Federico 2005)—was an increase in the net available farmland (Figure 4). In 1920, there were 20.091 million horses and 5.651 million mules in the US (Census Bureau 1960). Feeding horses and mules required 90 million acres of land in 1920; this was 25 percent of the 360 million acres of harvested crop land. With the growing use of tractors, the horse population declined to 13.742 million by 1930 (mules were relatively unchanged) which increased the “net” farmland for domestic consumption by 55 million acres. Note the land used to grow crops for export also declined by 21 million acres from 1920 to 1930. Horse populations meanwhile decreased in Canada, Australia, Germany, Italy, the United Kingdom, and other countries (Canada Statistics Bureau 1921; 1932). In the US, the net available land for domestic food consumption after

feeding horses increased by 26.2 percent over the 1920s, while the US population only increased by 15.6 percent (US Census Bureau 1960).

With demand for farm products being inelastic (Hausman, Rhode, and Wieland 2021), oversupply of farmland in the US would have contributed to the sharp decline in farm product prices—which was the primary source of deflation (Madsen 2001; Kennedy 2025).

Figure 4. Horses and Tractors on US Farms vs. Net Land for Domestic Consumption (1920–30)



Note: The decline in horses on US farms due to increasing use of tractors produced a 26.2 percent increase in the net available farmland for domestic consumption over in the 1920s. Data on horses, tractors and land is from US Census Bureau (1960); total tractor horsepower, HP, is conservatively estimated based on 20 HP per tractor.

A further important observation is that the decline in prices was highly non-uniform. From October 1929 to February 1933 (a low point in the Depression), prices of petroleum and farm products fell, in real terms, by 42.6 percent and 31.6 percent, respectively (Table 2). The price of bituminous coal, however, went up 32.8 percent in real terms. This is important because coal is

necessary for making steel—and hence many types of capital assets. The real prices of iron & steel and building materials increased by 29.3 percent and 16.7 percent, respectively. Coal, metals, and building materials are essential physical ingredients for capital formation. Their rising cost in real terms would have substantially contributed to the overall problem of declining capital investment, beyond impacts of interest rates or monetary policy from the Federal Reserve. The severe decline in spending on consumer durables (Romer 1990), such as automobiles, can similarly be explained by the rising real cost of materials. O'Brien (1989) also noted that railroad freight prices rose in real terms, increasing the severity of lost manufacturing jobs in the Depression.

Table 2. US Wholesale Price Indices for October 1929 and February 1933

Price Index	October 1929 Nominal	February 1933 Nominal	February 1933 Real
All commodities	96.3	59.8	100
Petroleum products	70.8	34.3	57.4
Farm products	103.9	40.9	68.4
Bituminous coal	92.0	79.4	132.8
Iron & steel	96.8	77.3	129.3
Building materials	97.8	69.8	116.7
Automobiles	109.9	90.9	152.0

Note: Nominal indices from the US Bureau of Labor (1926=100) (US DoL 1931, 1933); real indices from the author based on the all-commodities wholesale price index.

The decline of US railroads was a major structural feature of the energy transition. Olson (1988) poignantly noted, “[t]he railroad crisis transcended the Great Depression; the railroads were in a long-term decline from which they would never recover.” Study of the biophysical structure of US capital assets of 1929 showed the hegemony that railroads held in the economy (Kennedy 2023). In 1929, railroad assets were 24 percent of the non-residential capital stock. More than being the main transportation system, railroads were also the primary energy supply system, moving approximately 70 percent of the energy used in capital formation. The process of transitioning to a petroleum-based transportation system required overcoming lock-in to the incumbent socio-technical regime, in Hughes’ terms (Hughes 1987).

Railroad bonds were also an important component of the US financial architecture. Archival evidence from prominent bankers, time-series analysis of monthly US bank failures and panel data for Massachusetts state banks, indicate that declining railroads substantially contributed to US bank failures in the 1930s (Kennedy and Schiffman 2026).

STATISTICAL CORROBORATION

We now have a cohesive, energy-based hypothesis of how the Great Depression occurred. The hypothesis is supported by about a dozen pieces of evidence, including some elements that have been statistically verified—such as falling agricultural prices leading to deflation (Madsen 2001; Kennedy 2025) and declining output (Madsen 2001); and the role of railroads in bank failures (Kennedy and Schiffman 2026).

Conducting wider statistical tests concerning energy and the whole macroeconomy is more challenging. There cannot be a control experiment whereby no oil is discovered and hence no change in civilization occurs. We can, however, draw upon two studies.

The first is a classic paper in econometrics by Perron (1989) entitled “The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis.” In the paper, Perron used time-series data for 14 macroeconomic variables to show that there were two shock events during the twentieth century (prior to 1989) causing major changes in the underlying patterns of the US economy. The second of the two shocks was the oil crisis occurring in 1973, which clearly related to energy. We can now see that the first shock identified by Perron—the Great Crash—was also related to energy supply. In other words, without realizing it, Perron conducted an advanced econometric test of whether major changes to energy supply can cause significant impacts to the economy—and his results showed they do.

Further time-series analysis using monthly data for the 1930s was used to assess the economic impacts of changing prices for coal, oil and farm products over the decade (Kennedy 2025). Notable amongst the results were observations that changes in real bituminous coal prices

Granger-caused changes to industrial production, household income and money supply. These results follow from recognizing that bituminous coal prices rose in real terms during the first years of the Depression, while real oil prices declined.

IMPLICATIONS

While we have substantial evidence that an energy transition underlay the Great Depression, we should not conclude that all energy transitions necessarily cause depressions. There are aspects of the Great Depression—such as sudden discovery of new oil reserves and a revolution in agriculture—that presumably do not feature in our current *desired* energy transition. Clearly, however, we still have much to learn about the economic impacts of energy transitions.

Further study of energy transitions may be particularly important for understanding lock-in effects. Changes to incumbent socio-technical regimes can be complex (Hughes 1987). In 1929, for example, close to half of refined petroleum products in the US were carried to market by the railroads (Kennedy 2023)—i.e., by the old socio-technical system. Similarities exist today, with large diesel trucks transporting electric cars to vehicle showrooms. Overcoming carbon lock-in is a challenge (Unruh 2000), although the depreciation of capital assets does provide opportunities (Kennedy, Sers, and Westphal 2023).

REFERENCES

- Ayres, R. U., and B. Warr. 2005. "Accounting for Growth: The Role of Physical Work. Structural Change and Economic Dynamics 16 (2) 181–209.
- Béaur, G., and F. Chiapparino, eds. 2022. "Agriculture and the Great Depression: The Rural Crisis of the 1930s in Europe and the Americas." Taylor & Francis.
- Canada, Dominion Bureau of Statistics. 1921 and 1932. *The Canada Year Book*. Ottawa: Acland.
- Cleveland, C. J., R. Costanza, C. A. Hall, and R. Kaufmann. 1984. "Energy and the US economy: a biophysical perspective." *Science* 225(4665): 890-897.
- Cowles, A. and Associates. 1938. *Common-stock indexes 1871-1937*. Principia Press Inc. Bloomington, Indiana.
- Dangerman, A. J., and H. J. Schellnhuber. 2013. "Energy systems transformation." *PNAS* 110(7), E549-E558.
- Davis, J. S. 1934. "Wheat, Wheat Policies, and the Depression." *The Review of Economic Statistics*: 80-88.
- Dennis, M. A. 1985. "Drilling for dollars: the making of US petroleum reserve estimates, 1921-25." *Social Studies of Science* 15(2): 241-265.
- Federico, G. 2005. "Not guilty? Agriculture in the 1920s and the Great Depression." *The Journal of Economic History* 65(4): 949–76.
- Foxon, T. J. 2017. *Energy and Economic Growth: Why We Need a New Pathway to Prosperity*. Routledge.
- Galbraith, J. K. and J. Chen. 2025. *Entropy Economics: The Living Basis of Value and Production*. University of Chicago Press.
- Galbraith, J. K. and T. Ferguson. 1999. "The American wage structure, 1920-1947." *Research in Economic History* 19(2): 205–57.
- Georgescu-Roegen, N. 1971. *The Entropy Law and the Economic Process*. Cambridge, Massachusetts: Harvard University Press.
- Haberl, H., M. Fischer-Kowalski, F. Krausmann, and V. Winiwarter, eds. 2016. *Social Ecology: Society-Nature Relations Across Time and Space* (Vol. 5). Springer.
- Hall, C. A. and K. A. Klitgaard. 2011. *Energy and the Wealth of Nations*. New York: Springer

- Hausman, J. K., P. W. Rhode, and J. F. Wieland. 2021. "Farm product prices, redistribution, and the early US Great depression." *The Journal of Economic History* 81(3): 649–87.
- Hughes, T. P. 1987. "The Evolution of Large Technological Systems," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, edited by B. Wiebe, T. P. Hughes, and T. Pinch. Cambridge MA: The MIT Press.
- Jevons, W. S. 1865. *The Coal Question: An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of our Coal-Mines. 1st Edition*, London: Macmillan.
- Kennedy, C. 2022. "The intersection of biophysical economics and political economy." *Ecological Economics* 192: 107272.
- Kennedy, C. 2023. "Biophysical Economic Interpretation of the Great Depression: A Critical Period of an Energy Transition." *Journal of Industrial Ecology* 27 (4): 1197–211.
- Kennedy, C. A. 2024. "Energy constraints on macroeconomic paradigms." *Ecological Economics* 226: 108361.
- Kennedy, C. A. 2025. "Oil discovery, energy transition, and the decline in wholesale prices during the Great Depression." *Journal of Industrial Ecology* 29(1): 233–45.
- Kennedy, C. A., M. Sers, and M. I. Westphal. 2023. "Avoiding investment in fossil fuel assets." *Journal of Industrial Ecology* 27(4): 1184–96.
- Kennedy, C., and J. Corfee-Morlot. 2012. "Mobilising Investment in Low Carbon, Climate Resilient Infrastructure." OECD Environment Working Papers, (46), 0_1.
- Kennedy, C.A. and D. Schiffman. 2026. "Did 'the Railroads' Cause US Banks to Fail in the 1930s?" *Journal of Transport History*, <https://doi.org/10.1177/00225266261444718>
- Kessner, T. 2010. *The Flight of the Century: Charles Lindbergh and the Rise of American Aviation*. Oxford University Press.
- Kindleberger, C. P. 1986. *The World in Depression 1929-1939*. Los Angeles: University of California Press.
- League of Nations. 1931. *Report of the Economic Committee on the Agricultural Crisis*. No. C 239. M. 105. 1931. II. B. Geneva.
- Madsen, J. B. 2001. "Agricultural crises and the international transmission of the Great Depression." *The Journal of Economic History* 61(2): 327–65.
- Mill, J. S. 1848. *Principles of Political Economy with some of their Applications to Social Philosophy*, 7th edition, edited by W. J. Ashley in 1909. Longmans: London

- Morris, I. 2013. *The Measure of Civilization: How Social Development Decides the Fate of Nations*. Princeton University Press.
- O'Brien, A. P. 1989. "The ICC, freight rates, and the Great Depression." *Explorations in Economic History* 26(1): 73–98.
- Olien, D. D. and R. M. Olien. 1993. "Running out of oil: discourse and public policy, 1909-1929." *Business and Economic History*, 36–66.
- Olson, J. S. 1988. *Saving Capitalism: The Reconstruction Finance Corporation and the New Deal, 1933-1940*. Princeton, NJ, Princeton University Press
- Perron, P. 1989. "The great crash, the oil price shock, and the unit root hypothesis." *Econometrica: Journal of the Econometric Society*, 1361–401.
- Rogelj, J., G. Luderer, R. C. Pietzcker, E. Kriegler, M. Schaeffer, V. Krey, and K. Riahi. 2015. "Energy system transformations for limiting end-of-century warming to below 1.5 C." *Nature Climate Change* 5(6): 519–27.
- Romer, C. D. 1990. "The great crash and the onset of the great depression." *The Quarterly Journal of Economics* 105(3): 597–624.
- Schiffman, D. A. 2014. The Economic Historiography of the Great Depression (1929–1933). A Companion to Warren G. Harding, Calvin Coolidge, and Herbert Hoover, 417–443.
- Schurr, S. H., B. C. Netschert, V. F. Eliasberg, J. Lerner, and H. H. Landsberg. 1960. *Energy in the American economy, 1850-1975*.
- Unruh, G. C. 2000. "Understanding carbon lock-in." *Energy Policy* 28(12): 817–30.
- US Bureau of the Census. 1960. *Historical statistics of the United States, colonial times to 1957*. U.S. Government Printing Office, Washington D.C
- US Census Bureau Statistical Abstract. 1930, No. 819 and 1935, No. 774: Investments in "Engines, Water Turbines, Tractors and Locomotives"
- US Department of Labor. 1931, 1933. Wholesale Prices 1930, Bulletin of the United States Bureau of Labor Statistics., No. 543, September 1931; and April 1933
- US Department of the Interior. 1926. Report of the Federal Oil Conservation Board to the President of the United States, Part 1, Office of the Federal Oil Conservation Board, Washington, DC

US Department of the Interior. 1928. Report II of the Federal Oil Conservation Board to the President of the United States, Office of the Federal Oil Conservation Board, Washington, DC

US Geological Survey. 1922. "The oil supply of the United States." *AAPG Bulletin* 6(1): 42–46.

White III, W. J. 2000. "An unsung hero: the farm tractor's contribution to twentieth-century United States economic growth." PhD thesis. The Ohio State University.

White, L. 1959. "The Energy Theory of Cultural Development," Chapter 9 in *Readings in Anthropology, Vol 2.*, edited by M. H. Fried. New York: Cromwell

Williams, J. H., A. DeBenedictis, R. Ghanadan, A. Mahone, J. Moore, W. R. Morrow, ... & M. S. Torn. 2012. "The technology path to deep greenhouse gas emissions cuts by 2050: the pivotal role of electricity." *Science* 335(6064): 53–59.