Stalemate in Technology, 1925-1935: The Interplay of Stagnation and Innovation

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Real-Economic Stagnation

In the last few years, as the economic crisis has progressed "from stagflation to slumpflation" (Professor Milton Friedman in his Nobel Lecture), there has been renewed interest in crisis theory and empirical studies on the stagnation in the 1930's; and who did best in economic forecasting? He who dared to venture into using the Kondratieff cycle for projecting the decreasing growth rates of consumption, investment, employment, and production.

Similarly, at first sight, but profoundly different from the Kondratieff model, is the metamorphosis model of the interplay of stagnation and innovation[1], with the help of which we shall try to explain the real-economic, long-term, evolutionary change in the industry structure of developed nations. Without committing the folly of monocausality, but for the sake of stressing the significant explanatory power of what Schumpeter called the (evolutionary) "Process of Creative Destruction"[2], we propose that most of the in-equilibrium trends, and specifically – the shifts in trend, which have been observed during and since the Industrial Revolution[3], can be traced to changes in the rate and direction of technological innovation.

Our proposition requires first the distinction of types of industrial innovations and then makes statements of the relative order of magnitude of these types of change over time.

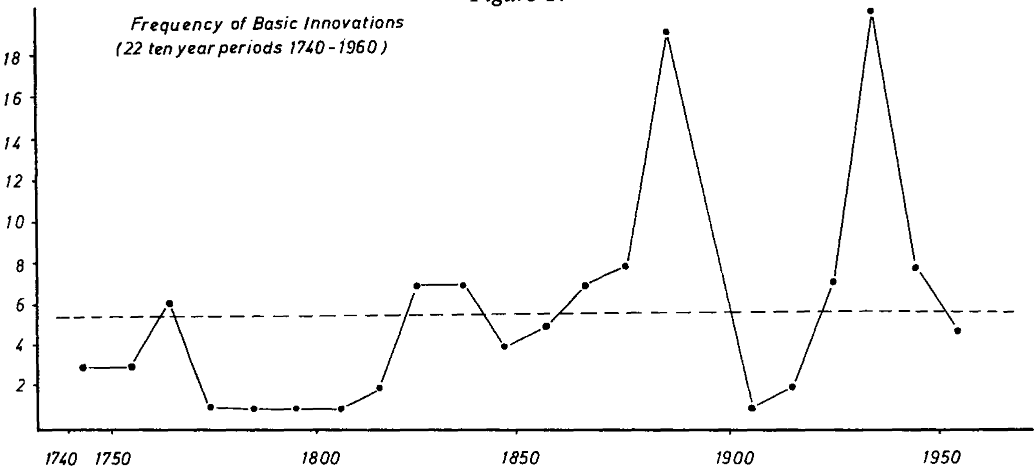
P 1: Technological *basic innovations* create new markets and new industrial branches. And basic innovations occur in clusters (see *Figure 1*).

P 2: *Improvement innovations* in established industrial branches occur in series. And the improvement effect of successive improvement innovations is governed by

1 Mensch, Gerhard, *Stalemate in Technology*, Cambridge, Mass., Ballinger 1979.
2 Schumpeter, Joseph A., *Capitalism, Socialism and Democracy*, New York: Harper & Row, 1942.
3 Freudenberger, Herman, und Mensch, Gerhard, *Von der Provinzstadt zur Industrieregion, Ein Beitrag zur Politökonomie der Sozialinnovation, dargestellt am Innovationsschub der Industriellen Revolution im Raume Brünn*, Göttingen: Vandenhoeck & Ruprecht, 1975.

a law of first increasing and then diminishing marginal return to the supplier; and for the user it is governed by a law of first increasing and then diminishing marginal utility.

Figure 1:



Source: Mensch, G., Das technologische Patt, a.a.O.

Consequently, as a corollary of P 1 and P 2, and under the assumption that the diffusion of innovation in many growth sectors is interrelated by a "Veblen Effect" (that is, by technical complementarity or psychological complementarity via reference groups), we may conjecture: There should be a phase in industrial development in which many sectors of the economy simultaneously suffer from stagnation, which is the joint effect of diminishing marginal returns and of diminishing marginal utility attached to that group of goods and services which have become the reference items for an affluent society.

This phase in the industrial evolution, which is often attempted to be partially explained by theories of overproduction, underinvestment, underconsumption, overconcentration, and underemployment, is called "Stalemate in Technology". It begins when many lines of business based on mature technologies turn stagnant, capital withdraws from it but cannot (temporarily) find profitable reinvestment opportunities in new types of technology, and while stagflation indicates structural readiness for radical innovations, these don't emerge instantly, don't come in the right time and place, and don't "fall from the sky" in the most convenient quantity and quality. Eventually, the mounting need for innovation produces a swell of basic innovations, and that highlights the recovery and puts an end to the stalemated situation.

Thus, there is a real-economic, circular phenomenon P1 – P2 – P1– P2 underneath the secular trends in production and prices. There is a pattern in structural change which characterizes the process of creative destruction. Even if there were not the well-known and often discussed methodological flaws in describing this structural change as "secular trends in production and prices", these indicators, since they are symptoms, will never be powerful indicators of the underlying phenomenon: Imbalanced technological change. "In analyzing history, do not be too profound, for often the causes are quite superficial", Emerson wrote. In this sense of obviousness, much of this pattern of structural change is caused by and is the after-effect of clusters of basic innovations. Thus, the stagnation in the 1920's is to a large extent due to (temporary) maturation of technology that came into practice in a clustering fashion in the decade around 1886; and the wheel turned with the emergence of another cluster of basic innovations and the swell of brand new technology, which, in the years around 1935, appeared on the scene en mass: New means of transportation and related technology (helicopters, 1936, rockets, 1935, diesel-locomotives, 1934, jet engines, 1941, and many supporting innovations as the radar, 1934, hydramatic transmissions, 1939, hydraulic clutches, 1937, power steering, 1930, catalytic petrol cracking, 1935, no-knock gasoline, 1935); new means of communication and related technology (TV, 1936, magnetic taperecording, 1937, Kodachrome, 1935); new materials (plexiglas, 1935, neoprene, 1931, nylon, 1938, wrinkle-free fabrics, 1932, titanium, 1937), and, of course, new weapons.

Basic Innovation and Industrial Evolution

Rather than understanding the stagnation of 1925–1935 and the great Depression as accident in the regular course of economic history, we suggest to view it as a regular phenomenon occurring in due course of industrial evolution. Stagnation of growth in old branches of industry and the genesis of new branches seem to have some "seasonal" dynamic which spans periods of two human generations or so (the Metamorphosis Model).

This thought is reflected in Simon Kuznets' definition of an *epochal innovation,* that "may be described as a major addition to the stock of human knowledge which provides a potential for sustained economic growth – an addition so major that its exploitation and utilization absorb the energies of human societies and dominate their growth for a period long enough to constitute an epoch in economic history"[4]. Stagnation, then, is the "natural" autumn after the summer's rich harvest, and in this sense, the 1920s may have been the fall of the epoch that began with the cluster of basic innovations in electricity, chemistry and other industrial sectors in the years around 1886.

Apparently, Alfred Chandler was the first to use the term "basic innovations", and the way he uses that term sheds light on our suggestion that the Great Depression was a "natural" (but may be unnecessarily harsh) "season" in the regular course of industrial evolution in the period after the "Great Depression of the 1880s"[5]. Chandler refers to the changes during the 20 to 25 years before 1903". In that period, the basic innovations were more in the creation of new forms of organization and new ways of marketing. The great modern corporation, carrying on the major industrial processes, namely, purchasing, and often production of materials and parts, manufacturing, marketing and finance – all within the same organizational structure – had its beginnings in that period. Such organizations hardly existed, outside of the railroads, before the 1880s. By 1900 they had become the basic business unit in American Industry"[6].

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4 Kuznets, Simon, *Modern Economic Growth,* New Haven: Yale University Press, 1966, 6th ed. 1973, p. 2.
5 Rosenberg, Hans, *Große Depression und Bismarckzeit,* Berlin: DeGruyter, 1967.
6 Chandler, Alfred, *The Beginnings of "Big Business" in American Industry,* in: Business History Review, 23 (1959), p. 1–31.

We find it hard to believe that this powerful business structure could have been pushed into stagnant performance in the 1920s and subdued to depressed behavior in the 1930s by any kind of monetary policy; only endogenous factors – structural inflexibility and offering less wanted goods and services to the public seem to us promising lines of investigation into the causes of the structural crisis 1925–35. These factors we shall now deal with briefly.

"Did Monetary Factors Cause the Great Depression?"

This question, the title of a recent book by Peter Temin[7], is now in place, as the monetarist's supposition is the nullhypothesis to our proposition. Temin, looking again into the monetary records of the United States, concluded from his study: "The proposition that monetary forces caused the Depression must be rejected." For two reasons: "Firstly, if there had been deflationary monetary pressure, it would have to be visible in the financial markets", which it was not. "Secondly, although the nominal stock of money fell in 1930 and 1931, prices fell also ... If the fall in the nominal stock of money was deflationary, prices were sufficiently flexible to absorb this pressure".

Underinvestment? Underconsumption!

Although the theory of vanishing investment opportunities (of A. Hansen, et al.), if taken as a temporal phenomenon of (know-how) factor immobility and frictional labor and capital unemployment, is very much in line with our proposition of technological stalemate, it does not really seem to explain the stagnation and depression in the period 1925–35. At least; in the US, firms kept investing in traditional, low profit sectors – having no better alternatives at hand than very risky paper investments, as the opportunities for investment in profitable new technologies did not emerge for a while in sufficient volume. In Germany, by contrast, private net investment fell below zero, disinvestment outweighing expenditures for new plant and machinery. Thus, in the US, "The Depression was not caused by a dramatic collapse of investment" (Temin), and in Germany, the fall of investment was rather the effect than the cause of depressive circumstances.

According to our understanding of the underlying structural crisis, investment was sluggish as a result of stagnant consumers' demand, which was caused by a mismatch of quality of supply and shifted needs of the people. This view accords with Temin's, who concluded:

> "At the current state of our knowledge, the unexplained fall in consumption is larger than the part we can explain (by monetary factors, G.M.), but the magnitude of the total fall is incontrovertible. The large decline in consumption expenditures for both durable and nondurable goods in 1930 had a profoundly depressing effect for the economy"[8].

Sharing the opinion of Peter Temin, we cannot for example agree with Gottfried Haberler, who attests to "the overwhelming importance of the monetary factor" in his 1976 paper on "The World Economy, Money, and the Great Depression 1919–1939". Our conjecture is,

7 Temin, Peter, *Did Monetary Factors Cause the Great Depression?*, New York: Norton & Co., 1976.
8 Temin, Peter, *Monetary Factors*, p. 172.

that in the 1920s, as in the decade between 1966 and 1975, structural reasons have caused consumer's abstinence more than anything else. If the presence teaches something for understanding history, for which the pertinent data is unavailable, why not look at recent events:

1. The Michigan Index of Consumer Sentiment in the US between 1956 and 1975 rose steadily up to 1966 = 100. Then it dwindled down to 40 by 1970 and fell – with a short upswing 1971 and 1972 – as deeply as below 10 by 1975. (The law of diminishing marginal utility governing demand for mass-produced consumer goods in satiated markets; proposition P2.)
2. Between 1968 and 1974, all consumer goods twice tested by the Stiftung Warentest in Germany have been checked for quality improvements (functional innovations); of the 66 product groups that had been tested at least twice, comparison shows that in two-thirds of the product groups there was no functional improvement (the new thing does no more for the user than the older vintage model did); only in one-third of the consumer goods was there an inducement to switch to the newest thing. (The law of diminishing marginal return governs supply of innovation in mass-produced goods and services in technologically mature markets; again proposition P2.)

Clearly, these structural reasons for wait and see and not buy came long before the crisis of 1973, which is the entry point of the monetarist hypothesis that the go slow on buying consumer goods was caused by job insecurity, shortage of disposable income, and other signs of crisis. In fact, the unfavorable consumer sentiment reached back to the super-boom of 1967 and 68; a pattern which might well provide an analogy for the causes of the fall in consumption before and during the Great Depression 1925–35.

Therefore, the underinvestment theory is weak if it is based on lack of finance due to a shortage of investable money. It can be strengthened if based on lack of profitable investment projects given large capacities in traditional lines of business, satiated demand in those markets, low rates of capacity utilization, on one side, and the unfulfilled desire of the people to buy something else than offered in gracious plenty.

The Imbalanced-Technical-Change-Hypothesis (ITCH)

Learning from recent events, when data is available, and formulating a conjecture about how it might have been in the twenties, when the data is unavailable we proceed to the Imbalanced-Technical-Change-Hypothesis (ITCH).

It builds on a further distinction between types of innovative investment projects:

Type E: (expansionary innovations)
: product innovations or service innovations, which by their improvement effect (in price or quality) mobilize potential demand for consumer goods and services; private and/or public;

Type R: (rationalizing innovations)
: process, product or service innovations in capital goods producing sectors of the economy, where by their improvement effect they allow for a more efficient use of raw materials, manpower, and other cost factors.

While our proposition P2 says, that the intrasectoral sequence of innovations will eventually offer less and less attractive change opportunities for producers and users, our imbalanced-technical-change-hypothesis is a cross-sectional statement and says:

P3: The ratio of expansionary innovations and rationalizing innovations changes over time.

(A) A cluster of basic innovations makes the E/R ratio step up;

(B) As the series of improvement innovations run their course, the E/R ratio goes down.

The last sentence (B) clearly is compatible with the "capital theory of technological progress", which holds the labor-cost saving motive responsible for the direction of technical change; however, this theory is clearly in contradiction with the sentence (A). As the reswitching debate goes in capital theory, it fails to grasp the point that high wages and low interests don't induce reswitching to older (more labor intensive) technologies but induce the propensity to switch to brand new, radically different technologies: basic innovations. And the critical aspect of this reallocation problem is the temporary unavailablility of safe, useful, agreeable new technologies.

Summarizing our propositions, we suggest that stagnation in industry, in the last decade, is, and in 1920s probably was, caused by a sluggish rate of really useful and profitable improvement innovations which, furthermore, went too far into the cost and labor saving direction and too slowly into the utility and labor augmenting direction.

Next, we present some data for illustrating the conjecture. And then, assuming this conjecture to be valid, we show by means of the mathematics of catastrophy theory that such a sluggish and disequilibrating rate and composition of "progress" produces structural instability, implies a considerable probability of breakdown, and produces structural readiness for basic innovations, and recovery along rather different lines of enterprise.

Imbalanced Technological Change Analysis

Ever since Ricardo expressed it in his famous chapter "On Machines", the ITCH-hypothesis has emerged, submerged and reemerged as economic history ran its course. In periods of "distress" (as they said in Ricardo's times), technological change has always been blamed for its labor saving effects; only in good times was it à la mode to speak of various ways by which innovation may be classified as "neutral". If occasionally as in Fellner's article on the direction of innovation, the possibility of an imbalanced technological "progress" was discussed:

- "... a high rate of innovation could not continue for very long if it became associated with a sufficiently pronounced maldistribution of the factor-saving effects".
- "We are, I believe, living in an era of accelerated innovation, and such an era could become one of increasingly pronounced difficulties as a result of the overshooting of the labor-saving or of the capital-saving effect"[9].

The possibility of it having a lasting effect on the economy and society was quickly discarded as highly unlikely:

- "But ... I believe that in this regard economic theory supports optimistic views much more nearly than pessimistic ones"[10].

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9 Feller, William, *Profit Maximization, Utility Maximization, and the Rate and Direction of Innovation,* in: American Economic Review, Papers and Proceedings, Vol. LVI (1966), pp. 24–32.

10 Fellner, William, *Profit Maximization,* p. 32.

Imbalanced Technological Change and Stagnation: Empirical Evidence

The ITCH-hypothesis with respect to series of improvement innovations (proposition P3, sentence 'B') has found strong support in the findings of the "Science-Indicator-Group", in which one of the authors participated. Classifying 322 improvement innovations which happened in the period 1952–1973 according to E-Type and R-Type, we found a somewhat even flow of expansionary innovations coupled with a rising tide of rationalizing innovations in this period (*Table 1*). Thus, the expansionary effect of demand-inducing innovations was more and more offset by the factor-saving effect of R-type innovations, with obvious consequences to macro-economic growth: it stagnated.

Table 1:

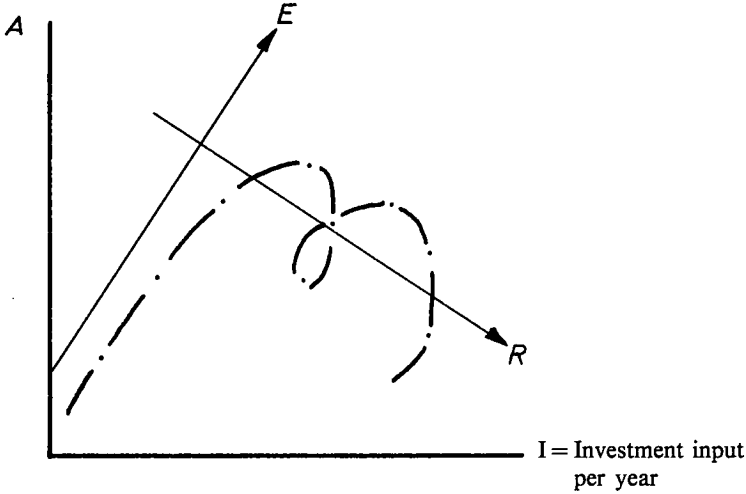
Period	Type of Innovation		E / R
	Expansionary	rationalizing	
1952 - 54	29	36	
1955 - 59	8	33	.54
1960 - 64	18	44	.41
1965 - 69	12	55	.22
1970 - 73	17	70	.24
TOTAL	84	238	

In Germany, real industrial growth between 1970 and 1976 was only 2 percent, but it was achieved with a labor force that shrank by 13 % as the ratio of E/R – investments in Germany (measured by the Ifo-Test) dropped significantly. Between 1970 and 1976, the proportion of E-type investments went down from 55 % (1970) to 18 % (1976), whereas the proportion of R-type investments went up from 33 % to 57 %. The observed shifts in the investment structure are highly correlated to the observed shifts in the mix of innovations. This data illuminates the interplay between innovation and stagnation. By analogy, we conjecture that the same interplay existed in the 1920s and produced structural instability and structural readiness for E-type innovation in the 1930s.

Imbalanced Technological Change and Structural Instability: Analysis

There is a rather direct way to test the ITCH. The procedure is explained in *Figure 2.* One can depict the input of investment capital (I) and the input of labor hours (A) by a string of points (A, I) over time. Over time, for the period 1950–1976, this string of points forms a spiral. This pattern we found for German data to hold even under regional and

Figure 2: Workhour- and Investment-Input in Industrial Sectors



sectoral disaggregation; and this spiralling pattern also holds for US-data 1900 to 1941 (see *Figure 3*).

We may assume that all the technological and organizational innovations which were embodied by the stream of investments have guided the (A, I) path into the spiraling pattern, whereby in the upswing periods the effect of E-type innovations and investments outweigh the effect of R-type innovations and investments. E und R may be considered the "control variables" in the process of structural change of the industrial apparatus.

These "controls" or "guidances" as can be seen from *Figure 2*, operate such that E is proportionate to A and I while R is proportionate to I but disproportional (laborsaving) to A. Thus, we obtain simple linear rules for transformation of coordinates:

$$E(A,I) = p_1 A + q_1 I + e$$
$$R(A,I) = p_2 A + q_2 I + r$$

where p_1 (d), p_2 (d), q_1 (α), q_2 (α) are all sinus-cosins-functions of the degree of turning (α) and e and r are the trans locations of the origin (0,0). For the best fitting degree of turning (α = 38°) and e = 0 and r = 1, we obtain E (A, I) and R (A, I) as given in *Table 2*.

The computed E/R-ratio given in the *Table 2* reveals: during the 3 decades prior to the crisis 1929/1930, and with the only exception of the pre-war boom of military contract work, the E/R-ratio went down. If the expansionary period 1900–1916 must be considered balanced by a E/R-ratio in the order of magnitude 30, the war period is characterized by bringing the E/R-ratio down to a fourth of that value, whereas the drop to about one-tenth of the original magnitude must be taken as a sign of too few expansionary and too many rationalizing innovations in the decade before 1930.

By analogy, again: The E/R-indicator for imbalanced technological change in the period 1950–1976 performs well: We found a high correlation of the E/R-ratio computed from E

Table 2: USA 1900–1934

INVESTMENT AND LABOR INPUTS GUIDED BY E- and R-TYPE INNOVATION

Year	A	I	E	R	E/R	Average E/R
1900	2,83	1,22	3,03	0,18	16,83	
01	3,07	1,30	3,22	0,13	24,76	
02	3,31	1,49	3,52	0,13	27,07	
03	3,40	1,44	3,57	0,04	89,25	
04	3,22	1,39	3,40	0,11	30,90	37,8
05	3,50	1,57	3,73	0,09	41,44	
06	3,73	1,91	4,12	0,21	19,61	
07	3,78	2,11	4,28	0,33	12,96	
08	3,35	1,82	3,76	0,37	10,16	
09	3,90	1,99	4,30	0,17	25,29	21,9
1910	4,01	2,04	4,42	0,14	31,5	
11	4,04	1,94	4,37	0,04	109,2	
12	4,26	2,15	4,68	0,07	66,85	
13	4,38	2,38	4,92	0,18	27,33	
14	4,05	2,04	4,45	0,12	37,08	54,4
15	4,00	2,01	4,39	0,12	36,58	
16	4,65	2,62	5,27	0,20	26,35	
17	4,74	3,05	5,61	0,48	11,69	
18	4,79	3,21	5,75	0,68	8,45	
19	4,95	3,70	6,18	0,86	7,18	18,o5
1920	5,07	4,77	6,93	1,64	4,22	
21	3,56	2,95	4,63	1,13	4,09	
22	4,03	3,56	5,36	1,33	4,03	
23	4,70	4,64	6,56	1,77	3,70	
24	4,22	4,46	6,06	1,91	3,17	3,8
25	4,42	4,95	6,53	2,19	2,99	
26	4,57	5,11	6,75	2,22	3.04	
27	4,49	4,84	6,52	2,05	3,18	
28	4,41	4,79	6,42	2,06	3,11	
29	4,73	5,60	7,17	2,50	2,86	3,o
1930	4,02	4,37	5,86	1,97	2,97	
31	3,30	2,75	4,29	1,13	3,79	
32	2,65	1,56	3,05	0,60	5,08	
33	2,81	1,53	3,15	0,48	6,56	
34	2,94	2,20	3,67	0,92	3,99	4,5

Legend: A = Average weekly working hours of employees in manufacturing (in 10^8 man hours)

Source: Historical Statistics USA, Series D 13o, D 8o3, D 765

I = Private domestic investment in producers durable equipment (in 10^9 \$ current/prices)

Source: Historical Statistics USA, F 56, ab 1929 eigene Berechnungen vgl. Series P 299

(A, I), R (A, I) and the E/R-ratio observed from the huge sample of innovations. Thus, we assume, for the period 1900–1934 similar E/R-ratios would be observable if one only would collect sufficiently many cases, which is not impossible but impractical.

For the time being, we may judge the ITCH-phenomenon well testified by the calculated E/R-ratio. Ergo: The *Imbalanced Technological Change Hypothesis* explains the stagnation trend observed in the years before 1929/30.

a) *A Model of Systems Breakdown*

If the socio-economic system is gradually changed by some rate of innovation, *the system becomes more and more structurally unstable if the direction of innovation is systematically imbalanced by a low E/R-Ratio.*

Table 3: E/R-ratio 1800–1950

	Period	BASIC Innovat. 1	ratio of E-expansionary to R rationalizing Basic - Innovation 2	3	4
			total period	two periods	
1	18oo - 185o	21	18oo - 185o 13 E : 8 R	before 1825 4 E : 5 R	after 1825 9 E : 3 R
2	185o - 19oo Electrotechnical Industry	22	185o - 19oo 11 E : 11 R	before 1876 3 E : 3 R	after 1876 8 E : 8 R
3	185o - 19oo Chemical Industry	28	185o - 19oo 17 E : 11 R	5 E : 6 R	12 E : 5 R
4	185o - 19oo Total of 3 and 4	5o	28 E : 22 R	8 E : 9 R	2o E : 13 R
5	19oo - 195o	5o	19oo - 195o 25 E : 25 R	before 1925 5 E : 8 R	after 1925 2o E : 17 R

Source: All basic innovations published in G. Mensch, Das technologische Patt, Frankfurt 1975, have been classified in E-type ("exponsionary") and R-type ("rationalizing") by a team of 12 collegues at the International Institute of Mangagement, Berlin, whom we are grateful to for their help.

This can be easily demonstrated by choosing a type of production function P (A, I) which allows for turning points to occur. We find such a production function on the assumptions that –

1) production (P) ist the output of some maximizing process operating within the boundaries of the current production potential V (P, I, A), and
2) both this potential V and the effective output P are dependent on inputs I and A which in turn are prearranged for by E-and R-type innovative investments.

By Taylor expansion of V about P, I, A, where P is both the disposition variable, and an output parameter, I and A are input parameters, we obtain

$$V (P, I, A) = 1/4\ P.P^3 + 1/2\ IP^2 + AP + \text{constant}$$

Under maximization, if the disposition variable P is used to measure the maximal production given at any time,

$$\frac{dV}{dP} = -P^3 + IP + A = 0$$

which is a very simple looking production function P (I, A). But it suffices as an approximation[11] to establish the crucial point: *Such a production process,* where the parameter I and A *depend on control variables* E and R that have gone off balance, *is structurally unstable.*

Structural instability – in this particular model of a production process – comes in by way of a splitting variable; I in this case: innovative investment can either expand or intensify the process, and if I (E, R) develops over time such that with increasing R there is only constant or even decreasing E, then innovative investments become critically one-sided. As I enters as a parameter to the quadratic terms of V (P, I, A), it produces a bifurcation set in the (A, I) plane (see *Figure 3*).

This bifurcation set is defined as a set of points (A, I) which are such parameter constellations that for all points (A, I) in this set,
1) V (P, A, I) has turning points (the second order derivative vanishes) and
2) V (P, A, I) has two maxima P (A, I), so that over the bifurcation set the production function is folded.

Consequently, under stress or disturbance, such a structurally unstable process can yield high or low output P with the same input (A, I) or may squeeze out a whole range of inputs without much drop in output. In dynamical terms, either or both may happen if the time path of points (A, I) – see *Figure 3* – passes over the lower bound of the bifurcation set. In the post-war years 1920/1921, this break-down situation in the US industry may just have approached this limit of stress endurance; but the system seems to have absorbed the post-war adjustment disturbances. In the years 1921/1931 the socio-economic system of the US might well already have become so inelastic that it could not take the exogenous shocks which came from overseas from Europe and Latin America – needless to say, partly by way of feedback to American crisis management (protectionism, monetary policy, etc.[12]). For German data see *Figure 4*.

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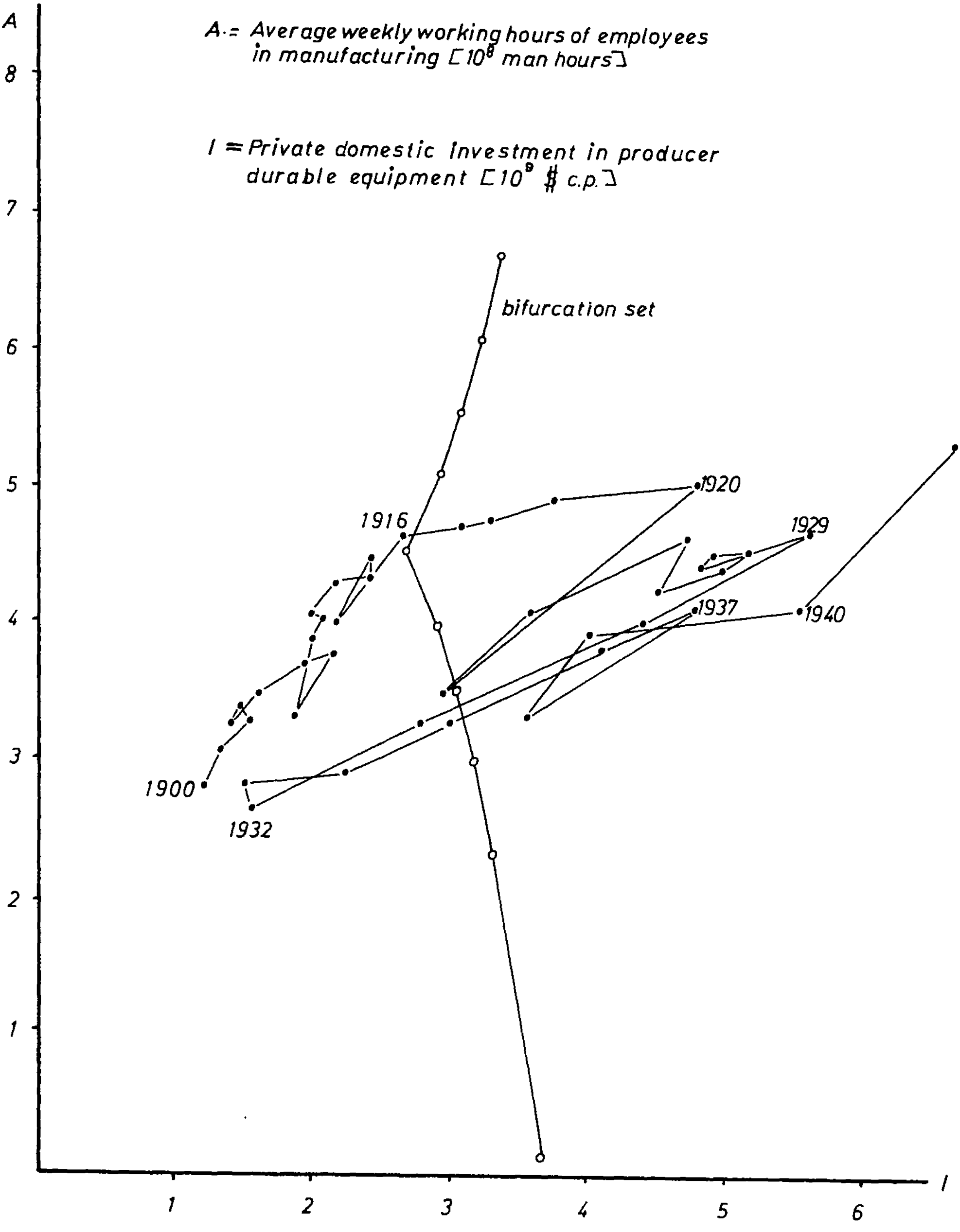
11 The correlation coefficient between A and I (–0.0919) and between A and P (–0.002) is about zero (no autocorrelation), but the correlation coefficient between P computed as P (A, I) and P observed is nearly one (0.9776). Hence, our production function is both meaningful and a good approximation of the empirical facts.

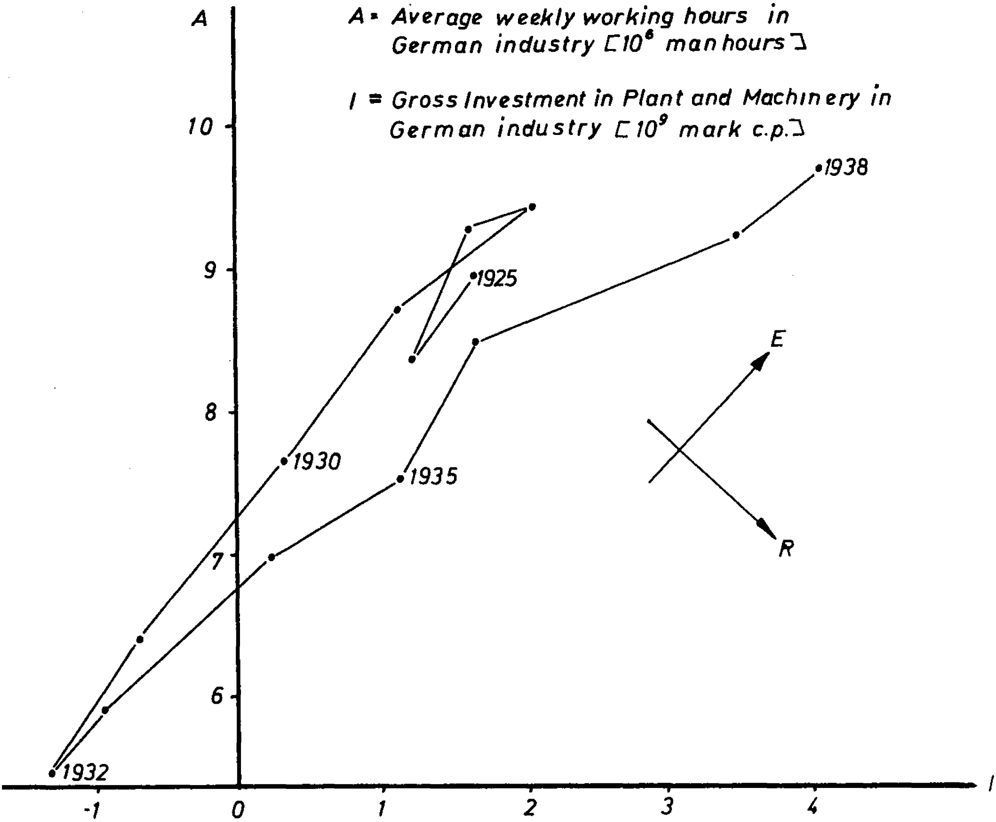
12 Acknowledgement: This analysis draws heavily from catastrophy theory as developed by R. Thom, *Stabilité Structurelle et Morphogénèse,* Reading, Mass.: W. A. Benjamin, Inc., 1972.

Figure 3: USA 1900–1941, A,I input



Source: see Table 2

Figure 4: Germany 1925–1938, A,I input



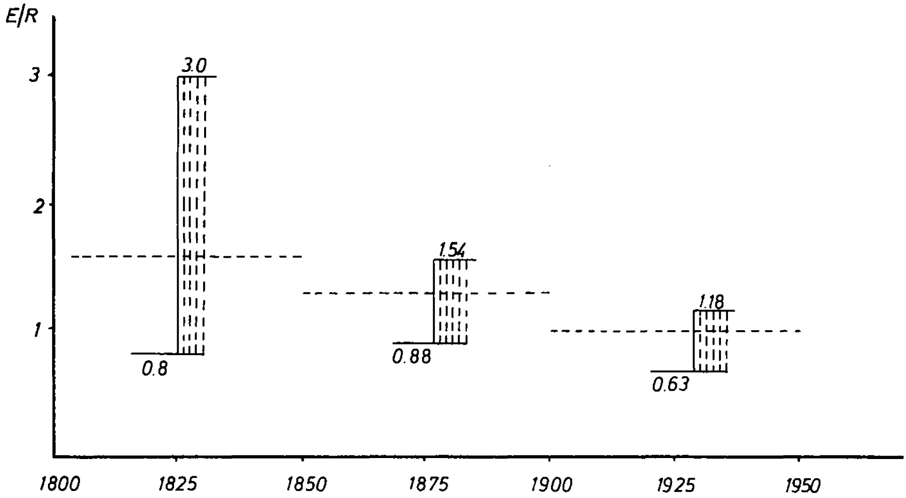
Source: W. G. Hoffmann u. a., Das Wachstum der deutschen Wirtschaft seit der Mitte des 19. Jahrhunderts, Berlin usw. 1965, S. 206, 214, 247

Thus, we have arrived at a real-economic explanation of the world economic crisis and Great Depression which is analytically at least as profound as the monetarist model of depression. If a socio-economic system is sufficiently destabilized by an imbalanced process of change, a number of things may happen; one possibility is breakdown such (as in *Figure 3*) that employment and investment sink far below the "upper-level equilibrium range".

b) *A model of Radical Change*

Another alternative, and by no means one that excludes the possibility of breakdown, is that *structural instability is gradually overcome by another stabilizer,* which, given the prior technological change imbalance, could conceivably come in by a sharp *reversal of the E/R-ratio.*

Figure 5: ER-ratio at the occasion of clusters of Basic innovations around 1825, 1876, 1935



Source : see Table 3, c.3,4

Structural instability always implies structural readiness for radical change, for example, change in the form of basic innovations as have occurred in a grape-clustering fashion in the years around 1935; a number of examples of new industries that emerged at the end of the Great Depression have been mentioned above. No wonder why in Chinese scriptures the Kanji stands both for crisis and opportunity. Thus, we have also arrived at some real-economic explanation of the recovery from the Great Depression – again by drawing on the evolutionary interplay between stagnation and innovation.

A cluster of basic innovations in a period of technological stalemate and depression always implies a drastic upward movement of the E/R-ratio (proposition P3, sentence A) and we have observed such step-ups in the years around 1825, around 1886, and around 1935 (see *Figure 5*).

A very complementary observation on the step-up of the ratio of "product-adding" versus "product-replacing" during the time in question, the reader finds in the earliest articles of Vladimir Stoikov, our late colleague of IIM, Berlin[13].

13 Stokov, Vladimir, *The Classification of Inventions: A Sample Study*, in: The Southern Economic Journal, 29 (1962/63), pp. 15–20; derselbe, *A Note on Product-Adding versus Product-Replacing Innovations*, in: Kyklos, XVI (1963), pp. 138–140.

III. Summary

This paper attempts to explain the coming and going of the Great Depression purely in real-economic terms by exhibiting some long-run regularities in the evolutionary interplay between innovation and stagnation. This interplay seems to go through long-range cycles of structural change.

According to our propositions, stagnation is the result of imbalanced technological change: for too many years there were too many rationalizing (R) innovations and too few expansionary (E) innovations. As the E/R ratio becomes too low, the socio-economic system becomes structurally unstable (crisis) and structurally ready (recovery) for a new spurt of basic innovations and a good many expansionary changes.

Zusammenfassung: Das technologische Patt, 1925–1935: Der Zusammenhang von Stagnation und Innovation.

Diese Studie versucht, das Kommen und Gehen der „Großen Depression" auf realökonomische Weise zu erklären, und zwar durch die Darlegung langfristiger Regelmäßigkeiten in der Wechselwirkung zwischen Innovation und Stagnation. Diese Wechselwirkung scheint langfristigen Zyklen strukturellen Wandels zu unterliegen.

Nach unserer Sicht, die schon in Ricardos Essay „On Machinery" zu finden ist, ist Stagnation das Ergebnis eines Ungleichgewichts zwischen Arten des technologischen Wandels. Zu lange Jahre hat es zuviele rationalisierend wirkende (R) und zuwenig expansiv wirkende (E) Innovationen gegeben. Wenn das Verhältnis von E/R zu niedrig wird, führt dies zur Destabilisierung der sozioökonomischen Struktur (Krisenneigung). Die Wirtschaft wird in dieser Stagnationsphase aber auch strukturell bereit für expansiv wirkende Basisinnovationen, die mit großen technischen und organisatorischen Veränderungen einhergehen.

So lassen sich die Stagnation in den zwanziger Jahren und der Schub von Basisinnovationen in den dreißiger Jahren auf einen Nenner bringen.