An Empirical Application of the Austrian School's "Stages of Production"

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Abstract The paper builds upon the work of Bohm-Bawerk, Hayek and Garrison to formulate an original method for calculating the average period of production (average length of 'roundaboutness' in the capital structure) in a society based on capital stocks. The method is then applied to "early capitalism" (1870-1914) and "modern capitalism" (1948 to present) based on data in the *Historical Statistics of the United States* to determine if there has been a decrease in time-preference in the modern welfare state in the USA versus that of the earlier period, a preference-change which would account for the much larger economic growth in the later period. The results show, as Austrian School capital theory would suggest, that, even despite the growth of the welfare state, the average period of production is greater during the later period of higher economic growth.

Keywords Austrian capital theory, Capital structure, Capitalism, Investment, Time-Preference, Hayek

JEL Codes B53, N12, B25, E22

It scarcely, perhaps, requires to be proved that the capitalist production of consumption goods, although carried out in roundabout ways and by many stages, does not, on that account, cease to exhibit an intimately connected and united work of production.

– Eugen v. Bohn-Bawerk (1888)

The Austrian School of economics uses *time-preference* as a key to understanding the expansion of output in an economy. As society develops and as risk is reduced through better institutions the average period of production in the economy is elongated (the risk to more innovative, more risky, and therefore more productive, means of production is reduced) and goods – more goods and more variety in goods – are produced and available for consumption. Time-preference, the preference for using (consuming) resources now versus the use of resources later in time, is reduced as the investment climate improves and as a society develops economically.

The more developed and wealthy a society is the more "roundabout" we should expect its capital structure to be, this is a fundamental tenet of Austrian Capital Theory (ACT). Bohm-Bawerk (1888) conjectured that there is "average" period of production that could measure this roundaboutness, however, to my knowledge, a method for actually measuring this "average period" has yet to be developed.[1] This paper attempts to fill that gap in ACT by developing a simple method for measuring roundaboutness using capital stocks. In addition the paper applies this original methodology for calculating roundaboutness empirically by analyzing the capital structures at two different and distinct periods in the economic development of the United States. We find that indeed an increased average period of production corresponds with greater economic growth.

We start by providing the history of Austrian School capital theory as it relates to roundaboutness and an average period of production, develop our original methodology for calculating an average period of production based on the work of our predecessors, present the stylized facts of the two periods in US history against which we will apply our method, conduct the empirical analysis (historical

[1] Fillieule 2007 develops a method for measuring an average period, but like Bohm-Bawerk's original presentation of the concept, it is based on the labor-embedded in an economy's first-order consumption goods, and the lag-times for which this aggregated and embedded-labor received its wage bundle, something which may be impossible to measure.

evidence[2]) which includes an analysis of the data categories used, conduct a more detailed analysis of the findings in relation to our stylized facts, and end with a concluding discussion.

1 The Austrian School "stages of production"

Carl Menger in his *Principles of Economics*, the founding work of the Austrian School published in 1871, was the first to identify higher and lower order goods, or, intermediate and consumption goods in today's vernacular, and writes how the more roundabout a society's capital structure the more wealth (welfare) that country is capable of.[3]

> "Assume a people which extends its attention to goods of third, fourth and higher orders, instead of confining its activity merely to the tasks of a primitive collecting economy – that is, to the acquisition of naturally available goods of lowest order (ordinary goods of first, possibly second, order). If such a people progressively directs goods of ever higher orders to the satisfaction of its needs, and especially if each step in this direction is accompanied by an appropriate division of labor, we shall doubtless observe that progress in welfare which Adam Smith was disposed to attribute exclusively to the latter factor. We shall see the hunter, who initially pursues game with a club, turning to hunting with a bow and hunting net, to stock farming of the simplest kind, and in sequence, to ever more intensive forms of stock farming. We shall see men, living initially on wild plants, turning to ever more intensive forms of agriculture. We shall see the rise of manufactures, and their improvement by means of tools and machines. And in the closest connection, with these developments, we shall see the welfare of this people increase." (Menger 1871, 73).

Eugen von Bohm-Bawerk in *The Positive Theory of Capital* (1888) then built upon the work of Menger and explicitly devised what he called the "stages of production" to describe the roundaboutness of a society's capital structure .

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[2] Bismans and Mougeot 2009 make the case, following Mises, that the use of historical statistics in formal modeling for prediction using ACT is methodologically unsound and state that what we seek is historical explanation, "In the Austrian tradition, empirical evidence is synonymous with historical evidence," (Bismans and Mougeot 2009, 242)

[3] Just as some classical economists believe, "it's all in Smith", some Austrian School economists believe, "it's all in Menger".

> "But there is still another circumstance that works in the same direction. The ripening of intermediate products into consumption goods demands a steady addition of current productive powers. At each stage of the production process new labor is added to the intermediate products which have been passed on to it from the previous stage, and they pass on to the following stage in a more advanced state." (Bohm-Bawerk 1888, 109)

In the same work Bohm-Bawerk described the concept of an "average period of production".

> "The production of timber is more than the labour of felling wood in the forest; it embraces the labour of the smith who makes the axe, of the carpenter who cuts the haft, of the miner who raises the ore, of the iron workers and steel workers who prepare it, and so on….It is more important and more correct to look at the period of time which elapses *on the average* between the expenditure of the original productive powers, labour and uses of land, as successively employed in any work, and the turning out of the finished consumption goods. Production is more or less capitalistic according to the average remoteness of the period at which the original productive powers exerted during the process are paid." (Bohm-Bawerk 1888, 87-88).

The next step in the evolution of Austrian School capital theory for our purposes here is F.A. Hayek in 1931's *Prices and Production*, who specifically ties a dynamic element to the 'capitalistic' system through the lengthening of production stages over time within a growing capitalist society.

> "I have already pointed out that it is an essential feature of our modern 'capitalistic', system of production that at any moment a far larger proportion of the available original means of production is employed is employed to provide consumers' goods for some more or less distant future than is used for the satisfaction of immediate needs. The *raison d'etre* of this way of organizing production is, of course, that by lengthening the production process we are able to obtain a greater quantity of consumer's goods out of a given quantity of original means of production." (Hayek 1931, 37)

Hayek attempts to show his concept of the organization of capital in a society (e.g. the capital structure in an economy) graphically, with the introduction of what has become known as the 'Hayekian triangles', Figure 1.

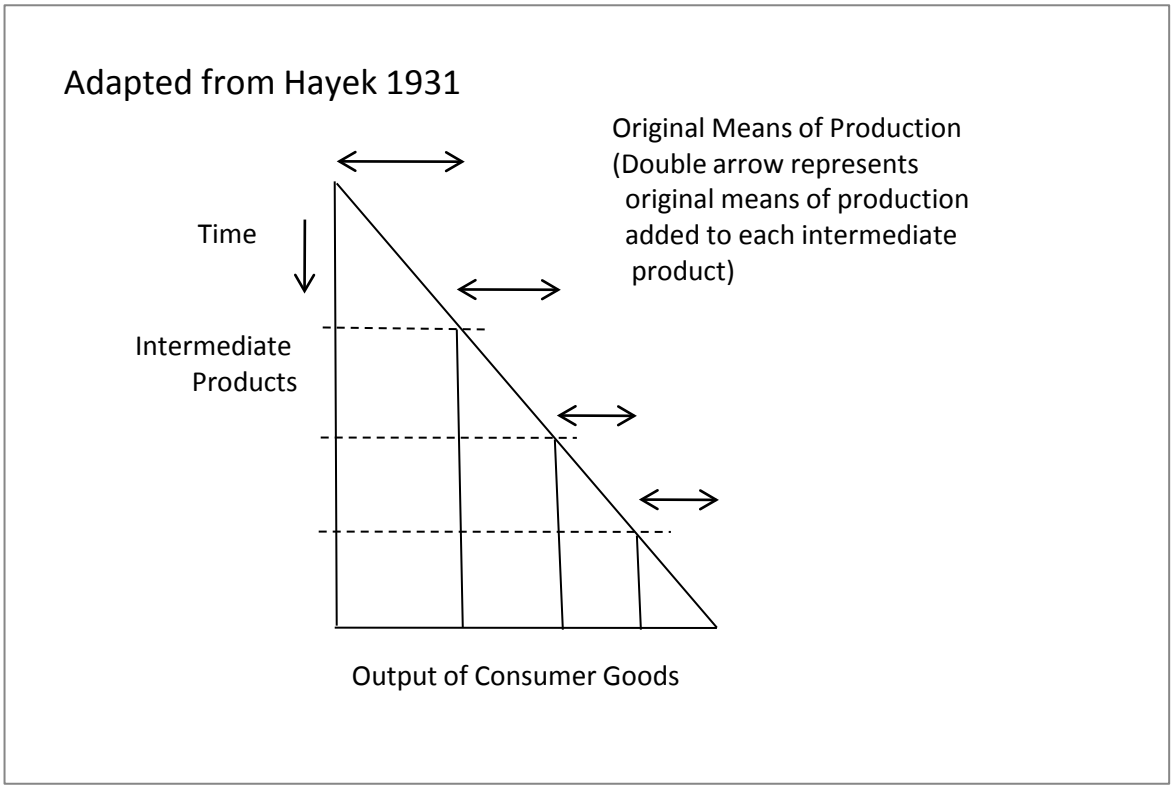

Fig. 1[4] The original Hayekian triangle

Roger Garrison in his contemporary work has simplified and clarified Hayek's concept of the triangles through using specific examples of stages of production in a sectoral presentation, what he calls "the structure of production (continuous-input/point-output)" (Garrison 2001, 47, Figure 3.5). It is from Garrison's work that we build our model for calculating the average period of production.

[4] Adapted from Hayek 1931:39, Figure I.

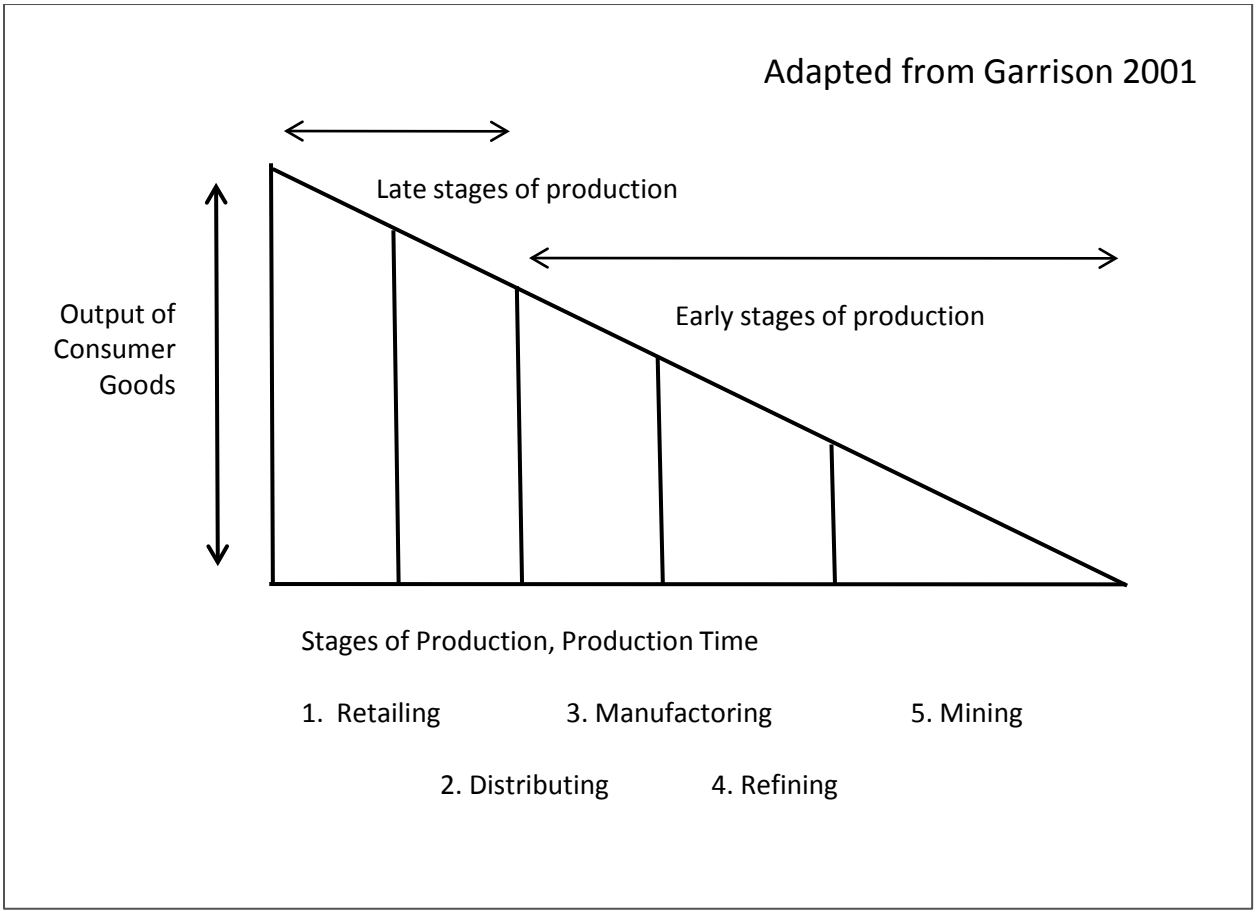

Fig. 2[5] Garrison's version of the Hayekian triangle

[5] I have reversed Garrison's "Hayekian Triangle" by putting the vertical heuristic for consumption on the left-hand side to give it a more familiar Cartesian form, showing that along the vertical axis the stage of production increases in payback time the further to the right it appears. Most of the various uses of the Hayekian triangles in this paper, except for the use of the triangles to define actually measurable capital stocks and an average period of production, have been built upon the work of Roger Garrison, though nothing is a direct representation of any of Garrison's work unless explicitly noted.

2 Methodology for calculating the average period of production based on capital stocks

The Austrian School capital theory as espoused by Hayek *et al* as noted is dynamic and continuous in nature. Hayek uses his 'triangles' only as an analogy to illustrate the concept in a simplified non-dynamic form.

> "Probably the simplest method of transforming the picture of the continuous process into a picture of what happens in a given period is to make cross sections through our first figure [the 'triangle', author] at intervals corresponding to the periods chosen, and to imagine observers being posted at each of these cross cuts who watch and note down the amount of goods flowing by." (Hayek 1931, 43).

> "In a stationary state, which is the only state I am considering, this output of consumers' goods is necessarily equal to the total income from the factors of production used, and is exchanged for this income." (Hayek 1931, 45).

In this paper I use a measurement of the capital stocks extant at Hayek's 'moment in time' to capture the average period of production between two distinctly different historical periods, what Edward Nell (2008) defines as "early capitalism" and "modern capitalism". An average period of production by itself may be a meaningless data-point, but it might be used effectively to compare the transformation of the time-preference of a given economy over time (assuming the time-periods are far enough apart and the data is consistently measured between periods).

Under Austrian School capital theory we can expect that when economic growth occurs that the capital structure has grown correspondingly, reflecting the underlying decrease in subjective time-preferences of the economic actors in that society. This can be captured in the Hayekian triangle as seen in Figure 3. The increase in the size of the triangle vertically represents an increase in consumption and an increase horizontally represents more, and more roundabout, capital investment.

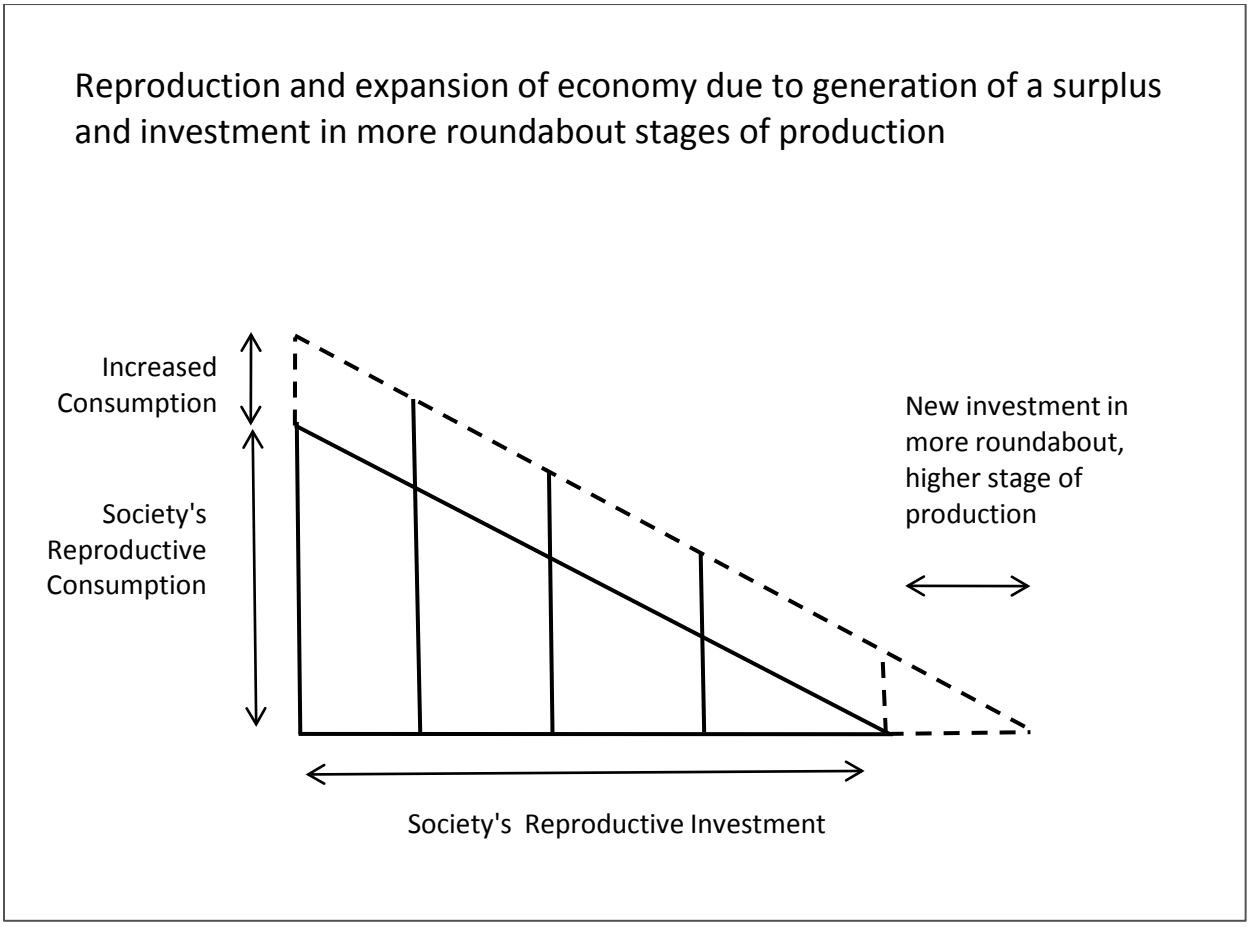

Fig. 3 Heuristic of Hayekian triangle showing economic growth

From here we start to build our methodology for measuring the average period of production and visualizing how this period of production should increase as the economic activity of an economy increased. First we will return to Garrison's triangle (Figure 2), however we now add the percentage of the economy's investment in each stage of production, Figure 4.

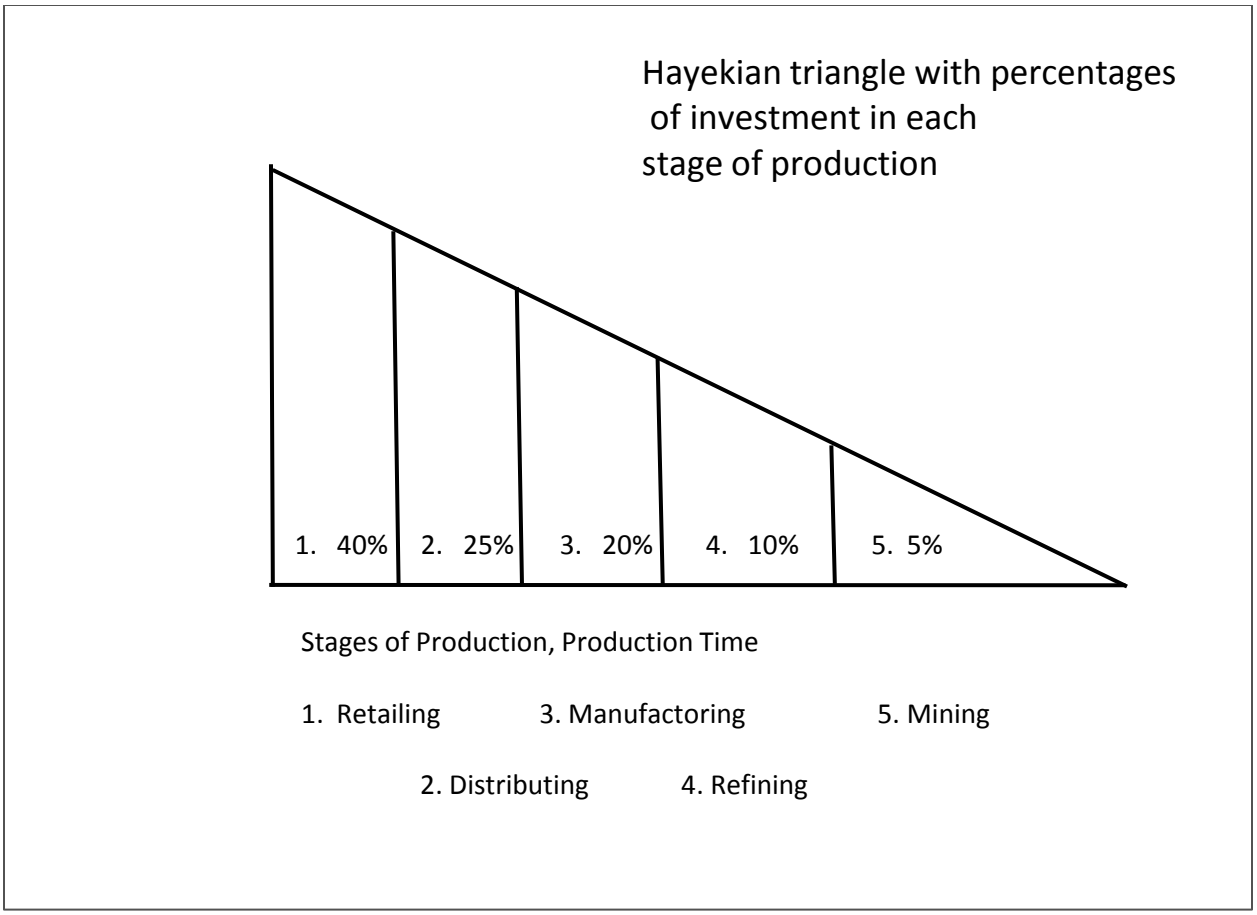

Fig. 4 Stages of production showing each stage's share of investment (capital stock) in an economy

We see in Figure 4 that at a given point in time our example economy has 40% of its investment (wealth measured by capital stocks) in retailing, 25% in distribution, 20% in manufactoring, 10% in refining and 5% in mining. We then use Bohm-Bowerk's concept of an "average period of production"[6] to create an

[6] Bohm-Bawerk provides an example which uses the average amount of labor-time spent (and therefore embedded in a good), and when that labor-time was paid, in producing the consumer goods through its various stages of production to derive an average period. For example the consumer goods in Economies A and B might on average each take 6 months to produce, but in Economy A the labor was paid over an average of 6 months, whereas in Economy B the labor was paid, on average, over a ten-year period. Economy B has the longer average period of production. See Bohm-Bawerk (1888: 89) for his illustrative methodology for calculating the average period.

average period of production for our sample economy. The average period of production is calculated by taking the weight of each production stage and multiplying it by the number of the production stage. The result for our example economy is shown in Figure 5.

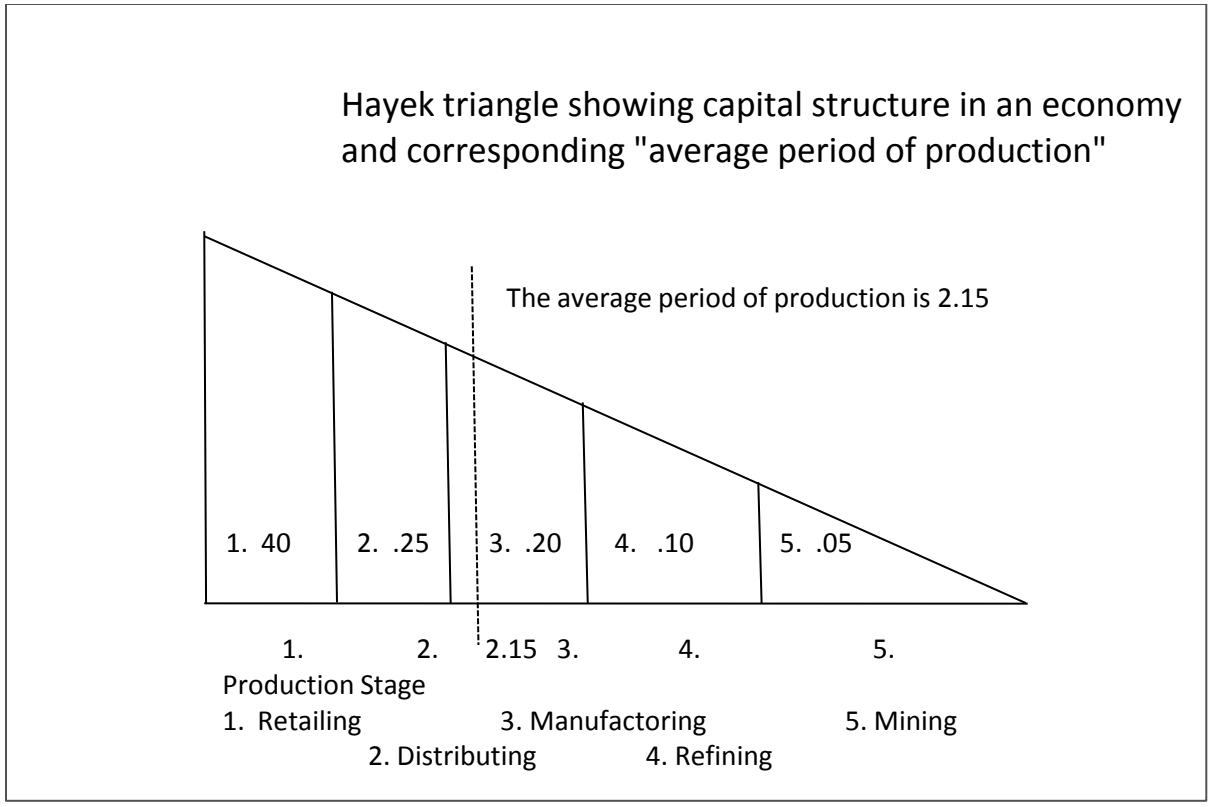

Fig. 5 Example of average period calculation using assignment of numbers to each stage and weighting by capital share

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Our method deviates from Bohm-Bawerk's and creates an index which measures an 'average period' based on numbering each stage of production in an economy and the percentage of the economy's investment in that stage. Our concept is more abstract, but empirical data can be applied to it, unlike, without great difficulty if at all, Bohm-Bawerk's labor and wage fund-based method.

The index we have created for our example economy based on Roger Garrison's Hayekian triangle places the average period of production at 2.15[7]; towards the lower stages of production in the manufacturing sector.

3 Stylized facts for early and modern capitalism

For our historical, comparative analysis we use two differing periods in the US economy, periods Edward Nell defines as "early capitalism" (1870-1914) and "modern capitalism", or the modern welfare state (1948 to present). We can see from Figure 6 that the latter period has experienced a much greater rate of economic growth.

[7] 2.15 is equal to (.4 x 1) + (.25 x 2) + (.2 x 3) + (.1 x 4) + (.05 x 5).

Formally, the average period of production is given by,

$$\text{Average period of production} = \sum_{i=1}^{k} x_i \; w_i \quad .$$

Where $i = (1, 2, \ldots, k)$, k is equal to the number of the highest stage of production in the economy (in our model $k = 5$, where five represents the mining stage of production); x is each stage of production, and w is the weight of the production stage's quantity of capital(capital stick) in relation to the quantity of capital in the economy as a whole,

$$\sum w_i = 1.$$

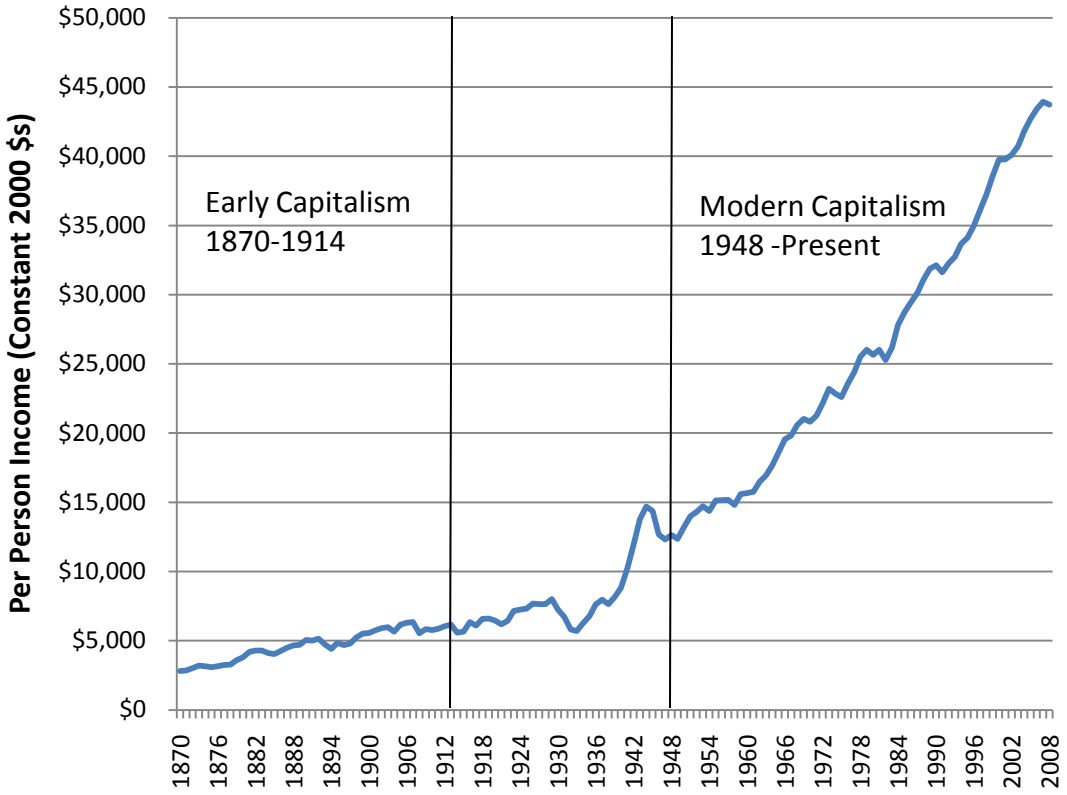

Fig. 6[8] Per person real income in the USA in early and modern capitalism

The main "stylized trends and tendencies"[9] between these two periods are as follows.

- In early capitalism government was around 4% of the economy, in modern capitalism government is greater than 30% of the economy[10]

[8] Source: author, with data from measuringwealth.org, accessed 12/6//2009.

[9] These stylized facts from Nell 2008.

[10] We are ignoring here any Hayekian knowledge problems due to increased factor rigidities caused by the growth in government as a percentage of the economy(of course which crowd-out entrepreneurial decision-making and co-determined effects on time-preference) and leave the economic growth between periods to speak for itself. We would expect time-preference increases

- Modern capitalism has shown a rise in the FIRE sectors (finance, insurance and real estate) compared to early capitalism.

Given the phenomenal growth rate of the economy in "modern" versus "early" capitalism we would expect time-preference to be much less, and thus the average stage of production much greater, in the later period than in the earlier period.

4 Empirical results

For data we are using the *Historical Statistics of the United States*, specifically the "National Wealth" data contributed by Susan B. Carter and Richard Sutch.[11] The Carter and Such data is the only data-source on capital stocks in *the Historical Statistics* which covers dates in both of the periods in which we are interested in (1870 through 1914, and, 1948 through today). The earliest period available in the Carter and Such data is 1900 and the latest is 1958 so these are the dates we will use for measuring "early" and "modern" capitalism respectively. From this data we derive 14 stages of production based on Carter and Sutch's classification schema, from the lowest to the highest order goods, or, from the latest to the earliest stages of production. [12]

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due to the growth of the State to be less than the time-preference decreases helping to explain the increase in economic growth.

[11] Carter and Sutch 2006:3-329. Note that our empirical analysis of the capital structure in the U.S. is based on very high-level (aggregated) data. A great field of research has been developed into the differing approaches for measuring capital formation in more detail. For an excellent summary of the literature see Gallman 1986.

[12] We are placing those items listed as land- and agriculture-related as lower ordered goods in like-classes because it is well understood that as an economy develops it devotes less resources to farming. Again, "We shall see men, living initially on wild plants, turning to ever more intensive forms of agriculture. We shall see the rise of manufactures, and their improvement by means of tools and machines." (Menger 1871, 73). Also, agriculture "epitomizes the initial stage of vertically integrated process". (Meacci 2009, 339, fn 10).

Government and publically-owned assets are placed before (e.g., as lower-ordered goods) privately-owned goods because government provides "transaction" services in addition to long-term infrastructure. See Wallis and North 1986 on the 'transaction sector'.

1. Agriculture land
2. Public land
3. Residential land
4. Non-residential land
5. Farm inventories
6. Public inventories
7. Non-farm inventories
8. Consumer durables equipment
9. Producer durables equipment
10. Farm structures
11. Institutional structures
12. Government structures
13. Residential structures
14. Non-residential structures

Figure 7 shows how these stages of production are represented in the Hayekian triangles.

We have placed residential as lower-ordered goods relative to non-residential in like categories as the latter is more indicative of entrepreneurial behavior. Institutional structures are lower-ordered because they are assets belonging to not-for-profit organizations. We have excluded Carter and Sutch's "Money gold and silver" category from analysis as these in our judgment do not represent ordered goods or stages of production (these amounts are also insignificant in relative value to other wealth in the economy). "Forests" and "Net foreign assets" are also excluded, the former as an insignificant part of the production process and the latter because it is not possible to break down the investment category into a discernable stage or stages.

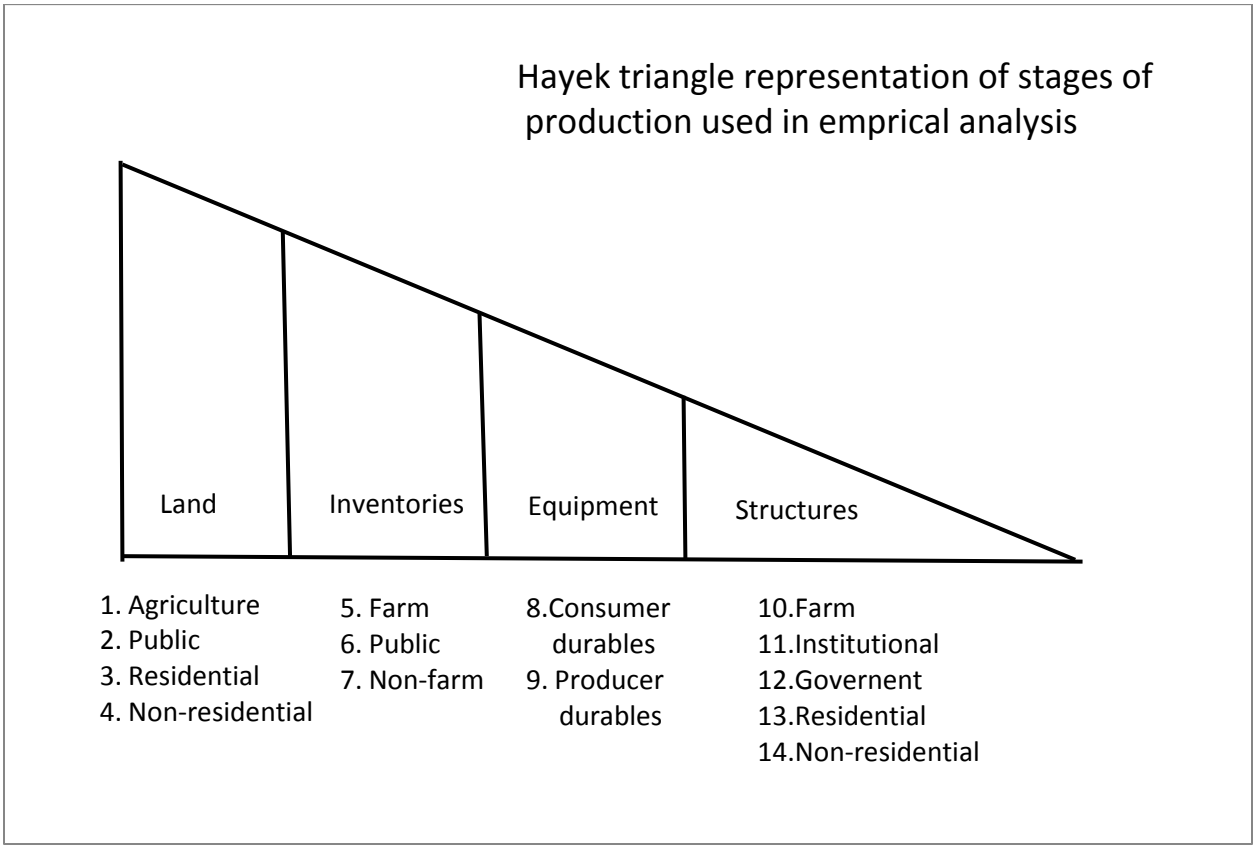

Fig. 7 Stages of production based on *Historical Statistics of the United States*

Using these data categories and the average period methodology developed in this paper above we then calculate the average periods for 'early' and 'modern' capitalism, shown below in Table 1, and find that, indeed, the average period is more roundabout in 'modern' capitalism, corresponding, as expected, with decreased time-preference and higher economic growth.

Table 1 Empirical results

		Early Capitalism (1900)		Modern Capitalism (1958)	
Stage of Production		Dollars ($ Billions)	% of Total	Dollars ($ Billions)	% of Total
1	Agriculture land	41.7	13.27%	52.9	4.42%
2	Public land	11.5	3.66%	34.2	2.86%
3	Residential land	19	6.05%	44.6	3.73%
4	Non-residential land	22.4	7.13%	64.6	5.40%
5	Farm inventories	18.4	5.86%	25.6	2.14%
6	Public inventories	n/a	n/a	8.9	0.74%
7	Non-farm inventories	14.2	4.52%	75.4	6.30%
8	Consumer durables equip.	21.7	6.91%	159.7	13.35%
9	Producer durables equip.	20.5	6.52%	137.4	11.49%
10	Farm structures	13.6	4.33%	28.2	2.36%
11	Institutional structures	4.7	1.50%	17.8	1.49%
12	Government structures	9.5	3.02%	126.8	10.60%
13	Residential structures	68.1	21.67%	283.6	23.71%
14	Non-residential structures	48.9	15.56%	136.4	11.40%
Total		314.2	100.00%	1196.1	100.00%
	Average period of production		**8.38**		**9.47**

5 Analysis of empirical findings

In Table 1we find that the average period of production in modern capitalism (1958) increased from that of early capitalism (1900) from 8.38 to 9.47, a not insignificant increase, especially considering that there has been perhaps incentives for under-reporting assets under the welfare state (see footnote 13). As expected we find that farm inventories and farm structures as a percentage of the economy decreased while non-farm inventories and consumer and producer durables equipment increased, showing the shift toward the manufacturing sector away from the agricultural sector during the process of economic development. We also find that the value of land as a percentage of the economy decreased, again expected with an increase of more capital intensive investment in more roundabout production technologies leading to more economic growth.

The housing sector remained relatively stable (increasing slightly) while government structures increased approximately 300 percent (this, obviously, fits our stylized fact of an increase in government in the economy in modern capitalism). We also see a significant decline in non-residential structures[13], this

[13] Note that non-residential structures (meaning factories and other private investments classified as more long-term investment than equipment) actually declined from early to modern capitalism. Because of this apparent anomaly I traced the data integrity back to the original author cited by Carter and Sutch for their data, Goldsmith 1962, to ensure that the data was accurate. Goldsmith states,

> "This close similarity between the gross value of corporate plant and equipment derived from the perpetual inventory method and reported in corporate tax balance sheets must mean one of two things. First it may mean that the capital expenditures on plant and equipment underlying the perpetual inventory estimates are very close to the capital expenditures entered in their own books (or, more correctly, *the set of books they keep for tax purposes* [emphasis added]); and that the estimates of the length of life of the different types of reproducible assets used in the perpetual inventory method are close to those employed by corporations for their own accounts. Or, second, it may mean that, insofar as there are deviations between the figures underlying the perpetual inventory method and those used in the corporations' own accounts – and undoubtedly there are – those deviations happen to cancel out, not only for the entire decade but for most individual years, when all non-agriculture corporations and all types of depreciable are combined. It is unfortunately not possible to determine whether the satisfactory correspondence in the aggregate series is the effect of only moderate discrepancies for individual industries and individual types of assets, or whether it is the result of very wide but fortuitously offsetting deviations" (Goldsmith 1962, 84-85).

would seem counterintuitive to the stylized fact of an increase in the FIRE (finance, insurance and real estate) sectors, however, the increase in government structures (real estate excluding land) more than makes-up for the decrease in non-residential structures. [14] The large increase in equipment for the production of durable goods (the intermediate stages of production) is indicative of an increase in the financial and insurance sectors needed to transact this equipment, consistent with the stylized facts of an increase in FIRE sectors. It is plain to see that this increase in intermediate goods relative to later stage land and inventories is what most fundamentally increased the average period of production between early and modern capitalism.

6 Concluding discussion

In this paper I have tried to outline the history and development of the Austrian School "stages of production" to illustrate relative changes in risk-preference and thus how the Austrian School uses the concept of roundaboutness to help explain economic growth and societal development. Using Austrian School capital theory as originated by Menger and developed by Bohm-Bawerk, Hayek and Garrison I have formulated a method to empirically test this theory by measuring capital structure "roundaboutness" in two distinct periods of US historical development,

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This might highlight the difficulty in relying on tax records for calculating capital and wealth values, especially when we recognize that the federal income tax did not become constitutional in the United States until 1913 with the ratification of the Sixteenth Amendment to the U.S. Constitution, e.g., and whose effects therefore do not appear in our data until modern capitalism and may, it might be reasonable to assume, skew reported values downward. In addition the estate tax was enacted in 1914. We can also assume that some crowding-out of private investment in capital structures took place due to the 300% increase in government structures between the two periods.

[14] Due to the growth of government, if we were to include government structures (as well as all government investment in the economy) as the highest order good for each class of assets we would see an even greater increase in the average period of production from early to modern capitalism. However this is anathema to the Austrian School theory of time-preference being entrepreneurial and subjective to individuals, as well as the understanding that politicians (who control government spending) have relatively high time-preferences due to frequent election cycles. If government was the highest order good, *reductio ad absurdum*, we would have the state-planned economy of the Soviet Union, which we have learned from history, was unsustainable economically.

"early" capitalism and today's modern welfare state. Even with the growth of the State, and therefore what we would expect to be an increase Hayekian knowledge problems, we find that investment has become more roundabout, indicating a decrease in time-preference, a result we find consistent with Austrian School capital theory helping to explain the more rapid growth of the economy in modern capitalism relative to early capitalism.

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