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The structure of production reconsidered

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Résumé : La présente étude réexamine le concept de structure de production à la lumière des travaux récents de Fillieule (2005, 2007) et Hülsmann (2008). A partir d'une analyse des rapports entre trois variables structurelles – le taux d'intérêt, le taux d'épargne brute et la longueur de la structure de production – nous étudierons trois mécanismes élémentaires de la croissance, se manifestant dans différents scénarios de croissance qui s'apparentent aux conditions actuelles de l'économie mondiale. Nous discuterons également les rôles joués par le capital humain et les crédits à la consommation au sein de la structure de production.

Abstract: This paper reassesses the concept of the structure of production in light of recent works by Fillieule (2005, 2007) and Hülsmann (2008). In particular, we reconsider the relations between three structural variables: the interest rate, the gross savings rate, and the length of the structure of production. Based on this reconsideration, we study three basic growth mechanisms in a monetary economy that can be applied to various scenarios that seem to be relevant under the contemporary conditions of the world economy. We also discuss the role of human capital and of consumer credit within the structure of production.

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The Structure of Production

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In present-day macroeconomics it is customary to analyse the problems related to savings, investment, and capital from an aggregate point of view. Thus capital is typically taken account of in the form of one aggregate variable, and investment in the form of a representative firm. The interconnections between different investments, in particular, the flows of "real" goods and of money in time, are neglected and relegated to sector studies of particular industries. The implicit assumption is that the analysis of such interconnections – which are also known under the shorthand of "structure of production" – is not likely to alter the conclusions of aggregate reasoning.

The only contemporary school of thought that places the structure of production at the centre-stage of macroeconomic analysis is the Austrian School.[1] The Austrians operate with aggregate variables too, but the level of aggregation is lower. The main variables in their analysis are savings, the interest rate, and the length of the structure of production. They argue most notably that the length of the structure of production is an important cause of the average physical productivity of labour, and thus of the wealth of nations.

The Austrians have spent most of their time explaining and restating the basic model of *changes* of the structure of production that was developed by Hayek (1931). According to Hayek, the length of the structure of production can be increased through the combined effect of additional savings and of a reallocation of factors, away from the producers closest to consumption and toward the producers that are further removed from consumption. This reallocation process is steered by a change of market prices, most notably by a change of the pure rate of interest. The purpose of Hayek's model was threefold: (1) to explain how higher savings entail growth; (2) to show that this growth process is independent of the level of

1 See in particular the book-length expositions in Rothbard (1993), Reisman (1996), Skousen (1990), Huerta de Soto (1998), and Garrison (2001). Rothbard, gave a detailed exposition of the Austrian theory of the structure of production, on which we will build in the present study. Later economists such as Huerta de Soto have also followed in these footsteps. Skousen and Garrison have elaborated graphical representations. These works rely on Menger (1871), Böhm-Bawerk (1921), Mises (1949), and Hayek (1931).

monetary spending and the price level; and (3) to explain how monetary expansion can cause inter-temporal disequilibria.

The purpose of the present paper is, first, to show that the conventional Hayekian model covers only one possible scenario for the alteration of the structure of production; second, to develop, on the basis of Rothbard (1993), Fillieule (2005, 2007), and Hülsmann (2008), a revised analysis of the relationship between savings, the interest rate, and the length of the structure of production. This analysis will then be applied to discuss (a) growth scenarios and their respective impact on the distribution of revenues, (b) human capital, (c) consumer credit, and (d) variations in monetary conditions.

The Conventional Account of the Structure of Production

Based on Jevons's and BB's insight that all production processes are dependent on the availability of present goods, which have to be saved from past revenue. This is the foundation of modern Austrian macroeconomics.

Flows of Goods within the Structure of Production

On the physical level, the Austrians disaggregate production into different supply chains that transform original factors of production (labour and "land") into consumer goods. Each supply chain is in its turn decomposed into different stages that are connected through physical and monetary flows. Each stage of production delivers producer goods to some stage "downstream" (that is, closer to consumption) and receives payments from that stage; the only exception being the stages closest to consumption, which deliver consumer goods and receive their revenue directly from the consumers. Similarly, each stage of production receives the services of producer goods and of original factors from some stage "upstream" (further removed from consumption), while paying money to that stage; the only exception being the stages that are furthest removed from consumption, which receive only original-fact services and make payments to their owners (see Figure 1).

This way of representing things might provoke the following objection: In the real world there often seems to be no such linear causality. Indeed, tools produced in stages of production close to consumption might just as well be used in stages upstream. For example, hammers are not only used by consumers, and not only by plumbing firms serving consumers, but also by mining firms and other producers situated rather upstream. This objection is valid as far as Rothbard's presentation goes, but it misses the mark as far as causality and the distinction between upstream and downstream is concerned. It is true that hammers and other tools can be used at various stages of production. However, they have been produced at distinct moments in time, with the help of factors of production (thus there is an upstream), and can be used to produce other goods (thus there is a downstream).

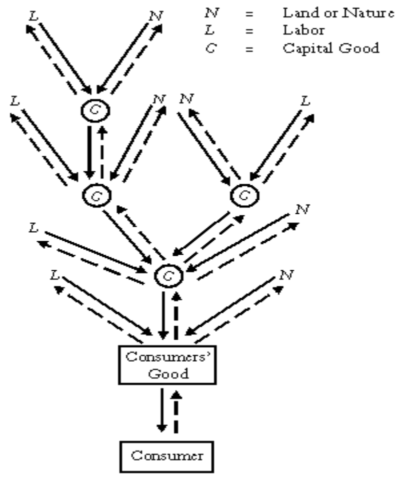


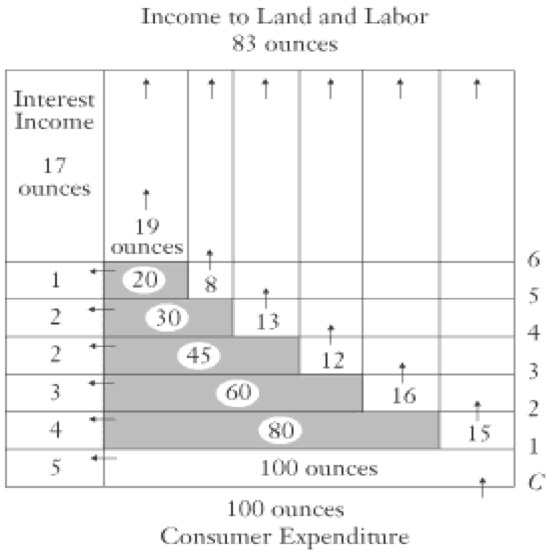
Figure 1
Stages in the Process of Production for the Ultimate Consumer
Source: Rothbard (1993), figure 32, p. 178

Rothbard deals with this objection with the hypothesis of unit services. He does not equate a stage of production with a firm, but with the production of discrete units of a good, with the help of only those units of factors of production that are necessary to produce those units of the good. Thus the production of a hammer for mining is situated in a stage upstream of present mining (but downstream from the mining that produced the iron needed to make the hammer) and thus far away from final consumption, whereas the production of a hammer for plumbing takes place in a stage closer to consumption.[2]

Let us restate the main subsequent elements of Rothbard's presentation, which will allow us to quickly reach the point of departure for criticism and further development. Rothbard proceeded to consider a concrete numerical example for a single supply chain in an evenly

2 The Austrian literature does not contain any graphical illustrations of the interconnections that exist between different stages of different supply chains. Notice that strict linearity of the causal chain only exists under the hypothesis adopted by Rothbard, namely, that factor use and factor pricing can be done, and is done, separately for each unit of a good.

rotating economy, with the help of a figure inspired by Hayek (1931, chap. 2, figure 2) and going back to Jevons (1871):



<u>Figure 2</u>
Income Accruing to Factors at Various Stages of Production
Source: Rothbard 1993, figure 41, p. 314

The horizontal extension of Figure 2 represents monetary spending in exchange for the supply of non-monetary goods, while the vertical extension represents the passage of time. The figure is most usefully read bottom-up. At the very bottom, consumer spending of 100 oz of gold is identical with the revenue of the stage of production furthest downstream. Out of these 100 oz, 15 oz are spent, in the next period, on original factors needed in that stage; and 80 oz are spent, also in the next period, on capital goods needed in that stage. Thus there is a residual income of 5 oz (100-15-80=5), which is the pure return on capital invested in that stage. Next consider the revenue and expenditure of the stage most closely upstream. This stage produces capital goods. Its total revenue is 80 oz, subsequent spending on original factors is 16 oz, subsequent spending on higher-order capital goods is 60 o, and the residual income is 4 oz. The next three stages can be interpreted in exactly the same manner. Then, in the stage furthest upstream, there is no more spending on higher-order capital goods. Revenue in this stage is 20 oz, 19 of which are subsequently spent on original factors, and 1 oz constitutes residual income.

In a next step, then, Rothbard aggregated all supply chains into one single aggregate supply chain, representing the entire time structure of production. From this aggregate point of view, the interrelations between different supply chains disappear, and only the different (aggregate) stages of production remain. The point of this aggregation is to bring the interdependency between the pure rate of interest, investment expenditure, and the length of the structure of production into focus.

Rothbard used the same numerical example as in the above case of a single supply chain to illustrate this aggregate structure of production. Thus our above Figure 2 (Rothbard's figure 41) becomes a representation of the whole economy (see ibid., p. 337). The bottom line of Figure 2 then needs to be read as follows: There is a total or aggregate consumer spending (that is, on all consumers' goods combined) of 100 oz of gold, which is identical with the aggregate revenue of all consumer-goods industries. Out of these 100 oz, 15 oz are spent, in the next period, on original factors needed in the consumer-goods industries; and 80 oz are spent, also in the next period, on capital goods needed in these industries. The residual income of 5 oz is the pure return on capital invested in that stage. The subsequent lines represent aggregate of stages of production upstream and need to be read accordingly.

Based on this aggregate representation of the time structure of production, it is possible to make an aggregate statement of gross and net revenues (Table 1).

Aggregate Gross Revenue	**Gross Savings**	**Net Savings**	**Consump-tion**	**Aggregate Net Revenue**			
				Savers (Capitalists)	**Land & Labour**	**Entre-preneurs**	**Σ ANR**
418	318	0	100	17	83	0	100

Table 1
Summary Statement of Structural Data in Rothbard's (1993) Example

The Aggregate Gross Revenue (418 oz of gold) is the sum of all gross incomes, including the gross incomes of the capitalists (100+80+60+45+30+20=335), the gross incomes of the owners of original factors (15+16+12+13+8+19=83), and the gross incomes of the entrepreneurs (0). Entrepreneurs earn no profit and incur no loss in equilibrium, and thus their gross aggregate revenue is zero under the above hypothesis of an evenly rotating economy. For the same reason, there is no net saving respectively net investment. All savings are used to reproduce, again and again, exactly the same time structure of production.

The aggregate *net* revenue of the owners of original factors is exactly equal to their aggregate gross revenue (83 oz) because, by definition, factor owners do not need to make expenditures to reproduce these factors. Similarly, the net revenue of entrepreneurs is equal to their gross revenue, because according to the definition used by Rothbard, entrepreneurs do not operate with any money of their own and thus have no expenditure to make. By contrast, the net revenues of the capitalists are *not* equal to their gross revenues. Rather, they merely earn the residual income, left over from gross revenue after the deduction of all productive expenditure. Since the capitalists in the above example earn an Aggregate Gross Revenue of 335 oz, out of which they save and spend a total of 318 oz on higher-order capital goods and on original factors, their net income is 17 oz.

Notice that aggregate net revenue (83+17=100) is equal to the aggregate sum spent on consumption, a necessary implication of the evenly rotating economy. For the same reason, the rates of return earned in the different stages of production are exactly equal to one another, and thus identical with the pure rate of interest. Indeed, different rates of return in different stages of production would imply that the economy is in disequilibrium.

Determination of the Pure Rate of Interest

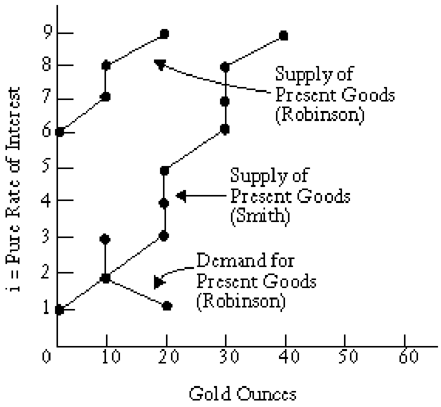
Rothbard's numerical example in our above Figure 2 (Rothbard's Figure 41) is more or less arbitrary, its sole purpose being to illustrate a time structure of production, and thus the flows of goods and monetary revenues, in inter-temporal final equilibrium. The next problem, then, is to explain these flows, and most notably the difference between revenue and cost in each stage of production. In other words, we need an explanation of the pure rate of interest.

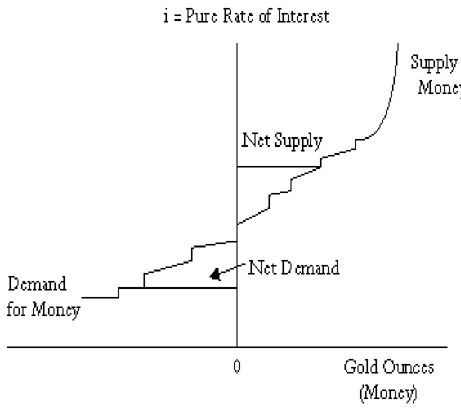
Following Böhm-Bawerk's approach, Rothbard argues that interest rates are formed through the exchange of present goods against future goods. All such exchanges are part of what he calls the "time market" on which a supply of present goods (monetary savings) confronts a demand for present goods. Rothbard demonstrates that both demand *and* supply schedules on this market derive from the same source, namely, individual time-preference schedules. The latter are therefore the unique cause of the pure rate of interest, which he also calls the social time-preference rate.[3,4]

3 See M.N. Rothbard, *Man, Economy, and State* (3rd ed., Auburn, Ala.: Mises Institute, 1993), p. 497. He provides detailed criticism of the Fisherian neoclassical approach, in which only the *supply* of present goods is determined by time preference, whereas the demand for present goods is determined by the marginal productivity of capital (see *Man, Economy, and State*, pp. 360-364.

4 Mises calls this rate "the rate of originary interest" or simply "originary interest." See Mises, *Human Action* (Scholar's edition; Auburn, Ala.: Mises Institute, 1998), pp. 523, 535.

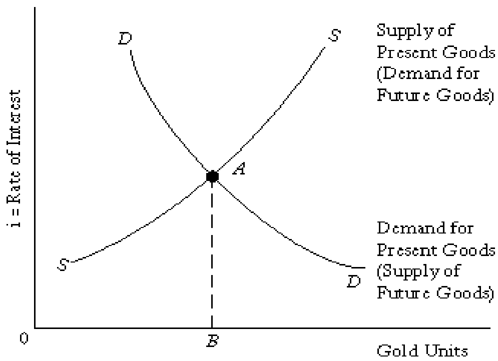
Each individual prefers present goods to future goods. In every single individual value scale, therefore, future goods rank lower than present goods of the same type, for example, 100 future dollars rank lower than 100 present dollars. However, the exact ordering is different from one individual to another. Some individuals have a higher time preference, while others have a lower one. As a consequence, for any rate of exchange between present and future dollars (for any rate of interest), some individuals will act on the demand side of the time market, while others will figure on the supply side (see Figures 3 and 4).





<u>Figure 3</u> (Comparison of Time Preference Schedules) and <u>Figure 4</u> (Individual Time Market Curve)
Source: Rothbard 1993, figure 42 (p. 329) and figure 43 (p. 331)

The time market is in equilibrium at the interest rate for which the aggregate demand for present goods equals the aggregate supply thereof. And this interest rate is exclusively determined by time preference (see Figure 5).



<u>Figure 5</u>
Aggregate Time Market Curves
Source: Rothbard 1993, figure 44, p. 332

Savings-Based Growth

Rothbard then proceeds to illustrate a savings-based growth process. The increase of gross savings (in Figure 6, this would correspond to a shift of the supply schedule of present goods to the right) by definition goes in hand with a reduction of consumer expenditure, and it entails a reduction of the pure rate of interest (new intersection with the demand schedule).

This leads to the following adjustments of the time structure of production. On the one hand, because consumer expenditure is being curtailed, less revenue is being earned, and thus less money is being spent on factors of production, in the consumers' goods industries and in the industries closest to consumption. On the other hand, the pure interest rate drops, which means that the spread between revenue and cost expenditure diminishes in each stage of production. Because one firm A's costs are nothing else but the revenues of its suppliers, it follows that the revenues of all factors of production (and in particular the revenues of any firm B supplying the firm A with capital goods) tend to increase *relative to* the revenue of A.

Thus an increase of savings entails always a net loss of aggregate revenue in the consumer goods industries. But for the revenues earned in the capital-goods industries, it entails two opposite tendencies. On the one hand, these revenues tend to fall because the reduction in final consumer spending triggers through the entire revenue chain. On the other hand, these revenues tend to increase *relative to* final consumer spending because the triggering of revenues is based on a lower discount rate.

It follows that non-specific factors of production (such as capital, labour, and energy) will be reallocated, leaving industries "downstream" and entering industries "upstream;" while specific factors, which by definition cannot be reallocated, will earn permanently higher revenues upstream, and permanently lower revenues downstream. To the extent that reallocation is possible, new industries will be created at the higher-order end of the structure of production.[5]

5 It is imaginable that the savings-induced reallocation of capital does *not* change the structure of production, under two conditions. The first one is that all factors except for capital be specific, so that they could not be reallocated. The second is that technological innovation be impossible, for lack of ideas or because of legal barriers. Under these two conditions, an increase of savings, combined with a drop of the interest rate, would leave the structure of production unchanged, and entail a mere redistribution of revenue, to the benefit of the owners of the specific factors needed upstream, and to the detriment of savers and of the owners of the specific factors needed downstream.

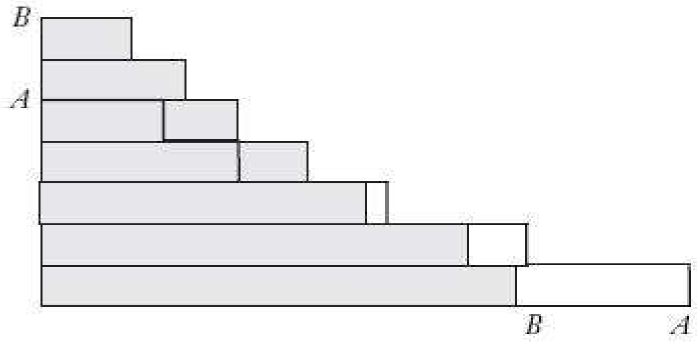


Figure 6
The Impact of Net Saving
Source: Rothbard (1993), Figure 60, p. 472

Rothbard illustrates this process with the above Figure 6, which is a simplified version of the above Figure 2. The initial structure of production is represented by the rectangles A-A, whereas the new structure of production is represented by the rectangles B-B. What has happened? On the one hand, the structure of production has become “flatter” because its tarts from a smaller base of consumer expenditure (the B-rectangle at the bottom is smaller than the A-rectangle). On the other hand, the structure has become “lengthier” because there are now additional stages upstream (the top two B-rectangles) that did not exist before.

A similar illustration is based on the so-called Hayekian triangle. In Hayek, Garrison, and others, it *is* a triangle.

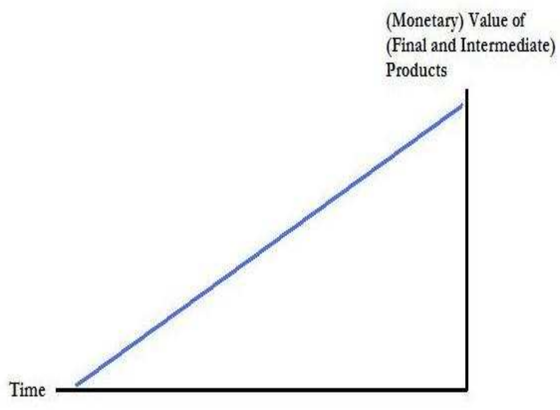
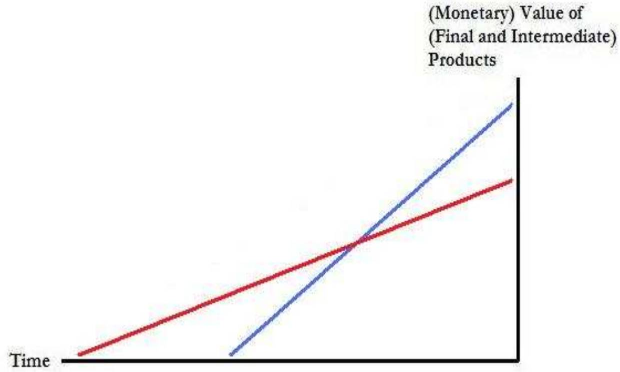


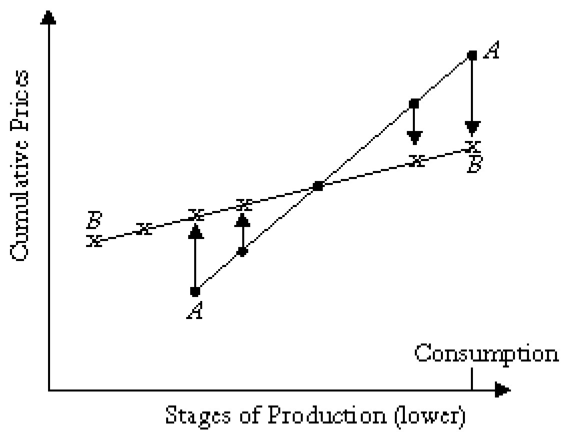
Figure 7
Hayekian Triangle
according to Hayek (1931), chap. 2, figure 1

The simultaneous lengthening and flattening of the structure of production can then be illustrated by the shift from the blue to the red curve in the following figure:



<u>Figure 8</u>
Lengthening and Flattening of the Structure of Production within a Hayekian Triangle

But this is not quite correct, because spending in the last stage is not zero, even if only original factors are used. Rothbard is therefore correct in modifying the Hayekian figure into a trapezoid of the following form:



<u>Figure 9</u>
Lengthening and Flattening of the Structure of Production
Source: Rothbard (1993), Figure 61, p. 473

The point of these figures is to illustrate how the economy can grow based on higher savings, *even if there is no variation whatever on the side of monetary factors*. In mainstream conceptions there prevails the notion that growth cannot occur unless it is accommodated by a corresponding increase of aggregate demand. The Austrian analysis shows that, even if aggregate spending (and thus aggregate revenue and aggregate demand) does not change, growth can occur, resulting from a lengthening of the average period of production.

Notice that, in distinct contrast to mainstream conceptions of the role of the interest rate, the declining interest rate is not per se a cause of economic growth. It is merely conducive to the lengthening of the structure of production, and it is precisely the lengthening of the structure of production that entails economic growth. Indeed, as Menger (1871) has pointed out, the longer the overall process, the more natural forces can be substituted for human labour, thus liberating labour for additional productive ventures. The result is a higher average physical productivity per capita.

Two Critical Annotations

Up to this point, we have restated the conventional Austrian model of the structure of production, and its application in growth theory. In what follows, we will take the conventional model as our point of departure, with only a few modifications designed to facilitate the exposition of our argument. Our critique will focus on two points. First, restating an argument for presented in Hülsmann (2008), we will fill a gap in the conventional theory by analysing the impact that variations of the demand for present goods have on the structure of production. Second, elaborating on Fillieule (2005, 2007) we will argue that the conventional model suffers from a basic misconception pertaining to the relationship between the PRI and the roundaboutness or length of the structure of production.

Impact of Changes of the Demand for Present Goods

As we have seen, the conventional Austrian model more or less exclusively focuses on the ramifications of an increase of the *supply* of present goods (more precisely, of savings) on the time structure of production, under the assumption that the *demand* for present goods remains constant. This assumption is unobjectionable. However, it does not always hold true in reality, and therefore it is useful to analyse the impact of changes of the demand for present goods.

Increases of the demand for present goods may result from any one of the following factors, or a combination thereof:

(a) immigration, implying a greater supply of labour hours (future goods) in exchange for money; immigration may in turn result (i) from deteriorating economic conditions in the immigrants' homeland and (ii) from lower transport costs;

(b) a greater willingness to work, demonstrated by the supply of additional labour hours in exchange for money;

(c) discoveries of additional supplies of raw materials (future goods) that can be exchanged for money;

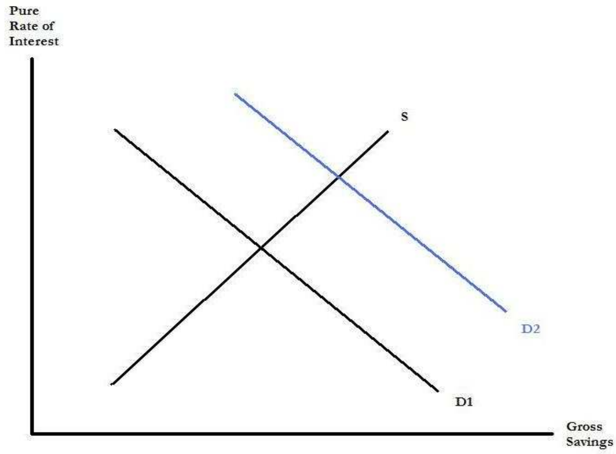
(d) the invention and development of new technologies that allow to use known supplies of raw materials at lower costs, thus increasing the supply of raw materials (future goods) that can be exchanged for money;

(e) a greater willingness to incur the risks of debt (producer credit and consumer credit).

The same relationships hold *mutatis mutandis* also for *decreases* of the demand for present goods. The above list is not meant to be exclusive, but serves to highlight a certain number of causes that determine the demand for present goods. Other causes are conceivable, in particular, causes that only operate under special circumstances. For example, the invention and development of new technologies that allow to produce capital goods at lower costs *may* entail an increase of the production of these capital goods (implying a higher demand for present goods) *if* the demand for them is sufficiently elastic. But if the demand for them is not elastic enough, or even inelastic, then those new technologies would result in a decrease of the demand for present goods.[6]

This argument can be generalised to cover human capital. Indeed, a greater technological facility to produce human capital (for example, through online education programmes) *may* stimulate human-capital formation *if* the demand for this capital is sufficiently elastic; and inversely, it may have no such impact of the demand is not elastic enough or inelastic.

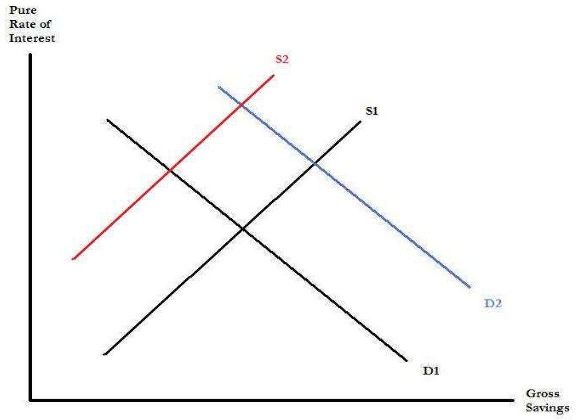
6 See Fillieule (2010).



<u>Figure 10</u>
Increasing Demand for Present Goods on the Time Market

The impact of changes of the demand for present goods on the time structure of production can be illustrated with the help of the conventional diagrams. Thus an increasing demand for present goods (savings) at a given supply of present goods will entail a higher PRI as well as a higher volume of savings and thus, by implication, a higher volume of investment expenditure (Figure 10). The opposite effects would result from a decreasing demand for money.

Taking account of variations of the demand for present goods leads to results that are at odds with the conventional Austrian model of the relationship between time preference and the volume of savings, respectively the volume of investment expenditure. In the conventional model, a reduction of the market participants' time preference schedules entails a higher supply of present goods *at a constant demand for present goods*, thus leading to a reduction of the PRI and to an increase of gross savings. However, Rothbard argues that on the time market *both supply and demand* are exclusively determined by time-preference schedules. It is therefore incoherent to assume that a reduced time preference would modify the supply schedule only, and leave the demand side unaffected. Rather, one would have to infer that a general reduction of time preference tends to affect both sides of the market (see Figure 11).



<u>Figure 11</u>
Impact of a General Rise of Time Preference on the Time Market

It would tend to increase the supply of present goods and, at the same time, tend to reduce the demand for present goods. As a consequence there will be a reduction of the PRI, but the volume of gross savings (and thus the volume of aggregate investment expenditure) will not be systematically affected. The latter could remain constant, or slightly increase, or slightly decrease, depending on the contingent circumstances of each particular case.

Inversely, a general increase of the market participants' time preference schedules would simultaneously reduce the supply of present goods and increase the demand for present goods. On the time market, the PRI would therefore tend to increase, while aggregate investment expenditure, respectively the volume of gross savings, would not be systematically affected.

If one assumes that the demand for and the supply of present goods can simultaneously move in the same direction, then even more combinations are possible. Figure 12 show that, if the supply of present goods increases along with the demand thereof, then the volume of gross savings tends to increase, while the PRI will not be systematically affected. (Inversely, if for analogous reasons both the supply of and the demand for present goods diminish, the opposite effects will result.)

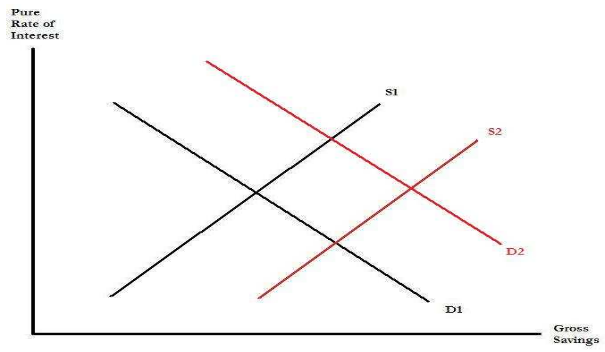


Figure 12
Impact on the Time Market of a Simultaneous Increase of the Supply of and Demand for Present Goods

This could for example be the case in an economy that attracts foreign savings and at the same time an influx of immigrant workers – a scenario that applies to countries such as US. One can also imagine that an endogenous population becomes simultaneously more parsimonious (supply of present goods increases) and more willing to work (demand for present goods increases), a scenario reminiscent of post-war Germany. In any case, this distinct theoretical possibility suggests that vigorous growth can occur at a constant PRI – a possibility neglected in the conventional Austrian account of economic growth.

These considerations lead to a surprising conclusion. Indeed, *it follows that virtually any PRI can go in hand with virtually any volume of gross savings*. In other words, it is not necessarily the case that a reduced PRI goes in hand with a higher volume of investment expenditure, as in the scenario that monopolises conventional Austrian theorising of about the structure of production. It follows that within the Austrian framework one can very well envision different growth scenarios. In Hülsmann (2008) we have distinguished two basic growth scenarios. Below we will argue that there are in fact five such basic growth scenarios.

The Relationship between the PRI and the Length of Production Reconsidered

The growth scenario analysed in conventional Austrian macroeconomics is the *only* growth scenario spelled out in any detail. The starting point of the analysis is always an increase of the gross savings rate (shift of the supply curve on the time market), and this increase is held to *always* entail the following two consequences: (A) a reduction of the PRI and (B) a lengthening of the time structure of production, and thus economic growth.[7] However, we

7 See Hayek (1931, p. 50), Rothbard (1993, p. 471).

shall see with the help of the following counter example that consequence (B) does not always follow.

In order to simplify our numerical illustrations, we will suppose that *all* original factors of production are used (and paid for) *exclusively in the most upstream stage*. Thus consider the following example of the spending streams in an initial general equilibrium:

159—138—120—104—90

Figure 13
Spending Stream within a Simplified Structure of Production

Figure 8 needs to be read from left to right. The first number (159) represents total spending on consumers' goods (first-order goods), in units of money, for example, tons of gold; the second number (138) represents total spending on the products of the next stage upstream, and so forth. Thus we here suppose a time structure of production with four stages. According to our simplifying hypothesis, all original factors are used in the fourth stage. In that stage, capitalist-entrepreneurs earn a total revenue of 104 tons of gold and they purchase original factors (but no producers' goods) for 90 tons. Thus aggregate original factor revenues are 90 tons.

Total spending at each stage is equal to the total spending at the previous stage discounted by a factor equal to the PRI, and the PRI is by definition the same for all stages of production. In our above example, the PRI is 15 percent, rounding errors being neglected for the sake of simplicity. Thus total spending on the products of the second stage (138) is equal to 159 divided by (1+0.15); total spending on the products of the third stage (120) is equal to 138 divided by (1+0.15), respectively it is equal to 159 divided by the square of (1+0.15); and so forth. In other words, our spending stream is a geometric sequence of the following sort:

$C ; C(1+i) ; C(1+i)2 ; C(1+i)3 ; ...; C(1+i)n$

It follows that aggregate spending (by definition equal to aggregate demand respectively to aggregate gross revenue) within this stylised structure of production can be calculated as follows:

$$AS=C+C(1+i)+C(1+i)2+C(1+i)3+\ldots+C(1+i)n$$

Equation 1
Aggregate Spending within a Simplified Structure of Production

Aggregate spending in our example is 611 tons of gold (159+138+120+104+90=611). Because of the hypothetical constancy of monetary conditions, the aggregate gross investment of 452 tons (611-159=452) is necessarily equal to aggregate gross savings, which corresponds to a gross savings rate of about 73 percent (452 divided by 611). The structure of production is in equilibrium at a PRI of about 15 percent and a length of 4 stages. We can summarise the initial equilibrium situation as follows:

AS	Number of stages	Interest rate	Gross savings rate	Gross savings	Consump-tion	Spending Stream
611	4	0.15	0.73	452	159	159—138—120—104—90

Table 2
Key Structure of Production Data of Initial Final Equilibrium

In order to study the impact of changes occurring on the time market, we will continue to make the usual assumptions designed to facilitate numerical illustration and comparison. That is, we continue to assume, with Rothbard, constant Aggregate Spending (to exclude the influence of monetary factors), an evenly rotating economy (to exclude the appearance of risk premiums), and the absence of consumer credit.

Consider now the consequences of an increase of savings. Suppose that there is an increase of the supply of present goods (savings) and that therefore the time market settles at a PRI of 2 percent and aggregate gross savings of 518 tons of gold (which makes for a 84 percent gross savings rate). Because savings increase by 66 tons, there must be a corresponding reduction of consumer expenditure, which falls from 159 to 93 tons. The resulting spending stream and other key data within the structure of production are then is as follows:

AS	Number of stages	Interest rate	Gross savings	Gross savings	Consump-tion	Spending Stream

			rate			
611	6	0.02	0.84	518	93	93—91—89—87—85—84—82

Table 3
Key Structure of Production Data of New Final Equilibrium in Accord with Conventional Theory

Clearly, in this case we have reconstructed the conventional Austrian scenario, in which a diminishing PRI and a higher volume of savings go in hand with a longer structure of production (six rather than four stages).

But now let us consider a different possibility. Suppose that the demand for present goods, for whatever reason, is very inelastic around the initial equilibrium and that, as a consequence, the increase of savings entails essentially a strong drop of the PRI from 15 to 2 percent, whereas aggregate gross savings only increase from 452 to 453 tons of gold. We are not here concerned with the likelihood of this scenario, but merely with its implications for the time structure of production. The resulting spending stream and other key data are now as follows:

AS	Number of stages	Interest rate	Gross savings rate	Gross savings	Consump-tion	Spending Stream
611	3	0.02	0.74	453	158	158—154—151—148

Table 4
Key Structure of Production Data of New Final Equilibrium Contradicting Conventional Theory

The structure of production has become *shorter*, despite the slight increase of savings and the very substantial drop of the PRI. This result squarely contradicts one of the main tenets of conventional Austrian capital theory, according to which the PRI is always negatively related to the length of the structure of production. As we see in our example, at least in some cases the PRI is positively related to the length of the production structure. A higher PRI can go in hand with a longer structure of production, and a lower PRI can go in hand with a shorter one.

The reason for the apparent irregularity that we have just discussed is that the PRI is not negatively related to the roundaboutness of production (to the number of production stages).

Rather, it is precisely the other way round.[8] The higher the PRI, the higher is the discount between the revenues of any two stages; in other words, the higher the PRI, the higher is the difference between revenue and cost expenditure in each stage. But if there is no change in aggregate demand, and if (as in our example) consumer expenditure is by and large stable, then this can only mean that a higher PRI "pushes investment expenditure back" further upstream.

AS	Number of stages	Interest rate	Gross savings rate	Gross savings	Consumption	Spending Stream
611	3	0.02	0.74	453	158	158—154—151—148
611	4	0.145	0.74	453	158	158—137—120—105—91
611	5	0.217	0.74	453	158	158—129—106—87—72—59
611	6	0.259	0.74	453	158	158—125—99—79—62—49—39
611	7	0.286	0.74	453	158	158—122—95—74—57—44—34—27
610	8	0.305	0.74	452	158	158—121—92—71—54—41—31—24—18
610	9	0.317	0.74	452	158	158—119—91—69—52—39—30—22—17—13
610	10	0.325	0.74	452	158	158—119—89—67—51—38—29—22—16—12—9
611	11	0.331	0.74	453	158	158—118—59—67—50—37—28—21—16—12—9—6
611	12	0.333	0.74	453	158	158—118—88—66—50—37—28—21—15—11—8—6—5

Table 5
Numerical Simulation of Key Structure of Production Data at a Constant Gross Savings Rate of 74%

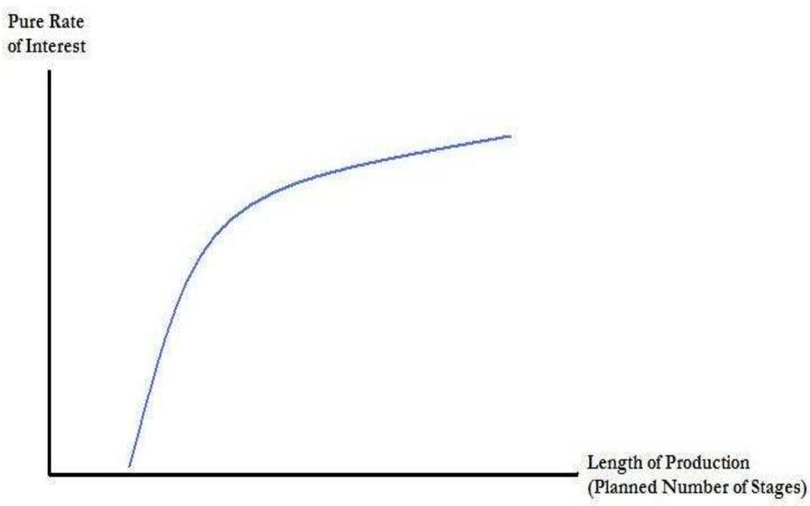
Let us illustrate this fact with a numerical simulation. Thus consider the above structure of production data, based on a constant gross savings rate of 74 percent, and omitting rounding errors (Table 5). They show that the number of stages *increases* as a consequence of an

8 In his brilliant paper, Renaud Fillieule (2007) notices this fact, based on a mathematical derivation of the relation between the average production period on the one hand, and the pure interest and consumer expenditure on the other hand. However, he neglects and almost refuses to come to grips with his discovery. He states: "This formula is interesting in that it shows that a diminution of the rate of interest *by itself* – i.e. in the unrealistic case where *i* decreases without any change in the ratio (I/O) – would lead to a *shortening* of the structure." (p. 202) Similarly, in the conclusion of his paper he further downplays his finding by stating on account of the aforementioned formula that "it shows that *with this kind of structure* [my emphasis, JGH], the average length is directly – and not inversely – related to the rate of interest." (p. 208) Because of the absence of any genuinely economic explanation of this finding, upon first reading Fillieule's paper, I was convinced there must be an error somewhere in the mathematical derivation of the formula. Being absorbed by other projects, I did not take the time to examine it in detail. Only some two years later, when I set out to develop some numerical and graphical illustrations of the Austrian model for my macroeconomics class at the University of Angers, did I stumble upon the same finding. At that time I had forgotten Fillieule's paper, which I "rediscovered" a few months later, only to find that he had anticipated much of my own work.

increase of the PRI. Whatever the level of aggregate expenditure, and whatever the aggregate savings rate (respectively the aggregate investment rate), an increasing PRI means that there are larger spreads between revenue and costs at each stage of production. Even if *consumer* spending remains constant, as in our simulation, there is an absolute decrease of business spending in each stage, with a snowballing tendency as one moves upstream. Where does the spending go? It can only go upstream, creating adding new stages of production and thus lengthening the overall production process.

Table 5 also shows that there is a ceiling for the possible level of the PRI. At the gross savings rate assumed in the above example, the ceiling seems to be around a PRI of 34 or 35 percent. As the PRI approaches this ceiling, its impact on the length of the structure of production grows exponentially. Moreover, it can be inferred from Table 5 that there is a minimal number of stages for each gross savings rate that does not depend of the PRI. In the above case, for example, it is impossible to have less than three stages, because the gross savings of 453 tons of gold cannot be profitably spread out over only one higher stage, with consumption expenditure in the first stage of only 158 tons.

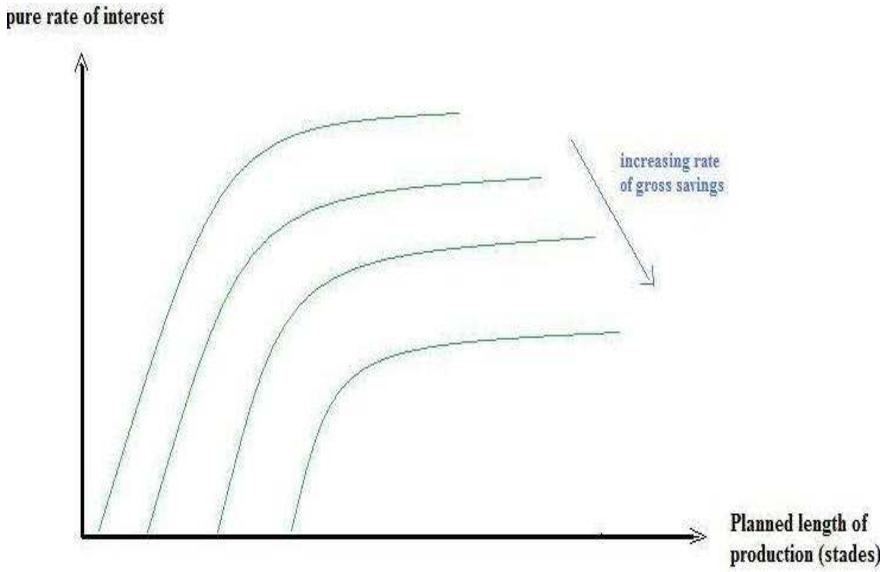
We can illustrate these findings concerning the relationship between the PRI and the length of the structure of production with the help of the following Figure 14:



<u>Figure 14</u>
Relation between the Pure Rate of Interest and the Number of Production Stages

This curve holds for a given gross savings rate. At a higher savings rate, the curve shifts to the right, because the additional spending can only be made within additional stages upstream.

(See numerical simulations in Appendix I). Thus we obtain the Figure 15 representing the impact of the gross savings rate.



<u>Figure 15</u>
Relation between the Pure Rate of Interest and the Number of Production Stages at Different Gross Savings Rates

Notice that, at increasing gross savings rates, the minimal number of stages increases whereas the ceiling on the PRI diminishes. In other words, an equilibrium structure of production can accommodate *any* gross savings rate, if only the PRI is sufficiently low.

Let us highlight again that the positive relation between the PRI and the roundaboutness of production squarely contradicts the conventional Austrian theory of interest, according to which an increase of the PRI tends to entail a shortening of the structure of production; whereas a decrease of the PRI tends to entail a lengthening of the structure or production.

No such anomaly appears as far as the impact of the gross savings rate on the length of the structure of production is concerned. Here numerical simulations confirm the account that we find in conventional Austrian theory, namely, that the savings rate is positively related to the length of production. The reason is that, at any given the PRI, more savings imply lower consumer expenditure, so that downstream investment expenditure will decline accordingly. The only place where this spending can go is further upstream, creating new industries for higher order goods.

The numerical simulation displayed in Table 6 is based on a constant PRI of 10 percent, again omitting rounding errors. The figures suggest that there is ceiling for the possible level of the gross savings rate. Such a ceiling must exist for any positive PRI because the revenue of the last stage cannot be zero or less. Moreover, it can be inferred from Table 6 that there is *no* minimal number of stages for each PRI.

AS	Number of stages	Interest rate	Gross savings rate	Gross savings	Consumption	Spending Stream
612	1	0.1	0.47	291	321	321—291
612	2	0.1	0.63	388	224	224—203—185
613	3	0.1	0.71	437	176	176—160—145—132
611	4	0.1	0.75	464	147	147—133—121—110—100
611	5	0.1	0.79	483	128	128—116—105—96—87—79
613	6	0.1	0.81	498	115	115—104—95—86—78—71—64
612	7	0.1	0.82	507	105	105—95—86—78—71—65—59—53

Table 6
Numerical Simulation of Key Structure of Production Data at a Constant PRI of 10%

We can illustrate these findings concerning the relationship between the gross savings rate and the length of the structure of production with the help of the following Figure 16:

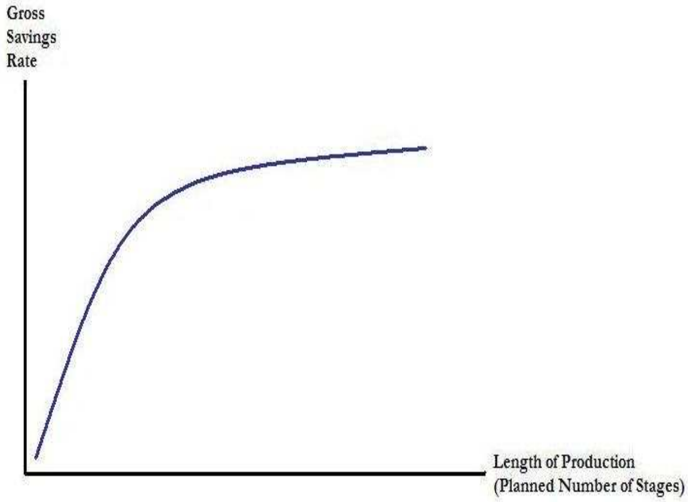
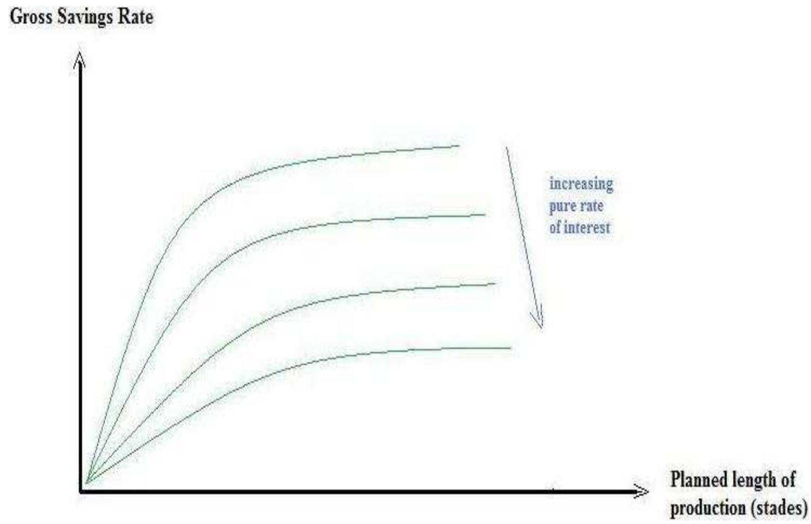


Figure 16
Relation between the Gross Savings Rate and the Number of Production Stages

This curve holds for a PRI. At a higher PRI, the curve shifts to the right, because the spread between revenue and cost increases at each stage, pushing spending back to additional stages upstream. (See numerical simulations in Appendix I). Thus we obtain the Figure 17 representing the impact of PRI on the relation between the gross savings rate and the length of production:



<u>Figure 17</u>
Relationship between the Gross Savings Rate and the Number of Production Stages at Different Pure Rates of Interest

To sum up, our analysis has stressed an anomaly that appears, from the point of view of conventional Austrian macroeconomics, as far as the relation between the PRI and roundaboutness is concerned. We have demonstrated that increases of the pure interest rate tend to lengthen the structure of production, rather than to shorten it; and inversely, a lower PRI tends to entail less roundabout production processes.

This fact contradicts the core tenet of the time-preference theory of interest. According to this theory, a lower time preference is tantamount to a greater willingness to wait for productive efforts to come to fruition. In other words, low time-preference persons will at all times and all places have a tendency to embark on more long-term projects than similar people with a higher time-preference. In a monetary economy, things are not fundamentally different. The same universal relation between time preference and the planning horizon subsists. The only difference is that this relation is now mediated through the interest rate. A lower time preference entails a tendency for interest rates to drop, and this drop of the interest rate incites investors to make additional investments upstream, thus lengthening the structure of production.

However, as we have seen, these claims are not true and are indeed the exact opposite of the truth. This raises two questions: First, why has this error been overlooked for such a long time? Second, what is the meaning of the positive relation between the PRI and the length of the production structure? We cannot at this place go into full detail trying to answer these questions. We can merely suggest a few elements that are part of the answers.

As far as the first question is concerned, three circumstances seem to have played a role in maintaining what, all things considered, must be called an astonishing lapse.

One, there was without any doubt a certain intellectual laziness. The basic “universal” relation between time preference and the investment horizon intuitively makes sense and finds, within the context of a monetary economy, a ready confirmation in the standard savings-based growth scenario that more or less monopolised the attention of Austrian economists. As a consequence, until very recently nobody had a closer critical look.

Two, the main point of the conventional Austrian model was to disproof the standard Keynesian respectively neo-mercantilist claim that growth depends on the level of monetary spending and the price level. Further development of the conventional model was of secondary importance next to combating this formidable opponent.

Three, Austrian scholars have also been misled by the implications of a purely technical device, namely, the Hayekian triangle. The triangle cuts the horizontal coordinate at point zero. With this starting point, the only possibility of accommodating higher savings at a lower PRI is, indeed, through a lengthening of the structure of production (see Figure 8, above). However, as we have seen, the triangle is a wrong representation of reality precisely in this regard. Cost expenditure in the last stage of production is not zero, but positive, and can be very substantial from an aggregate point of view, especially in a developed economy, in which the last stage uses capital goods that have been produced in previous periods. Hence, Rothbard’s trapezoid representation of the time structure of production is preferable to Hayekian triangles, and such trapezoids can easily be used to illustrate the positive relation between the PRI and roundaboutness. Indeed, in the trapezoid figure proposed by Rothbard, the surface under the expenditure curve is equal to the amount of aggregate spending:

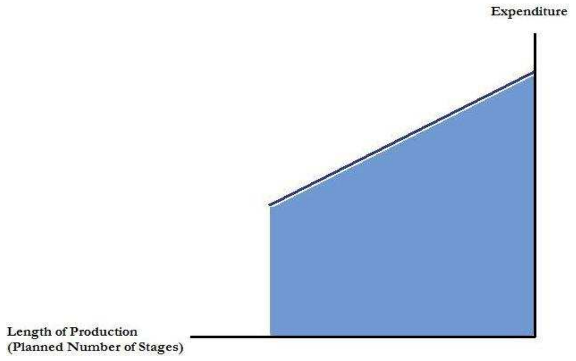


Figure 18
Aggregate Spending within the Structure of Production

It follows that if the curve becomes steeper (the PRI increases), the total volume of spending must diminish; and if the curve becomes flatter (the PRI diminishes), the total volume of spending increases.

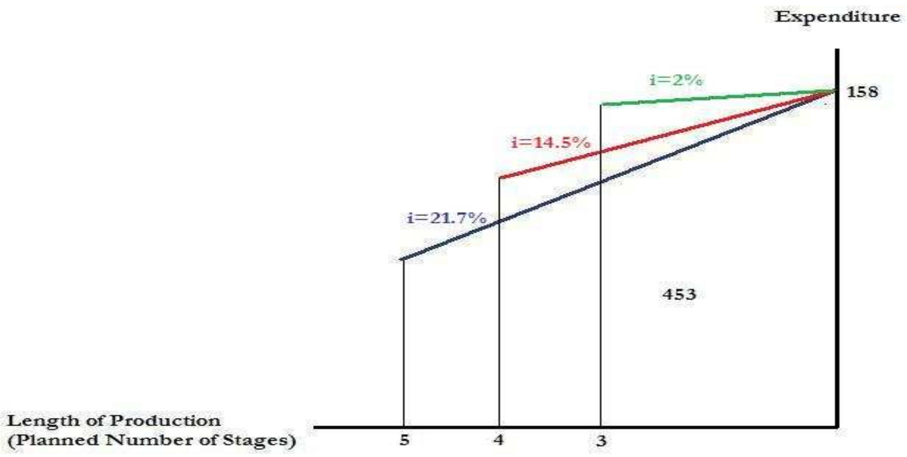


Figure 19
Impact of a Varying PRI at a Given Gross Savings Rate

Figure 19 is a graphical illustration of the first three lines of Table 5, in which we had given a numerical simulation of the key structure of production data at a constant gross savings rate of 74 percent. Because the gross savings rate does not vary, total consumer expenditure is always 158 tons of gold, and total savings (equal to total investment expenditure) is always 453 tons. At an interest rate of 2 percent (top green line), the 453 tons of savings are spent within three stages of production; at an interest rate of 14.5 percent (middle red line), the 453 tons of savings are spent within 4 stages; and at an interest rate of 21.7 percent (bottom blue line), it needs 5 stages to spend those 453 tons.

Now let us briefly turn to the second question we raised above, namely, the question pertaining to the meaning of the positive relation between the PRI and the length of the structure of production. What is the economic role or function of a lengthening of the structure of production resulting from an increase of the pure rate of interest? There is at least one function that we have already stressed in a different context, although at the time were still holding the conventional model to be accurate. In Hülsmann (2009) we have highlighted the fact that a higher PRI thins out the upstream stages. Fewer investments are made upstream and these investments earn a relatively high return, which means that the firms are relatively safe from insolvency. Yet this means nothing else but that the structure of production becomes more robust. Unforeseen events have a less dramatic impact on the solvency of the different firms and, thus, on the stability of entire network of firms. In short, higher interest rates switch the structure of production into "safety mode." Inversely, a lower PRI enlarges the upstream stages. Relatively more investments are now made upstream, and in each stage firms operate at lower margins. The economy is therefore more vulnerable to unforeseen events.

Again, we propose these reflections as tentative steps toward a more systematic analysis of the causes and consequences of variations of the PRI. Our main point at this stage of the enquiry is the plain fact, completely overlooked until very recently, that the PRI is positively related to the length of the structure of production. From this starting point, we can now venture to reconstruct the Austrian approach to macroeconomics.

In the following chapter, we will elaborate, very much in tune with Fillieule (2007), a model of the relations between three macroeconomic or structural variables, namely, the interest rate, the gross savings rate, and the length of the structure of production. We shall apply this model to analyse different growth scenarios and their impact on the distribution of monetary and real revenues. We will also use this model to discuss human capital formation, consumer credit, and changes in monetary conditions. A subsequent chapter will then deal with the analysis of booms and busts.

Toward a Richer Theory of the Structure of Production

The conventional theory of the structure of production suffers from an overly narrow focus on just one scenario for savings-based growth, respectively for capital consumption. The real world is richer than that. In the present chapter, we will therefore try to develop some new analytical tools to cope with this reality. Our main objective is to prepare toward an encompassing and systematic theory of the possible modifications of the structure of production.

Structural Variables

As we have stated in the introduction, the main point of the conventional Austrian model of the structure of production is (1) to explain how higher savings entail growth; (2) to show that this growth process is independent of the level of monetary spending and the price level; and (3) to explain how monetary expansion can cause inter-temporal disequilibria. As we have seen, the Austrian model stresses a small number of structural variables that are held to determine growth. These are the interest rate (i), the gross savings rate (s), and the length of the structure of production, approximated in our account by the number of stages of the same length (n). These three variables are interdependent. Their relations can be represented verbally, algebraically, and graphically. In the present section, we will briefly consider an algebraic representation and then turn to propose a graphical model that we shall use to illustrate our subsequent discussions.

Figures 15 and 17 illustrate the important fact that not all combinations of the structural variables (s, i, and n) are possible in final equilibrium. For example, at a given length of the structure of production, the higher the gross savings rate, the lower must be the PRI, lest there be no equilibrium at all; and inversely, the higher the PRI, the lower must be the gross savings rate. The explanation of this fact is that there is a quantitative relationship – though not a constant one – between the structural variables. For the simplified setting that we have considered in our previous discussion – notably assuming that all originary factors are used only in the most upstream stage – this quantitative relationship can be derived from Equation 1, which we have introduced above:

$$AS=C+C(1+i)2+C(1+i)2+C(1+i)3+\ldots+C(1+i)n$$

<u>Equation 1</u>
Aggregate Spending within a Simplified Structure of Production

Equation 1 contains absolute spending variables, namely, aggregate spending (AS), aggregate consumer expenditure (C), and – by implication – aggregate gross savings (S). It is therefore tempting to misread the equation, as suggesting that the structure of production depends on absolute spending levels. However, the equation can be transformed and reduced to a relation between the structural variables (for the derivation, see Appendix II). Thus one obtains the following Equation 2:

$$s= (1+i)n-1- 1(1+i)n- 1$$

<u>Equation 2</u>
Cardinal Relation between the Gross Savings Rate (s), the Pure Rate of Interest (i), and the Number of Stages of Production (n) in a Simplified Setting

The cognitive value of Equation 2 is rather limited. It holds only for the possible but unlikely setting that we have assumed to simplify our previous discussion. It can therefore not be applied to more probable – and more complex – cases, in which originary factors are used in varying degrees in different stages of production. Moreover, the equation does not express any insight that was not previously gained through verbal or discursive reasoning. Actually, it is far from being a self-evident expression of the basic relations that we identified beforehand. It needs far more than basic mathematical training to infer from Equation 2 that there is a positive relation between the interest rate and the length of the structure of production, and a negative relation between the interest rate and the savings rate. In short, Equation 2 is unsuitable as a pedagogical device.

What Equation 2 does is to illustrate, for one very simple setting, the fact there are cardinal relations between the structural variables. But these cardinal relations are contingent because the setting itself is contingent, for the reasons that Mises, Hoppe, and other Austrian economists have stressed in their writings on the epistemology of economics. Therefore, Equation 2 is of general significance only to the extent that the *ordinal* relations between the structural variables are universal. There is always and everywhere a positive relation between the interest rate and the length of the structure of production; and there is always and everywhere a negative relation between the interest rate and the savings rate

As a pedagogical device, we propose to summarise the basic interdependence between the structural variables with a four-quadrant graphical illustration (Figure 20) featuring the following panels:

(I) a panel representing the time structure of production, in the form of a Rothbardian trapezoid;

(II) a panel representing the macroeconomic budget line expressing the fact that monetary conditions (demand for and supply of money) determine aggregate spending, which in turn is composed of aggregate consumer expenditure and aggregate investment expenditure (equal to gross savings);[9]

(III) a panel representing the time market;[10]

(IV) and a panel representing the relation between the PRI and the length of the production structure (our above Figure 14).

9 Fillieule (2005, p. 3) calls this the "line of aggregate expenditure." He relies on Reisman's (1996, pp. 536-540) concept of "invariable money." Our conception differs marginally from this approach in that we distinguish between the demand for money and the money supply as two distinct – though not always independent – factors determining aggregate expenditure.

10 The time market is more encompassing than the market for loanable funds used in Garrison's (2001) graphical model. For a critique of Garrison's model, see Hülsmann (2001) and Fillieule (2005).

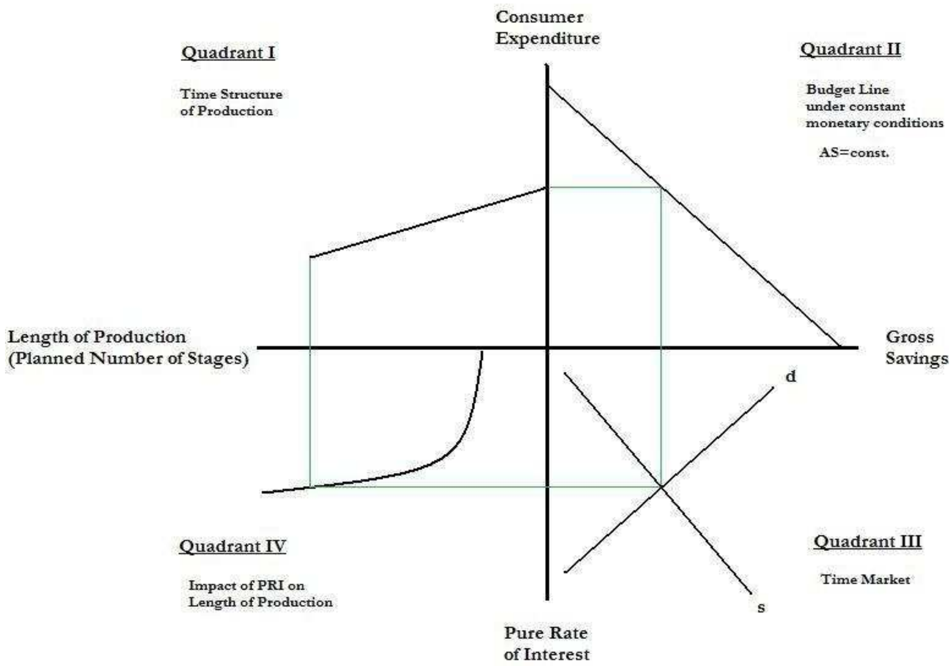


Figure 20
A Structure of Production as Determined by Interdependent Structural Variables

Figure 20 represents an economy in final general equilibrium. The partial equilibrium on the time market (Quadrant III) yields a pure rate of interest and a total volume of gross savings that are being exchanged for factors of production and for IOUs. Monetary conditions, which determine the budget line respectively the level of aggregate spending (Quadrant II), are assumed to be stable. One part of aggregate spending comes in the form of investment expenditure. This part is equal to the total volume of gross savings precisely because we assume monetary conditions to be stable – there is no hoarding or dishoarding, and no money production. As a consequence, all money units that are not used for consumer expenditure are saved and are spent on factors of production, either directly or through financial intermediaries.[11] The partial equilibrium on the time market in conjunction with the budget line implies a certain volume of aggregate consumer expenditure on which the structure of production is built (Quadrant I). The length of the structure is determined by the total volume of gross savings and by the PRI. This co-determination is displayed in the curve of Quadrant IV (Figure 14), a curve that represents the relation between the PRI and the length of the structure of production *at a given gross savings rate*. The PRI determines the

11 We still suppose that there is no consumer credit. We will drop this assumption in a subsequent section.

discount rate between the different stages of production and therefore, as we have seen, the length of the structure of production.

It needs to be stressed from the outset that the four-quadrant scheme in Figure 20 represents only the *interdependence* of the structural variables, but not the *causal relationships* that are here at work. The ultimate causes of the structural variables are the subjective values of the market participants. These values entail all prices, revenues, and allocation of factors of production within the time structure of production (Quadrant I). The *same* values are reflected in the demand for and supply of present goods and future goods on the time market (Quadrant III), which is nothing but a summary or aggregate expression of the time structure of production (Quadrant I), where *the very same* present goods and future goods are being exchanged in different stages. The two quadrants I and III therefore represent the same fact from two different points of view (aggregate and disaggregated according to the stages of production). The other two quadrants (II and IV) too do not represent elements of causal chain or sequence of events. Rather, they represent material or mechanical relations through which human values come to be reflected in the structure of production. Quadrant II displays the mechanical fact that the same dollar cannot be used at the same time for consumer expenditure *and* for investment expenditure *and* for cash hoarding, but only for one of these uses. Quadrant IV represents the mechanical fact that a rising PRI makes it necessary to spread out investment expenditure in new stages upstream.

Let us now proceed to show how this graphical tool can be used to illustrate modifications of the structure of production. As a first step consider the type of modification that has centre stage in the conventional Austrian account of savings-based growth, respectively of dis-saving and capital consumption. Figure 21 (below) represents three different final equilibrium situations. The first one is the initial equilibrium displayed in Figure 20 characterised by an initial total volume of gross savings (S1) and a corresponding gross savings rate of S1/AS. The second equilibrium represents a lengthening of the structure of production subsequent to an increase of gross savings (from S1 to S2) along with a drop of the PRI. The third equilibrium represents a shortening of the structure of production due to capital consumption. It results from a drop of gross savings (from S1 to S3) along with a rise of the PRI. As we have seen in the previous chapter, the impact of the PRI on the roundaboutness of production depends on the gross savings *rate*. To take account of this fact, in Quadrant IV we therefore have to replace Figure 14 with Figure 15.

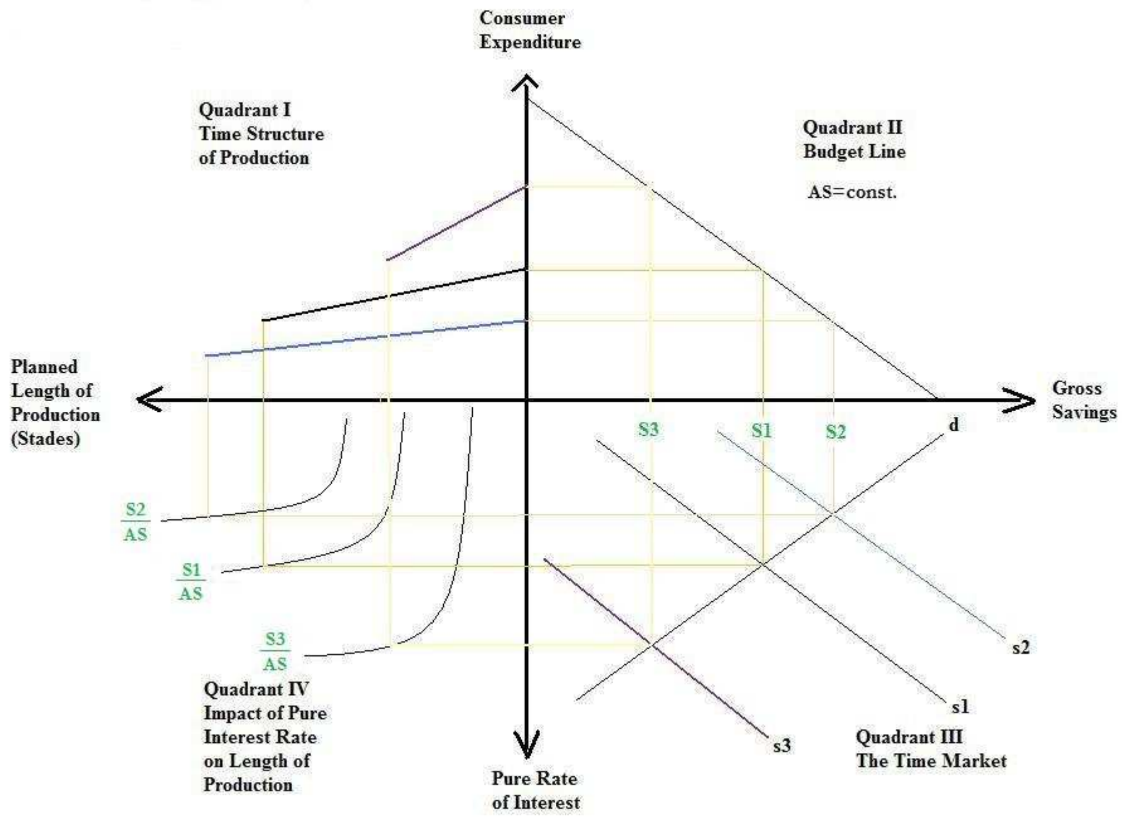


Figure 21
Interdependence between Structural Variables at varying Gross Savings Rates

Again, this four-quadrant scheme is merely an illustration of insights that we have gained on other grounds. It does not add to our knowledge, but serves as a pedagogical tool to visually convey the interdependence between the variables that, from the Austrian point of view, determine the time structure of production. In what follow we will apply it to illustrate our discussion of growth, distribution, and other issues.[12]

Human Capital

It is customary to distinguish between original factors of production (land, labour) and produced factors of production (capital goods). However, original factors very rarely exist in their state of nature. Most of them have been altered through various acts of production. They include an original component and a capital component. A piece of arable soil is composed of

12 In the present work, we focus on capital-based growth mechanisms. This does not exclude the presence of other mechanisms, for example, as in endogenous growth theory. See Young (2009) and Engelhardt (2009).

the original land and the various modifications designed to make it more easily arable and abundant. Similarly, each human person is a complex living being, endowed with various original attributes, talents, and aspirations of a physical, intellectual, and spiritual kind, as well as with additional “cultural” attributes, dispositions, abilities, and aspirations that have been produced through a long-winding and ongoing educational process. Such cultural acquisitions range from table manners and discipline at work over the respect of honesty and contracts to the ability to love and trust God and people. What makes a human being truly a “person” is a cultural achievement. We can call a person’s cultural acquisitions the human capital of that person.

Human capital is a capital good in the exact sense in which we speak of capital goods in general, namely, in the sense that it yields “income and other useful outputs over long periods of time.”[13] Not all spending made to increase human capital is made in order to obtain future monetary revenue. However, there are incentives to invest in human capital for exactly the same reasons that lead to investments in material capital goods. From the point of view of the theory of the structure of production, human capital has four particular features:

(1) It is permanent (ideas do not wear) and therefore does not need to be reproduced and replaced.

(2) part of it is non-specific (table manners, honesty, serviceableness, etc.) and part of it is specific (engineering skills, knowledge of capital theory, etc.)

(3) it is inseparable from the person;

(4) a large part of it is produced for other purposes than monetary revenue.

We can define *investments* in human capital as that part of spending made to increase human capital that is made in order to obtain future monetary revenue. Investments in human capital are competing with all other projects into which these sums could have been invested. The resources used to form human capital (food, teaching materials, materials used to built

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13 G.S. Becker, *Human Capital* (3rd ed., Chicago: University of Chicago Press, 1994), p. 15. The author continues: “Schooling, a computer training course, expenditures on medical care, and lectures on the virtues of punctuality and honesty are capital too in the sense that they improve health, raise earnings, or add to a person's appreciation of literature over much of his or her lifetime. Consequently, it is fully in keeping with the capital concept as traditionally denned to say that expenditures on education, training, medical care, etc., are investments in capital. However, these produce human, not physical or financial, capital because you cannot separate a person from his or her knowledge, skills, health, or values the way it is possible to move financial and physical assets while the owner stays put.”

school houses, etc.) are *ipso facto* not available for other projects where they could also have been used.

As in the case of all other forms of capital investments, investments in human capital have to be contextual. It does not make sense to train 10,000 young men and women to become ocean-liner captains if only 100 ocean-liners exist. All capital needs to be produced in the right proportion, given the existing structure of production – in other words, given all other factors of production. It follows that there is such a thing as an optimal amount of investment in human capital. Correspondingly, it is possible that there not be enough investment in human capital; and it is also possible that investment in human capital is excessive. There can be lacking investment in training and information acquisition, but there can also be too much of it.

A currently fashionable dogma denies the second possibility. The evidence is the statistical spread of income between high-school gradates and the graduates of bachelor, master, and PhD programmes. But this evidence is irrelevant to demonstrate to point. It merely demonstrates that educational differences have an impact on income differentials. But this is beside the point. What is here in question is the overall productivity of the structure of production. By definition, all combinations of factors of production, except for the optimal one, reduce the physical productivity of the entire structure of production *as compared to that optimal combination*. It is therefore very well possible that we have too many college graduates, in the sense that this reduces the overall physical productivity of the economy. The resources needed to train these students are lacking at other places of the economy where they could have been employed more productively. Below, we will argue that today the general tendency is to overinvest in human capital, and especially to malinvest in it – the wrong type of human capital is being created at the expense of other types that could have been created instead.

Capital-Based Growth: Basic Mechanisms

Economic growth is difficult if not impossible to define because it presupposes the possibility to make comparative aggregate statements about heterogeneous goods. A growing economy is one that produces more consumer goods than in a previous period. But in the real world there is no such thing as a *ceteris paribus* increase of production. Rather, any increase of the production of some goods goes in hand with other changes, for example, with changes in living conditions. Industrial societies do not only produce more cars and airplanes than agricultural societies; they also feature fewer purely green landscapes and fewer spotlessly blue skies. No economist is in a position to state that industrial conditions are somehow "better," "more," or "preferable" to the ones prevailing in agricultural societies *and* to claim general validity for his statement. Some people might disagree and could not be proven to be wrong.

Growth theory cannot possibly overcome this difficulty. What it can do is to explain why and how it is possible to increase the production of a great number of goods at the same time, recognising that this increase is costly because it goes in hand with other changes that might be regretted. Thus we can speak of growth whenever it is possible to *generally* increase the total physical output in a given period. This definition is still not clear-cut, but the difficulties that we here confront are analogous to those encountered, for example, in defining price inflation as a permanent increase of the price level. It is difficult to say whether there is growth when the production of cars increases by 100,000 units whereas the production of airplanes drops by 5,000 units. By contrast, there would clearly be a general increase of total physical output if both car production and airplane production were to increase. This is what we have in mind when speaking about growth.

Austrian economists uphold the classical tradition in growth theory. Following Adam Smith, the classical economists have recognised three basic growth mechanisms: (1) the accumulation of capital, resulting from invested savings; (2) the division of labour; and (3) technological progress. Austrians have elaborated in particular the first and the third mechanism. They have stressed the role of entrepreneurship in promoting innovation (third basic mechanism), a point that we shall largely neglect in the present paper. Austrians have also stressed the time dimension of the investment of savings, and the negative impact of monetary policy on the inter-temporal equilibrium of investments within the structure of production (first basic mechanism). In this field, their arguments are quite essentially based on an insight first formulated by Carl Menger in his *Principles of Economics*. Menger (1976: 73f; 1871: 26ff) argued that growth results from the increasing control of evermore remote causal factors determining the production of consumers' goods:

> In its most primitive form, a collecting economy is confined to gathering those goods of lowest order that happen to be offered by nature. Since economising individuals exert no influence on the production of these goods, their origin is independent of the wishes and needs of men, and hence, so far as they are concerned, accidental. But if men abandon this most primitive form of economy,

> investigate the ways in which things may be combined in a causal process for the production of consumption goods, take possession of things capable of being so combined, and treat them as goods of higher order, they will obtain consumption goods that are as truly the results of natural processes as the consumption goods of a primitive collecting economy, but the available quantities of these goods will no longer be independent of the wishes and needs of men. Instead, the quantities of consumption goods will be determined by a process that is in the power of men and is regulated by human purposes within the limits set by natural law. […] Increasing understanding of the causal connections between things and human welfare, and increasing control of the less proximate conditions responsible for human welfare, have led mankind, therefore, from a stage of barbarism and the deepest misery to its present stage of civilisation and well-being […]

This implies that longer production processes – by the very fact that they are longer – can be physically more productive than production processes of a shorter duration. The longer the production process, the more natural forces can be converted into tools that make the production of consumer goods ever more abundant. This insight was the jump-off point for Böhm-Bawerk's magisterial contribution. Following Menger – and also W.S. Jevons – he emphasised that any lengthening of the structure of production presupposes increased savings that allow the human beings engaged in the longer process to bridge the longer time needed until the additional consumer goods were ready for consumption. In short, the larger the volume of savings, the longer the possible production processes and thus the higher the potential physical productivity of labour.

These insights about the relations between the underlying real variables in growth processes naturally raised the question how these "real relations" are modified in a monetary economy. Hayek, Rothbard, and their present-day followers answered this question by developing a model of the now conventional savings-based growth mechanism. Higher savings tend to lengthen the structure of production and thus entail a *change of relative spending within the structure of production*, to the benefit of upstream and to the detriment of downstream stages. The change of relative spending creates revenue differentials between the stages. This incites the owners of all non-specific factors (especially labour and savings) to reallocate their resources further upstream. As a consequence, more tools and other producer goods are being created, which is tantamount to increasing the physical productivity of labour in the consumer-goods industries. Hence, the aggregate physical output of the economy is being increased.

However, this conventional Austrian growth scenario needs to be nuanced. It relies on the assumption that two variations always occur simultaneously, namely, a drop of the PRI and an increase of gross savings. But, as we have seen, there is no reason to assume that these two variations always go together. An increase of the gross savings rate could go in hand with an increase of the PRI, and a drop of the PIR could occur jointly with a reduction of the gross savings rate. Hence, we have to analyse the growth effects of these variations separately, even though in actual practice they are often mixed. Decreases of the PRI can entail growth effects by changing relative spending within the structure of production. Increases of the gross savings rate can entail growth effects both by changing relative spending, and by attracting additional resources into the economy. Generally speaking, one can distinguish *three basic growth mechanisms* in a monetary economy.[14]

(1) A change of relative spending between upstream and downstream stages may result from the mere lengthening of the structure of production – that is, even if the PRI does not change. The creation of additional stages upstream *ipso facto* changes relative spending within the structure of production. The new stages create producer goods that make human labour in the downstream stages more productive. The lengthening therefore tends to entail growth.

(2) There can also be a change of relative spending within the time structure of production that results from the decrease of the interest rate. If the PRI drops, there is a simultaneous widening of the upstream stages resulting from greater expenditure, and a thinning of the downstream stages resulting from decreased expenditure. Even if the overall length of the structure of production did not increase, the relative widening of the upstream stages would have a similar effect as the previously discussed lengthening. It would attract more labour and capital upstream, thereby increasing the output of producer goods that make human labour in the downstream stages more productive. Hence, *a relative widening of the structure of production, too, tends to entail growth even if the overall length of the structure of production does not increase*.

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14 We exclude at this point endogenous growth from our consideration, because it does not seem to originate on the time market. We shall discuss endogenous growth in the context of human capital.

(3) Finally, increases of the gross savings rate, *even if they do not affect relative spending between the different stages*, increase investment spending and therefore increase the revenues of employed as compared to unemployed factors of production. They therefore create incentives for the owners of hitherto unemployed factors to sell respectively rent them out on the market. In short, increases of the gross savings rate tend to make more factors of production available, thereby increasing the total physical output of the economy.

Thus we have identified three basic mechanisms through which changes on the time market, respectively changes within the time structure of production, tend to entail economic growth. Now things get complicated because, as we have emphasised, the PRI and the gross savings rate may vary in just about any combination. As we shall see, only in one of these combinations all three mechanisms are operative. In all other combinations only two or less growth mechanisms are at work. Sometimes the mechanisms work in opposite directions. For example, a drop of the demand for present goods entails a lower PRI and a lower gross savings rate than would otherwise have occurred. The lower PRI then increases relative spending in some of the upstream stages and on that account entails growth, whereas the drop of gross savings reduces factor revenues and therefore factor employment. Will these opposite tendencies neutralise one another, or will one of them supersede the other one? Our theoretical analysis does not tell. The (contingent) quantitative impact of each of the three mechanisms can only be determined ex post for each concrete historical setting.

Scenarios of Growth and Distribution

In what follows, we shall proceed to analyse all scenarios in which at least one of the aforementioned growth mechanisms is at work, even if it is counterbalanced by one or both of the other mechanisms. We shall call these scenarios growth scenarios.[15]

We can distinguish eight such growth scenarios. Each of them is characterised by a particular variation of the time market and of the structure of production. For each of them, we shall analyse how monetary and real revenues will change for (a) savers-investors, (b) the owners of originary factors, and (c) from an aggregate point of view. Thus we get a rough

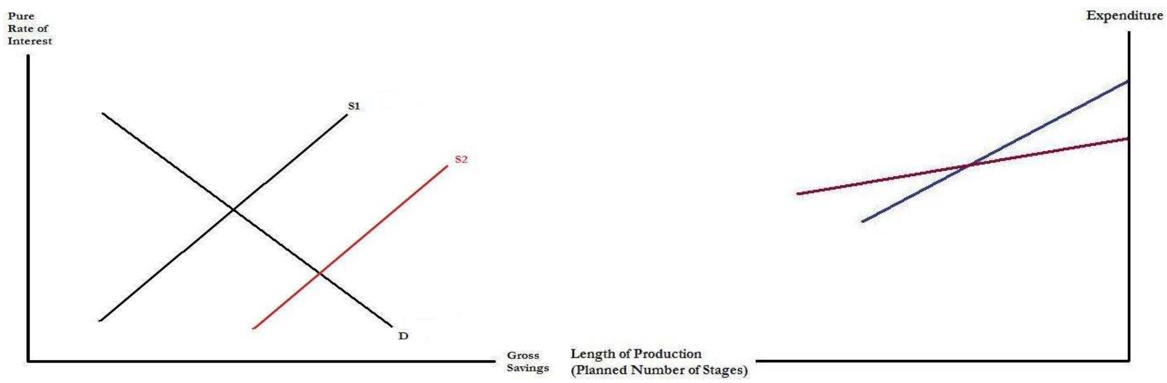
15 In Hülsmann (2008), we have distinguished two basic growth scenarios based on the distinction between the length and the width of the structure of production. We now hold that these distinctions are not precise and detailed enough and need to be superseded by the following discussion.

notion of the respective growth scenario affects the distribution of income between capitalist-entrepreneurs on the one hand, and land and labour owners on the other hand.

Moreover, for each scenario we will try to figure out in very rough terms how it ranks relative to the other scenarios in its growth potential. This ordinal ranking will be based on the number of growth mechanisms that operate *positively* (lengthening of the structure of production, change of relative spending in favour of upstream stages, increase of the gross savings rate) as well as by the number of those that operate *negatively* (shortening of the structure of production, change of relative spending in favour of downstream stages, drop of the gross savings rate). Each positive influence increases the "case probability" of growth. Each negative influence diminishes the case probability of growth.

Growth Scenario I

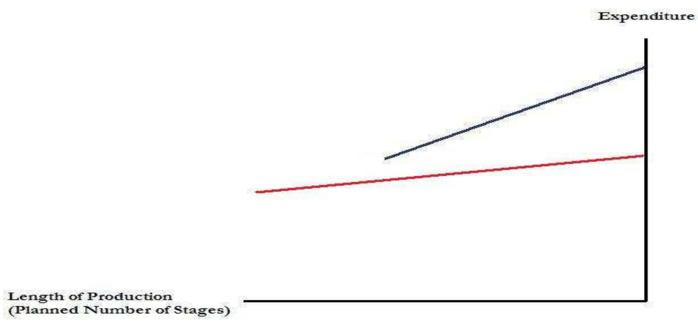
Let us start our analysis with the scenario conventional Austrian scenario of savings-based growth. It is characterised by an increase of the gross savings rate at a constant demand for present goods. This entails a drop of the PRI and also a lengthening of the structure of production. Hence, this scenario has the unique feature of positively combining all three basic growth mechanisms. It is therefore the strongest possible growth scenario. Figure 22 gives an illustration. For the sake of simplicity we do not reproduce all four quadrants, but only the panels showing the time market and the structure of production.



<u>Figure 22</u>
Growth Scenario I
Increase of the Supply of Present Goods at a Constant Demand Schedule
Entailing a Lengthening of the Structure of Production

How does this scenario affect monetary and real revenues in the new final equilibrium? What can be said about its impact on the final distribution of revenues? The general tendency of monetary revenues is to fall, because the vigorous growth occurs at constant monetary conditions, thus entailing a significant drop of the price level (growth deflation). This fall will be most moderate in the case of the owners of *non-specific* factors such as labour and energy resources (coal, gas, etc.). Their monetary revenues will tend to equal their discounted marginal value product (DMVP), which is roughly speaking equal to the arithmetic product of their marginal physical product (MPP) and the price of this physical product, divided by the interest rate.[16] In the present scenario, the MPP increases whereas the interest rate falls. On that account, therefore, the DMVP of factors of production tends to increase. However, the falling price level entails an opposite tendency, so that on that account the DMVP of factors tends to diminish. Again, the overall result depends on the particular situation of each factor. Some non-specific factors might end up earning higher monetary revenues, while others will earn less than before. The general tendency is for a slight decrease because of the strong drop of the price level.

The owners of *specific* factors of production used in the upstream stages might even end up earning higher monetary revenues. This depends on the extent of the increase of the savings rate. In Figure 22, we see that, in the new equilibrium, monetary spending is higher in some of the upstream stages than before, and that it creates entirely new incomes in the additional stages created most upstream. However, consider the following variant of Growth Scenario I, in which the gross savings rate drops so much so that it diminishes spending in all but the new stages:



<u>Figure 23</u>
Variant of Growth Scenario I
Diminished Spending in All but the Most Upstream Stages

16 For a more precise exposition with the same result, see Rothbard (1993), pp. 477-78 and Appendix A, pp. 428-431.

In this case it is likely – though not necessarily the case – that all factors except for the specific factors used in the new stages will earn lower monetary incomes than before.

What about savers-investors? Their interest incomes are subject to two opposite forces. On the one hand, they save and invest more and on that account obtain more interest payments. On the other hand, the interest rate drops and on that account they earn lower interest payments. The overall result depends on the particular circumstances of each case. We therefore have to say that the present scenario does not have any systematic implications for the monetary revenues of savers-investors.

Now let us turn to the new final distribution of *real* revenues. From the outset it is clear that the latter will strongly increase in the aggregate, because total monetary spending remains constant whereas the price level plunges. For savers-investors this implies that their real revenues will tend to increase. As we have seen, their *monetary* revenues will not be systematically affected, and thus the drop of the price level entails a tendency for their *real* interest revenue to increase. The increase of real revenues is even more clear-cut in the case of the owners of original factors. Indeed, their real revenue tends to be equal to their marginal physical product (which strongly increases) divided by the interest rate (which declines).

Growth Rank	**n**	**i**	**s**	**Monetary Revenues**			**P**	**Real Revenues**		
				Σ	**Savers**	**OF**		**Σ**	**Savers**	**OF**
1	↑	↓	↑	↓	↕	↕↓	↓↓	↑↑	↑	↑↑

<u>Table 7</u>
Key Features of Growth Scenario I

Table 7 summarises our foregoing discussion. Our analysis of the other seven growth scenarios can rely on the considerations that we have just presented and can therefore be more concise.

Growth Scenario II

Our second growth scenario is characterised by a simultaneous increase of the gross savings rate and of the demand for present goods. These changes have no systematic impact on the PRI, and thus there is no relative change of spending on that account. However, the gross savings rate is substantially higher in the new structure, which is therefore much more physically productive on that account. Moreover, the new structure is much lengthier, because with a PRI that is by and large unchanging, the greater volume of savings can only be invested upstream. Thus there are two growth mechanisms at work, and the third growth mechanism is neutral. We estimate that this is the 2nd most growth-friendly variation of the time market and the production structure.

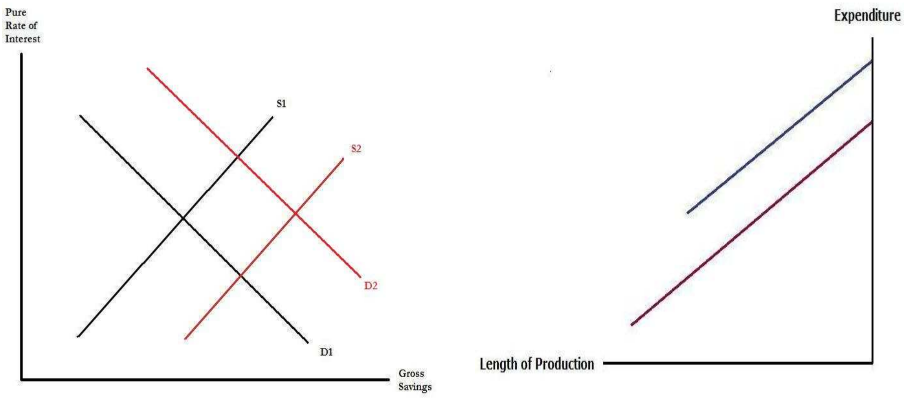


Figure 24
Growth Scenario II
Simultaneous Increase of the Supply and Demand Schedules on the Time Market

As far as *monetary* revenues are concerned, the general tendency is for them to fall, again because the growth deflation. What we have said in Scenario I concerning the monetary income of the owners of original factors of production applies in the present scenario by and large as well. (The only difference concerns the fact that in Scenario II spending drops in *all* stages, except for the new stages that are being created upstream.) One would have to expect that wages and rents remain stable or diminish slightly. By contrast, the monetary income of savers-investors will significantly increase, because the PRI does not change whereas the volume of savings strongly increases.

Real revenues will strongly increase in the aggregate. For savers-investors this implies that their real revenues will strongly increase. The owners of original factors, too, will experience a significant increase of their real incomes, for the same reasons we have spelled out in discussing Scenario I.

Growth Rank	n	i	s	Monetary Revenues			P	Real Revenues		
				Σ	Savers	OF		Σ	Savers	OF
2	↑	↕	↑↑	↓	↑	↑↓	↓↓	↑↑	↑↑	↑

Table 8
Key Features of Growth Scenario II

The present scenario is only slightly behind the first one in its positive implications for growth. (We have to keep in mind that it involves a much stronger increase of the gross savings rate than in Scenario I.) The main difference between the first two scenarios concerns their impact on the distribution of revenues. Scenario I is more favourable for income derived from original-factor ownership than for income derived from saving-investment – though both types of income increase in real terms – whereas in the present scenario it is the other way round.

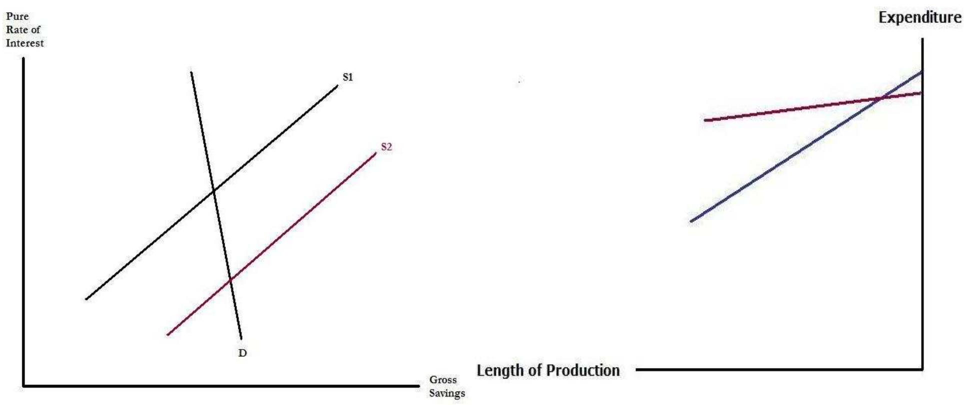
Growth Scenario III

Our third growth scenario is a variant of the first one. Like the latter, it is characterised by an increase of the gross savings rate at a constant demand for present goods, and by a drop of the PRI. However, this time there occurs no lengthening of the structure of production, because the drop of the PRI overcompensates the increase of the gross savings rate. This is the scenario that we already discussed in the previous chapter to demonstrate that the conventional Austrian growth scenario (Scenario I) is not the only one. Consider again our above numerical example. Compare the initial spending stream (Table 2) with the spending stream that we considered as a counterexample (Table 4):

159—138—120—104—90

158—154—151—148

Figure 25 gives a graphical illustration of the corresponding changes on the time market and within the production structure.



<u>Figure 25</u>
Growth Scenario III
Increase of the Supply of Present Goods at a Constant Demand Schedule
Entailing a Shortening of the Structure of Production

The old structure is lengthier, and *on that account* it is more physically productive than the new one. However, in the new one, spending in the second and third stages (as compared to the consumer-goods stage) is relatively higher than in the first structure. In this case too, therefore, more activity will be shifted from the consumer-good industries to stages of production upstream, and *on that account*, the new structure is more physically productive than the first one. Finally, the gross savings rate is marginally higher in the new structure, which is therefore more physically productive *on that account* too. We estimate that this is the 3rd most growth-friendly variation of the time market and the production structure.

The impact of this scenario on the *distribution* of monetary and real revenues is analogous to the first one. The *level* of monetary revenues will tend to be higher than in Scenario I because growth is less intense and there is therefore less pressure on prices. However, because the tendency for the economy to grow is less clear-cut than in the first scenario, the level of real revenues will also tend to be less elevated. Let us summarise these key features in Table 8:

				Monetary Revenues			P	Real Revenues		
Growth Rank	**n**	**i**	**s**	**Σ**	**Savers**	**OF**		**Σ**	**Savers**	**OF**
3	↓	↓↓	↑	↓	↓	↕	↓	↑	↕	↑

Table 9
Key Features of Growth Scenario III

The most striking feature of the present scenario is its similarity to the first one. In both case, the initial causal change is an increase of the supply of present goods (savings) on the time market. But depending on the demand for present goods (the "price-elasticity" of demand), the repercussions on the time structure of production and the impact on growth are very different. The bottom-line is that a plummeting PRI, when resulting from an inelastic demand for savings, does not necessarily make for vigorous growth.

Growth Scenario IV

We have just seen that one and the same initial change of inter-temporal values, reflected in an increase of savings at a constant demand for savings, can give rise to two very different growth scenarios. Similarly, the following growth scenario is one out of two that spring from the same initial change, namely from an increase of the demand for present goods at a constant supply of present goods. On the time market, this implies a new final equilibrium at a higher PRI and a higher gross savings rate. The structure of production lengthens, but at the same time it thins out at the higher stages, with the only exception of the new stages that are being created upstream (Figure 26).

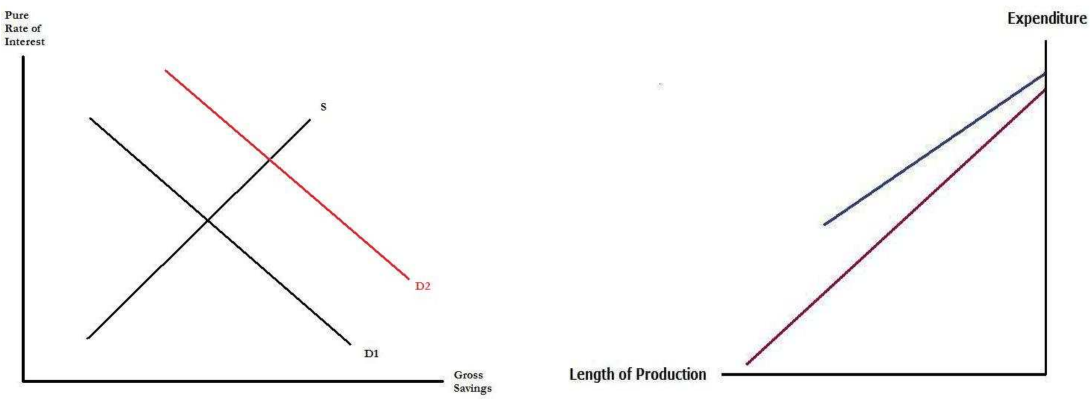


Figure 26
Growth Scenario IV
Increase of the Demand for Present Goods at a Constant Supply Schedule

The new structure becomes increasingly thinner toward the upstream, except for the very highest stages, and on that account is *less* physically productive than the new one. However, the new structure is also lengthier and on that account *more* physically productive than the old one. Last but not least, the gross savings rate is higher in the new structure, which is therefore more physically productive on that account too. We estimate that this variation of the time market and the production structure is on a par with Scenario III and falls therefore within the 3rd highest growth rank. As in Scenario III, there are here two growth mechanisms at work: the lengthening of the structure of production, and the increase of the gross savings rate; and as in Scenario III, one of the growth mechanisms is deteriorating.

The striking difference between the present scenario and Scenario II is that, in the latter case, the PRI drops, whereas here it increases. However, we hold that this difference has a systematic impact, not on growth, but on distribution only.

As far as *monetary* revenues are concerned, the general tendency is for them to fall because the growth deflation. The monetary income of the owners of original factors of production will have a clear tendency to fall (a) because spending drops in *all* stages, except for the new stages that are being created upstream; and (b) because a rising PRI means that the marginal value product of the original factors will be discounted more than before. By distinct contrast, the monetary income of savers-investors will significantly increase, because both the PRI and the volume of savings strongly increase. Scenario IV therefore implies a significant reshuffling of the relative weight of income sources. Income from factor ownership will significantly decrease relative to income from saving-investment.

Real revenues will increase in the aggregate. For savers-investors this implies that their real revenues will very strongly increase. For the owners of original factors, the situation is more ambiguous because the increase of interest rates implies a stronger discount of their marginal physical product, which could completely offset the expected increase of that marginal physical product.

Growth Rank	n	i	s	Monetary Revenues			P	Real Revenues		
				Σ	Savers	OF		Σ	Savers	OF
3	↑	↑	↑	↓	↑	↓	↓	↑	↑	↕

Table 10
Key Features of Growth Scenario IV

The present scenario is ranked on the same level of growth friendliness as Scenario III. The essential difference between these two scenarios concerns their impact on the relative weight of income types. Scenario III is more favourable for income derived from original-factor ownership than for income derived from saving-investment, whereas in the present scenario it is the other way round.

Growth Scenario V

The third growth scenario is characterised by a decrease of the supply schedule and a simultaneous increase of the demand schedule on the time market.

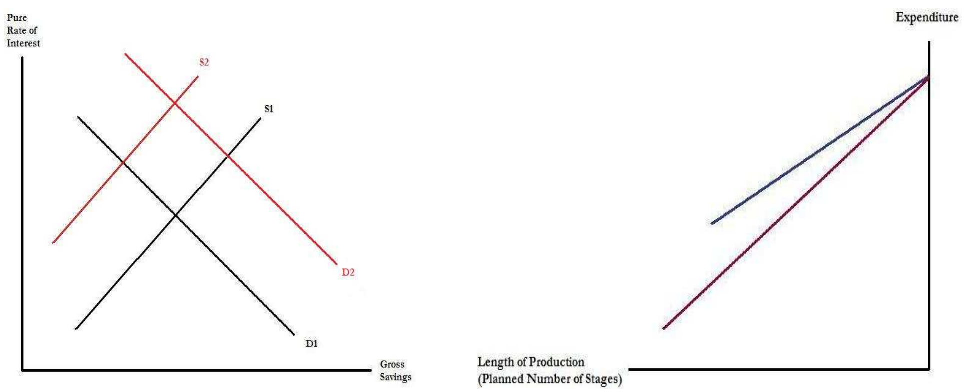


Figure 27
Growth Scenario V
Simultaneous Increase of the Supply and Demand Schedules on the Time Market

These changes have no systematic impact on the gross savings rate. The PRI is substantially higher in the new structure, which implies a lengthening of the structure of production. The latter therefore becomes more physically productive on that account. However, the same circumstance also exercises an adverse effect, as relative spending diminishes toward the upstream, with the only exception of the new stages. In Scenario V, only the lengthening of the structure of production is here favourable for growth, whereas the gross savings rate stays put, and the relative spending (except for the new stages upstream) deteriorates as far as the prospects for growth are concerned. We rank this scenario below all other scenarios that we have so far considered (4th rank). Indeed, it has no *systematic* tendency to entail economic growth. It will have this consequence only accidentally, namely, if the advantage of the lengthening more than offsets the disadvantage of the deteriorating relative spending.

As far as *monetary* revenues are concerned, the general tendency is for them to remain stable, because of the lacking growth dynamics (no growth deflation) and because consumer spending remains stable too. However, the strong rise of the PRI will have a significant impact on the relative weight of the different income classes. The monetary income of the owners of original factors of production will fall because a rising PRI means that the marginal value product of the original factors will be discounted more than before. By distinct contrast, the monetary income of savers-investors will increase, because the PRI while the volume of savings stays put.

Real revenues will by and large remain stable in the aggregate. The real income of savers-investors will increase. The income from original factor ownership will diminish, because the increase of interest rates implies a stronger discount of their marginal physical product, while there is no significant increase – if any – of the marginal physical product itself.

Growth Rank	n	i	s	Monetary Revenues			P	Real Revenues		
				Σ	Savers	OF		Σ	Savers	OF
4	↑	↑	↕	↕	↑	↓	↕	↕	↑	↓

Table 11
Key Features of Growth Scenario V

Growth Scenario VI

The sixth scenario is the exact opposite of Scenario V. It is characterised by an increase of the supply schedule and a simultaneous decrease of the demand schedule on the time market. Thus we can illustrate it with the above Figure 27, which only needs to be read backwards, with the red demand and supply schedules representing the initial situation, and the dark schedules representing the new final equilibrium.

As in Scenario V, the changes we are considering now have no systematic impact on the gross savings rate. The PRI is now substantially lower in the new structure, implying a shortening of the structure of production, which therefore becomes less physically productive on that account. However, the drop of the PRI also tends to promote relative spending upstream, with the exception of the stages that disappear. In Scenario VI, only the reshuffling of relative spending toward the upstream (except for the stages that disappear) is favourable for growth, whereas the gross savings rate stays put, and the structure of production shortens. It therefore has no *systematic* tendency to entail economic growth. We therefore rank it in category 4.

The impact of Scenario VI on monetary and real revenues is exactly analogous to the one of Scenario V. Thus its distributional consequences are the exact inverse of those that we found in that former scenario. Table 12 summarises the key features of Scenario VI.

Growth Rank	**N**	**i**	**s**	**Monetary Revenues**			**P**	**Real Revenues**		
				Σ	**Savers**	**OF**		**Σ**	**Savers**	**OF**
4	↓	↓	↕	↕	↓	↑	↕	↕	↓	↑

Table 12
Key Features of Growth Scenario VI

Growth Scenario VII

Scenario VII is the exact opposite of the above Scenario IV. It is characterised by a decrease of the demand for present goods at a constant supply of present goods. On the time market, this implies a new final equilibrium at a lower PRI and a lower gross savings rate. The structure of production shortens, but at the same time it becomes wider in the higher stages, with the exception of the stages that disappear. We can illustrate Scenario VII with the above Figure 26, which only needs to be read backwards, with the red demand and supply schedules representing the initial situation, and the dark schedules representing the new final equilibrium.

As the new structure becomes increasingly wider toward the upstream, except for the highest stages, it is on that account more physically productive than the new old. However, the new structure is also shorter and its gross savings rate is lower. Thus, Scenario VII features only one basic mechanism promoting growth, whereas the other two basic mechanisms entail the opposite tendency. It therefore seems to be barely justified to speak of a “growth” scenario at all. However, we cannot exclude on purely theoretical grounds that the one positive mechanism overcompensates the two others. This has to be determined empirically for each individual setting. In any case, this is the least probable of all growth scenarios that we have considered. We therefore rank it in a 5th category.

The impact of Scenario VII on monetary and real revenues is exactly analogous to the one of Scenario IV. Thus its distributional consequences are the exact inverse of those that we found in that former scenario. Table 13 summarises the key features of Scenario VII.

Growth Rank	**n**	**i**	**s**	**Monetary Revenues**			**P**	**Real Revenues**		
				Σ	**Savers**	**OF**		**Σ**	**Savers**	**OF**
5	↓	↓	↓	↑	↓	↑	↑	↓	↓	↕

Table 13
Key Features of Growth Scenario VII

Growth Scenario VIII

Our last scenario is the exact opposite of the above Scenario III. It is characterised by a decrease of the supply of present goods at a constant and *inelastic* demand schedule, *resulting in a lengthening of the structure of production*. On the time market, this implies a new final equilibrium at a higher PRI and a lower gross savings rate. The structure of production lengthens, but at the same time it becomes thinner in the higher stages, with the exception of the new stages. We can illustrate Scenario VIII with the above Figure 25, which needs to be read backwards, with the red demand and supply schedules representing the initial situation, and the dark schedules representing the new final equilibrium.

Just as in the preceding case of Scenario VII, the present growth scenario features only one basic mechanism promoting growth, whereas the other two basic mechanisms entail the opposite tendency. We therefore rank it in the same 5th category in which we have classed Scenario VII.

The impact of Scenario VII on monetary and real revenues is exactly analogous to the one of Scenario III. Thus its distributional consequences are the exact inverse of those that we found in that former scenario. Table 14 summarises the key features of Scenario VIII.

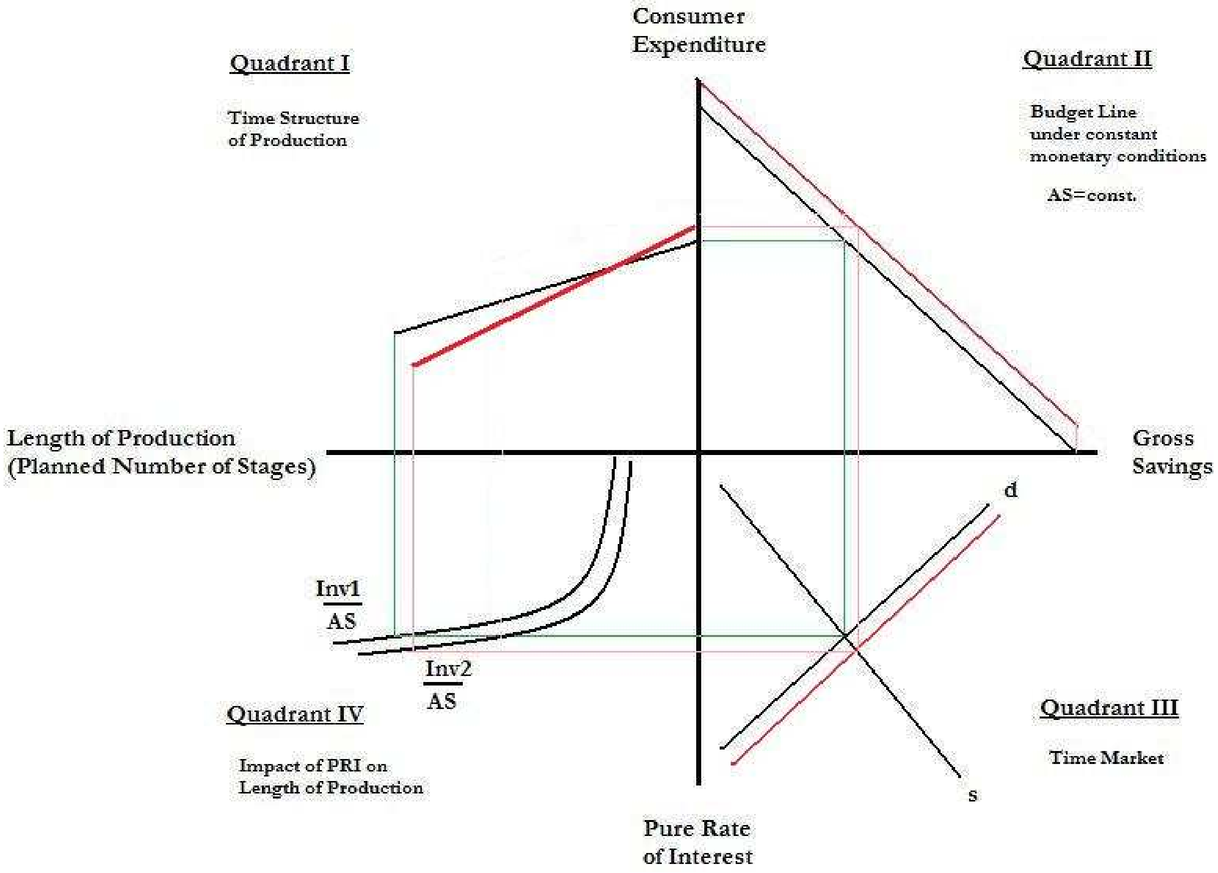
Growth Rank	n	i	s	Monetary Revenues			P	Real Revenues		
				Σ	Savers	OF		Σ	Savers	OF
5	↑	↑↑	↓	↑	↑	↕	↑	↓	↕	↓

Table 14
Key Features of Growth Scenario VIII

This completes our analysis of different growth scenarios from the point of view of the Austrian theory of capital. We shall now turn to consider two complications, by dropping previous assumptions, namely (1) the assumption that the economy operates without consumer credit and (2) the assumption that monetary conditions remain stable.

Consumer Credit

Consumer credit transfers a part of the available gross savings to consumers. Aggregate investment spending diminishes while consumer spending increases. The impact of consumer credit on the structure of production can be illustrated with Figure 28. Notice that the accounting identity between savings and investments, which resulted from our previous hypothesis, no longer exists. In our representation of the interdependence of the structural variables, we account for this by shifting the budget line upward.



<u>Figure 28</u>
Impact of Consumer Credit on the Structural Variables

Because credit is being granted on a competitive basis, the consumer-credit-induced demand for present goods tends corresponds to a right-shift of the demand schedule on the time market. As a consequence, the PRI and the volume of gross savings will tend to increase. This implies a thinning out of the structure of production in the higher stages, along with a simultaneous lengthening. However, the lengthening might be offset or even overcompensated by the simultaneous reduction of investment expenditure.

Thus we see that consumer credit has certain consequences that are similar to our growth Scenario IV (increase of the demand for present goods at a constant supply schedule). However, the important difference is that the volume of savings available for investment drops. An economy with increasing consumer credit features one single growth mechanism – *and even this one only under the most favourable circumstances* – namely, the lengthening of the structure. By contrast, the other two basic growth mechanisms have turned negative. In other words, consumer credit does nothing for economic growth. Quite to the contrary, it tends to shrink the productive potential of the economy as a whole – just as common sense would suggest. Its impact on monetary and real revenues is summarised in Table 15.

Growth Rank	n	i	s	Monetary Revenues			P	Real Revenues		
				Σ	**Savers**	**OF**		**Σ**	**Savers**	**OF**
5	↑	↑	↑	↑	↑	↕	↑	↓	↕	↓

Table 15
Key Features of the Basic Consumer-Credit Scenario

Monetary Variations

So far we have assumed that monetary conditions remain stable throughout each transformation of the structure of production from the initial final equilibrium to the new one. This assumption is of the greatest pedagogical value, as it allows us to disentangle the analysis of the relations between the structural variables from monetary considerations. But it is also a heroic assumption that threatens to invalidate the entire analysis, because money is not just a neutral veil layered over the economy. Rather, money is part of the real economy, and any change in the demand for money or in the money supply affects the distribution of revenues and therefore also the structure of production.

However, from the Austrian point of view, these money-induced structural do not necessarily show up in the aggregate. In line with classical economics, the Austrians hold that variations in monetary conditions do not have any *systematic* impact on the structure of production. A change in the demand for money will affect relative spending and relative revenues, but there is no way to tell the implications of these changes for the time market and for the structure of production. Let us illustrate such a case in Figure 29. It represents an increase in aggregate spending, which can only result from (a) an increase of the money supply that is not offset by a simultaneous increase of the demand for money, and (b) from a decrease of the demand for money that is not offset by a simultaneous decrease of the money supply.[17]

17 Accordingly, a *decrease* of aggregate spending would result from (a) a decrease of the money supply that is not offset by a simultaneous decrease of the demand for money, and (b) from an increase of the demand for money that is not offset by a simultaneous increase of the money supply. In Figure 29, this would correspond to a movement from the red lines to the black ones.

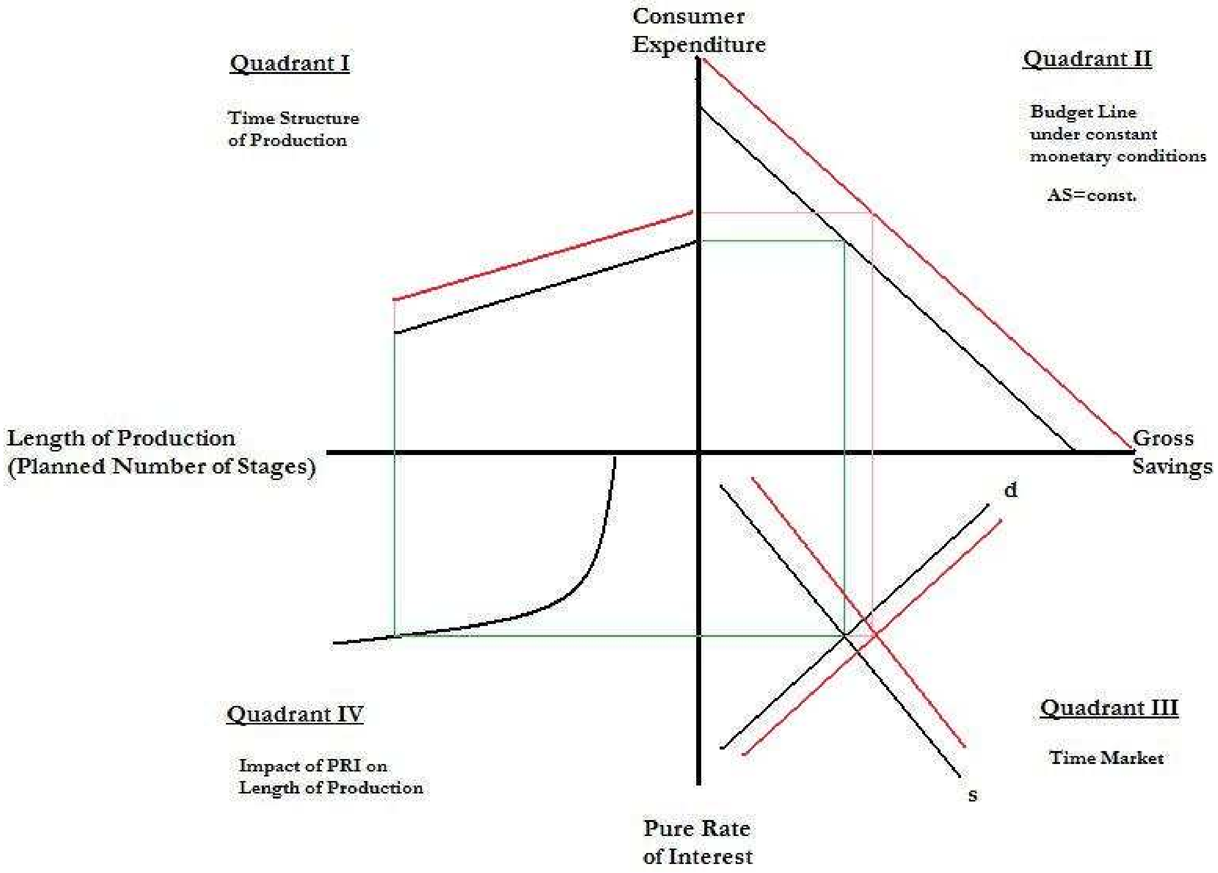


Figure 29
Impact of a Decreasing Demand for Money (or of an Increasing Money Supply) on the Structural Variables

The increase of aggregate spending is reflected in an outward shift of the budget line. On the time market both the demand for and the supply of present goods (or more precisely, of monetary capital) will increase. The main reason is that the higher spending will sooner or later entail a rise of all monetary revenues. It is therefore *possible* for capitalists-entrepreneurs to pay higher factor prices and to lend more money, and they *will* do this under competitive pressure, in order not to lose market shares. Competitive pressure also props up the *demand* for monetary capital, as capitalist-entrepreneurs line up to benefit from the increase of aggregate spending. It follows that the time market will settle at a new final equilibrium with a greater volume of monetary capital being exchanged.

However, there is no reason to expect any systematic impact on the gross savings *rate*, and neither is there any reason to expect any systematic impact of these changes on the PRI. Therefore, the key structural variables remain unaffected. The structure of production operates as before (as far as its *time* structure is concerned), featuring the same relative spending and the same length as before. The only difference from an aggregate point of view is the higher price level, and the corresponding higher level of monetary revenues. Aggregate real revenues remain unaffected, and there is also no impact on the relative weight of the different income sources.

Conclusion

In the present contribution, we have reassessed the concept of the structure of production by focussing on the relations between its three structural variables: the interest rate, relative spending, and the length of the structure of production. Based on this reconsideration, we have studied basic growth mechanisms in a monetary economy that can be applied to various scenarios that seem to be relevant under the contemporary conditions of the world economy. We have also discussed the role of human capital and of consumer credit within the theory of the structure of production.

The main result of our study is that the Austrian approach has been unduly restrictive in its focus on one single scenario of modifications of the structure of production. We have shown that the Austrian method of studying the impact of the time market on the structure of production yields a rich matrix of theorems. These new tools can be used in applied work to develop a nuanced analysis of contemporary macroeconomic problems.

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Appendix I: Additional Simulations of the PRI and Roundaboutness

AS	Number of stages	Interest rate	Gross savings rate	Gross savings	Con-sump-tion	Spending Stream
610	6	0.012	0.85	519	91	91—89—88—87—86—85—84
613	7	0.05	0.85	522	91	91—86—82—78—74—71—67—64
611	8	0.08	0.85	520	91	91—84—78—72—66—61—57—53—49
611	9	0.1	0.85	520	91	91—82—75—68—62—56—51—46—42—38
611	10	0.115	0.85	520	91	91—81—73—65—58—52—47—42—38—34—30
612	11	0.125	0.85	521	91	91—80—71—63—56—50—44—39—35—31—28—24
612	12	0.135	0.85	521	91	91—80—70—62—54—48—42—37—33—29—25—22—19

Table 16
Numerical Simulation of Key Structure of Production Data
at a Constant Gross Savings Rate of 85%

AS	Number of stages	Interest rate	Gross savings rate	Gross savings	Con-sump-tion	Spending Stream
611	1	0.15	0.46	284	327	327—284
611	2	0.79	0.46	284	327	327—182—102
611	3	1.00	0.46	284	327	327—163—81—40
612	4	1.08	0.46	284	327	327—157—75—36—17
611	5	1.11	0.46	284	327	327—154—73—34—16—7
610	6	1.13	0.46	284	327	327—153—72—33—15—7—3
610	7	1.35	0.46	284	327	327—153—71—33—15—7—3—1

Table 17
Numerical Simulation of Key Structure of Production Data
at a Constant Gross Savings Rate of 46%

<u>Appendix II:</u> Derivation of Equation 2

The starting point is Equation 1:

$$AS=C+C(1+i)+C(1+i)2+C(1+i)3+...+C(1+i)n-1$$

Here AS stands for aggregate spending, C for aggregate consumer spending, i for the pure rate of interest, and n for the number of stages of production.

Spending can be either on consumers' goods (consumption) or on producers' goods (saving-investment). Thus we can write

$$AS=C+S$$

Given that the gross savings rate is $= SAS$, it follows that $AS=C+s\cdot AS$ respectively $C=AS(1\text{-}s)$.

If we substitute AS (1–s) for C in the above Equation 1, we obtain

$$AS=AS(1\text{-}s)+AS(1\text{-}s)(1+i)+AS(1\text{-}s)(1+i)2+AS(1\text{-}s)(1+i)3+...+AS(1\text{-}s)(1+i)n-1$$

Eliminating AS, we obtain

$$1=(1\text{-}s)+(1\text{-}s)(1+i)+(1\text{-}s)(1+i)2+(1\text{-}s)(1+i)3+...+(1\text{-}s)(1+i)n-1$$

which illustrates the contention, central to classical economics and Austrian economics, that the time structure of production does not depend on the *level* of spending, but rather on *relative* spending on consumers' goods as compared to producers' goods, that is, on the gross savings rate.

Since the above equation is a geometric row, we can obtain a shorthand expression through the usual transformations. That is, as an intermediary first step, we divide the equation by (1 + *i*) and obtain the following new equation

$$1(1+i)=(1-s)(1+i)+(1-s)(1+i)2+(1-s)(1+i)3+\ldots+(1-s)(1+i)n$$

Subtracting the two equations from one another, we obtain

$$1-1(1+i)=1-s-(1-s)(1+i)+(1-s)(1+i)-(1-s)(1+i)2+(1-s)(1+i)2 \ldots-(1-s)(1+i)n$$

Thus

$$1-1(1+i)=1-s-(1-s)(1+i)n$$

Which gives

$$-1(1+i)=-s-1(1+i)n+s(1+i)n$$

And then

$$1(1+i)n-1(1+i)=-s\cdot(1-11+in)$$

We can then solve the equation for s:

$s=1(1+i)-1(1+i)n\ (1-11+in)$

So that

$s=(1+i)n-1(1+i)n-1(1+i)n\ (1-11+in)$

and

$s=1(1+i)n\cdot(1+in-1-1)(1-11+in)$

Which is nothing but:

$s=1+in-1-1(1+i)n\cdot(1-11+in)$

And thus we obtain Equation 2:

$s=1+in-1-1(1+i)n-1$

QED

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