

# THE INTEREST RATE AND THE LENGTH OF PRODUCTION: AN ATTEMPT AT REFORMULATION

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*ABSTRACT:* Austrian economists since the time of Böhm-Bawerk have argued that lowered interest rates lead, in general, to longer production processes. Recently Hülsmann (2011) and Fillieule (2007) have challenged this argument and demonstrated with mathematical precision that lowered interest rates shorten production processes. This paper argues that it may be misleading to search for a direct causal effect of interest rates on the length of production because another, related factor affects it more directly. We name this factor *intertemporal labor intensity*, since it has to do with the moment of hiring labor. We discuss the relationship between savings and the interest rate, and modify a textbook depiction of the structure of production by changing interest rates. After explaining the concept of intertemporal labor intensity, the paper discusses a crucial assumption of Hülsmann (2011) and Fillieule (2007) on the ratio of labor to capital.

*KEYWORDS:* capital theory, interest, production structure, Böhm-Bawerk

*JEL CLASSIFICATION:* B13, B53, D24, E43

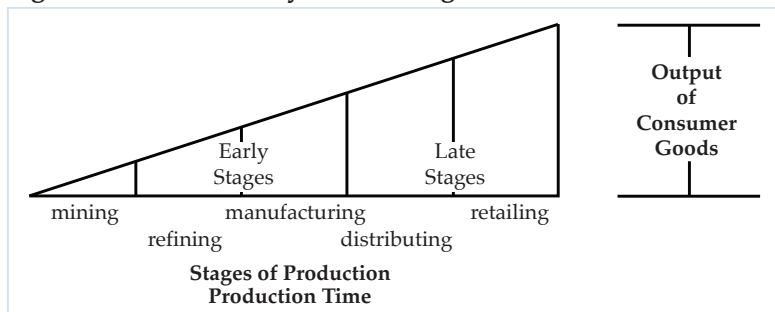
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## INTRODUCTION

Representatives of the Austrian school, starting with Böhm-Bawerk, have developed a unique way of presenting capital structure in the form of consecutive stages. Friedrich von Hayek reflected on the issue deeply and presented it in geometric terms. His follower Roger Garrison has developed the concept of what he calls the Hayekian triangle (Garrison, 2001, pp. 11, 47):

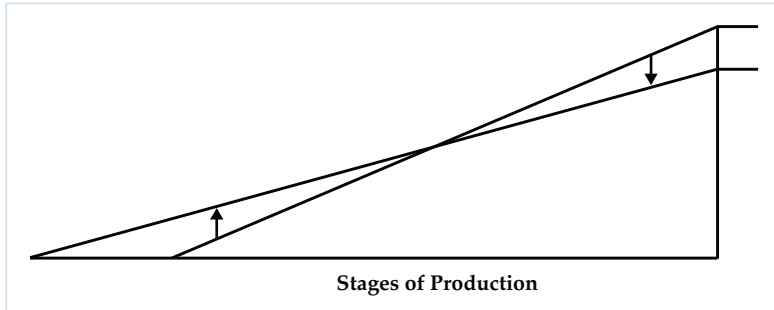
**Figure 1: Garrison's Hayekian Triangle**



As the diagram shows, in the beginning of the production process, firms only employ complementary primary factors: time, labor, and land. They develop capital goods, the product of primary factors, which are sold to another capitalist entrepreneur. The next capitalist then employs those transformed goods with additional labor and natural resources. The next capitalist acts in a similar manner, and so forth, until the product reaches the consumption stage. In every step, the capitalist employs a mixture of primary factors and capital goods.

In Garrison's approach, with more capital accumulated, consumption on the vertical axis decreases, and production lengthens, freeing up factors from later stages to be employed in earlier stages (Garrison, 2001, p. 62):

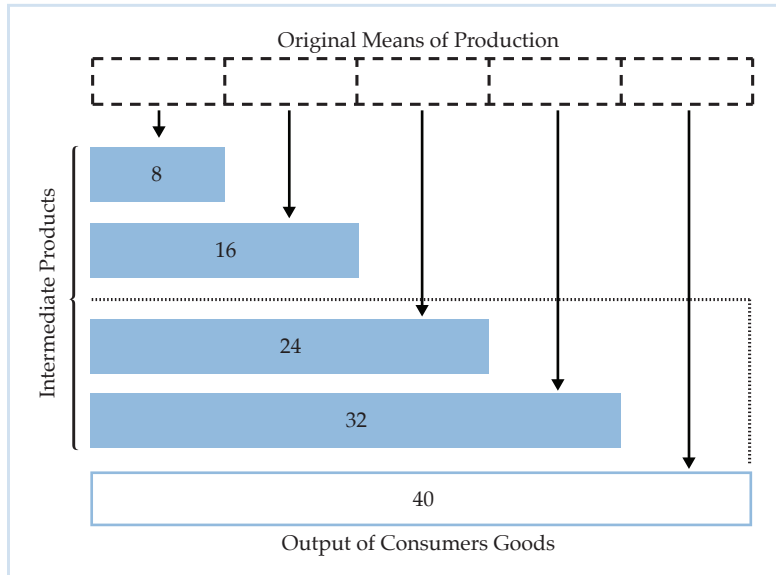
**Figure 2: Increased Savings and a Decreased Interest Rate in Garrison's Hayekian Triangle**



The most problematic feature of this presentation is that it does not use purely monetary terms (cf. Hülsmann, 2001, p. 40). A clearer way of illustrating production would require presenting monetary factors. Setting the subject of monetary versus real phenomena aside, it is worth noting that Hayek did not in fact use “triangles,” but rather trapezoids. Why is this relevant? In triangles, the line starts from the bottom, so the production process has to begin with zero expenditures, which in capitalist production is clearly not the case. Hayek seemed to have been aware of this point, since he did not draw triangles. In fact, there is no such thing as a Hayekian triangle.<sup>1</sup>

Hayek envisioned a trapezoid in the following way (Hayek, 1931, p. 233):

<sup>1</sup> Hayek may be the author of this confusion, since he called the structure a triangle (Hayek, 1931, p. 228), even though he presented it later as a trapezoid. Also as Jacob Marschak notes (Hayek, 1931, p. 229), these figures are actually Jevons’s investment figures (see Jevons, 1957, p. 230). Perhaps it would be more historically accurate to talk about Jevonsian trapezoids rather than Hayekian triangles.

**Figure 3: Hayek's Trapezoid**

The remainder of this paper is structured as follows: The first section briefly presents the problem posed by Hülsmann and Fillieule. The second section discusses how savings drive the interest rate. The third section deals with a textbook example of the structure of production. The fourth section modifies the example by changing interest rates. The fifth section introduces the concept of intertemporal labor intensity. The sixth section discusses a crucial assumption of Hülsmann (2011) and Fillieule (2007) regarding a fixed labor to capital ratio. The last section concludes.

## 1. THE AUSTRIAN CAPITAL THEORY OF BUDGET CONSTRAINTS

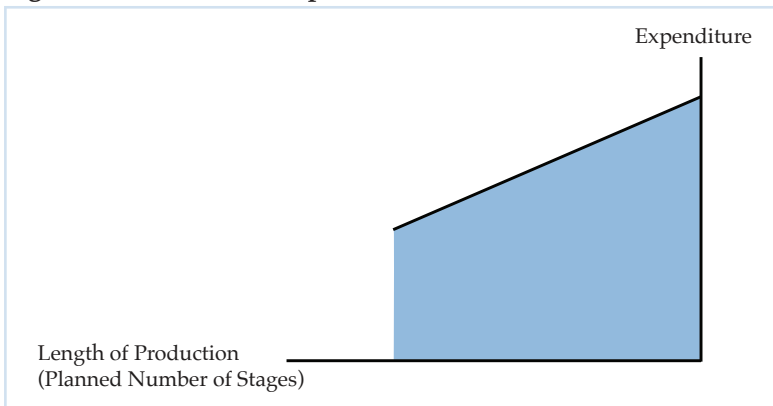
What has been often missing in discussions about capital theory is the basic element of microeconomic theory: budget constraints.<sup>2</sup> This appears quite natural, since economists usually consider

<sup>2</sup> Hayek too seems to have at least slightly neglected that fact (Hayek 1931, pp. 233–243).

capital theory on the macro scale and in real terms (depicting aggregated processes). Yet it seems critical to also include budget lines in capital and interest considerations, because we analyze capital in monetary terms, and interest as a real-world phenomenon is always presented as monetary. In the framework of equilibrated trapezoids, this requires one to assume fixed total spending, as Rothbard does in *Man, Economy, and State* (2004, pp. 517–527).<sup>3</sup> Of course, in the modern monetary system, the money supply is not fixed and is directly related to capital expansions. Nevertheless, for the purpose of grasping a critical connection between the interest rate and production processes, we will use the notion of *ceteris paribus* as long as we only make sensible and meaningful assumptions. Fixed total spending (fixed money supply with unchanged demand for money) is one such assumption.

Hülsmann's approach, which revises Garrison's triangle, portrays a sort of Rothbardian trapezoid (Hülsmann, 2011, p. 25):

**Figure 4: Hülsmann's Trapezoid**

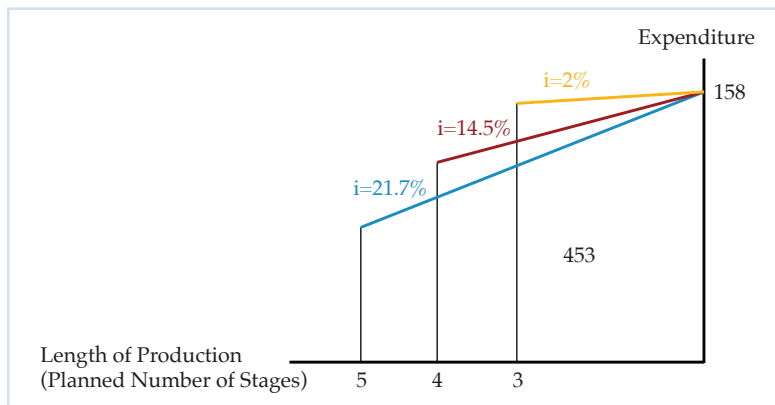


Because of the monetary constraint, the trapezoid formulation can offer us a few insights on shrinking and expanding production structure. The shaded area below the line represents the fixed total

<sup>3</sup> The supply of money is fixed and the demand for money is unchanged, therefore total spending stays the same. The latter does not necessarily imply the former. It is theoretically possible that under fixed total spending money supply could for example be increased and the demand for money decreased (so that net effect is fixed spending).

spending. With a decreasing interest rate, the curve has to have a lower slope, since the discounting of consumption has to be lower. The spending in the beginning has to increase. The assumption of fixed total spending leads to another important consequence—less money will be available in the earlier stages. Therefore, with a falling interest rate the production processes have to become shorter, despite what a long Böhm-Bawerkian tradition taught us (for example, Skousen [1990, p. 234]). Fillieule (2007) also reaches this path-breaking conclusion. Various criticisms can be raised against Hülsmann (2011), but in the mathematical form in Fillieule (2007), the argument can hardly be debated. If the money supply remains fixed with unchanged demand for money, a lower discount rate has to sweep out the spending in the earlier part of production and “move” it closer to final consumption.<sup>4</sup> Therefore, inescapably, a lowered interest rate decreases the length of the production process. Hülsmann’s paper presents this elegantly (2011, p. 25):

**Figure 5: Lower Interest Rate (with Fixed Total Spending) Shortens Production**



<sup>4</sup> We skip the mathematical side of the argument. It relies on a geometrical series, where the ratio in the series is the interest rate. The sum of the series is supposed to remain constant (fixed money supply under unchanged demand for money, a sum of all spending). If the spent sum is to remain fixed (money supply), then with a falling ratio (falling interest rate) the number of terms has to be smaller (number of production stages has to be lower, therefore in this framework the production trapezoid is shorter). Even though the mathematical side is beautiful, we will see it lacks important additional considerations. Also, in comparison to Hülsmann, Fillieule pays more attention to other details, as we shall see below.

Fillieule (2007) gives the above presentation a more rigorous mathematical form. Both geometrically and algebraically, under given budget constraints there seems to be no escaping the conclusion that lowered interest rates increase the value of the discounted product and therefore increase the volume of spending in the stages closer to consumption. Hence, because more money is spent in a stage closer to consumption, less money is available at the earlier stages. This conclusion is far-reaching and may surprise Austrians. Higher interest rates increase the length of production; lowered interest rates decrease it.

This argument is a textbook illustration of both the advantages and disadvantages of mathematical economics. On the one hand, there is beauty in the elegance of both algebraic and geometrical exhibitions of the structure of production. On the other hand, as is often the case with mathematics in economics, there is a critical hidden assumption. Yet the assumption seems to be highly debatable. The assumption is that in all stages of production there is the same proportion of labor employed to capital expenditures (in monetary terms). In other words, to use the Marxian term, the “organic composition of capital” is the same in all stages.

Interestingly, Marx used implicitly fixed labor intensity to “prove” the labor theory of value or to demonstrate that under that condition prices seem to respond to labor efforts in each production process. But the truth was that the assumption of fixed composition made this case look as if labor hours determined prices. In similar manner, both Hülsmann and Fillieule assume fixed labor intensity to demonstrate that lower (higher) interest rates lead to shorter (longer) processes of production. As we will see below, it is their assumption of fixed organic composition of capital that causes shortening of the production process, with lower interest rates being only a supplementary, and not necessary, condition.

Before we move on to the importance of labor intensity for the length of production, let us briefly note that Hülsmann does not pay attention to labor intensity at each stage of production, whereas Fillieule assumes it to be the same through the whole structure. (Actually Hülsmann appears to imply that all labor expenditures are made only in the beginning of the production structure.) As Fillieule states (2007, p. 207): “the ratio of originary factors to investment at each stage (by definition of a proportional structure) is the same in all stages.”

## 2. CHANGES IN THE INTEREST RATE WITHOUT CHANGES IN TOTAL CONSUMPTION?

One immediate criticism, which can be raised against Hülsmann is that his trapezoid extension is given without a necessary decrease in total consumption. Similarly Fillieule (2007, p. 202) with his algebraic demonstrations presented a perfectly sensible equation in which with an unchanged consumption/savings ratio, lower interest shortens the production structure. The immediate counterargument could therefore be: for the interest to fall, total consumption has to fall, and therefore total savings have to increase.

There are two counterpoints to be made at this stage. Firstly, to defend the framework: even if consumption has to fall in the trapezoid so that more savings are lengthening the structure, the final net result—longer or shorter processes of production—would be the question of *interest rate elasticity to changes in the consumption/savings ratio*. Increases in savings (decreases in consumption) would surely make the production structure longer. Nevertheless, once they exercise their influence in this way, the next question arises: how does a decrease in the interest rate affect the structure additionally (apart from the influence of lower consumption and higher savings)? Does it make it even longer if interest falls significantly? Simple comparative analysis of the scenarios shows that the further the interest is decreased, the more it counteracts the effects of increased savings, *ergo* counterfactually decreases the length of production (or, in the framework, the net effect manifested by shorter processes is quite possible). Provided the elasticity of interest is high enough, it can easily counteract the structure sufficiently to make it shorter.

Secondly, and more importantly, one can imagine decreases in the interest rate *without decreases in total consumption*. Yes, it is possible in the Rothbardian framework (as Figures 6 and 7 below illustrate). In Rothbard's trapezoid, the interest can, for example, be cut in half and total consumption could stay the same. What has to increase is total savings. How can, then total savings increase without total consumption going down? Imagine a simple scenario of capitalists decreasing their consumption by X units (total savings increase). Imagine that this additionally



saved money is being spent only on higher wages. Under the framework—for the purpose of simplicity—workers are being treated as pure consumers, so that wages are fully spent on consumption. Hence a decrease in capitalists' consumption by  $X$  units is fully (under such scenario) counterbalanced by an increase in  $X$  units of laborers' consumption. At the same time, total savings are increased (because capitalists are saving more), and the interest rate can fall with total consumption unaltered.

We do not plan to argue that such is the usual case for the capitalist system. We actually argue the opposite. Empirically, additional savings by capitalists are not fully consumed by increases in wages, and capitalists are investing their money in capital goods, which extends the structure rather than shortening it. Yet this point cannot be demonstrated in an exclusively mathematical manner.

The general conclusion drawn from those frameworks is that—to use the unfortunate neoclassical terms—with a given amount of total savings, total consumption and a given interest rate, we can draw “multiple equilibria” of production structures (parallel cases were observed in the famous “capital reswitching” debates). Similarly, on paper we can draw many different demand curves acting in a very peculiar and strange manner. Nevertheless we are always left with a question of how well the scheme reflects real world changes. To answer, we must go beyond what graphs and math offer us.

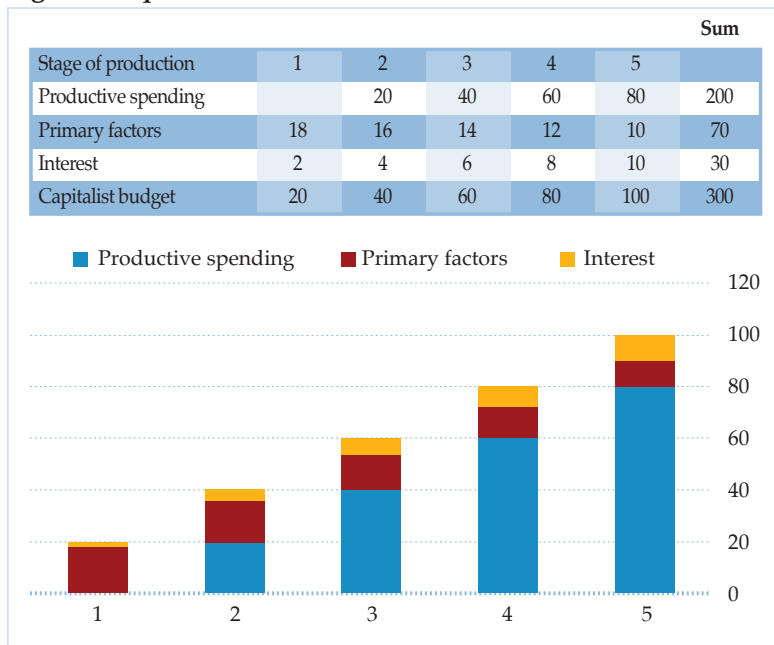
When savings go up, the interest rate falls. Effects on the structure depend on how additional savings are distributed. Below, we offer simple examples about possible scenarios and discuss which are more likely to happen in reality. The only way to fully picture how additional savings work (or may work) is to go to the roots of the Austrian theory of capital, disaggregate total spending, and start with one of Rothbard's most important contributions: his imputation diagram.

*“Where does the saved money go?”* is the question not to be omitted in capital debates. Hülsmann assumes that most of it goes to bid for wages in the first stage of production, whereas Fillieule assumes that it is equally distributed between stages of production. The purpose of our paper is to relax those assumptions.

### 3. A TEXTBOOK EXAMPLE OF THE STRUCTURE OF PRODUCTION

Below, we present a typical textbook example of the production process with specific assumptions. Pure capitalists are owners of money capital. Part of their money is being consumed, while the rest is being spent on investments, including expenditures on labor and capital goods (goods produced by other capitalists). Pure laborers are not saving their income. Instead, they spend it on consumption. After the whole process, monetary holdings are restored. Revenues generated by all money holders' spending return the production structure to the initial position. Let us consider the following example:

**Figure 6: Equilibrium Structure**



The process consists of 5 stages. At the first stage of production, only primary factors are used. The capitalists have 20 units of money. Two units are being spent on consumption; the rest is spent on labor producing capital goods. The value of these goods

consists of frozen time and primary factors, so they are worth 20 units. At the second stage capitalists (owning 40 units) pay 20 units for the capital goods and add 16 units for labor. They also spend 4 units on consumption, which is their interest income (interest incomes are equal to capitalists' consumption because of the equilibrium assumptions of the model). The value of the produced capital goods is 40 units, and capitalists buy the goods in the next stage. They pay additionally for labor 14 units and spend 6 units on consumption. The new, reshaped capital goods are sold for 60 units. (Again, we are in equilibrium, so the initial budget is the same as the budget after all expenditures.)

In the fourth stage the capitalists, apart from paying for capital goods valued at 60, pay for labor worth 12 units and spend 8 on consumption. Capitalists in the last stage pay 80 units for the capital good, so their budget returns to the previous point. In this final consumer stage, capitalists spend 10 units on personal consumption, and 10 units on labor. Spending on labor along with an 80-unit investment in capital goods allows the capitalist to sell final consumer goods for revenues worth 100. The equilibrium is restored.

In general, the total money supply is 300 units; consumption is 100 units. The budget for primary factors is 70 units; capitalists' consumption is 30 units. Productive spending on capital goods is 200 units (a sort of gross investment demand). The interest rate is roughly 11 percent in all stages.

Now, we can raise the question—what will happen if the interest rate falls? There are two true answers to this question. First, it depends on other factors. Second, the way the model is presented, the interest rate cannot really fall by itself. There must be other factors causing the interest rate to go down in the first place. Therefore the answer should be rather that those factors will cause the production structure to respond.

#### **4. LOWERED INTEREST RATES WITH THE SAME, LONGER, AND SHORTER STRUCTURES OF PRODUCTION**

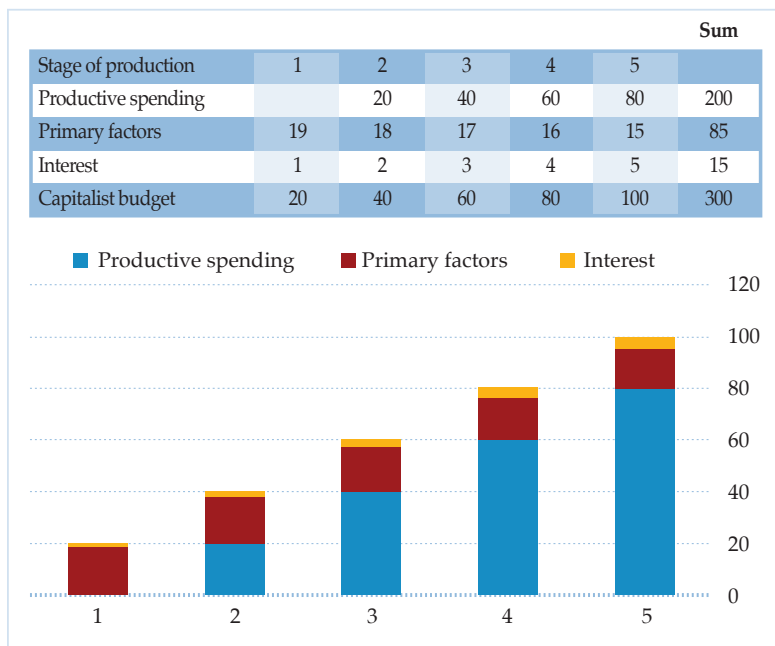
How can anything change in the above equilibrium, assuming there is no credit or monetary expansion in the system? Capitalists have

to change their spending (or some laborers have to start to save and thereby become capitalists). The change in the pattern of spending could lead to various changes in the structure of production.

Let us start with capitalists decreasing their consumption and increasing their productive spending. What do they spend additional money on? Is it for capital goods or labor payments? At which stage? The answers to such questions are decisive for the final result. What will happen to the structure of production? Will it become longer, shorter, or the same? The answer is: it can be any of these.

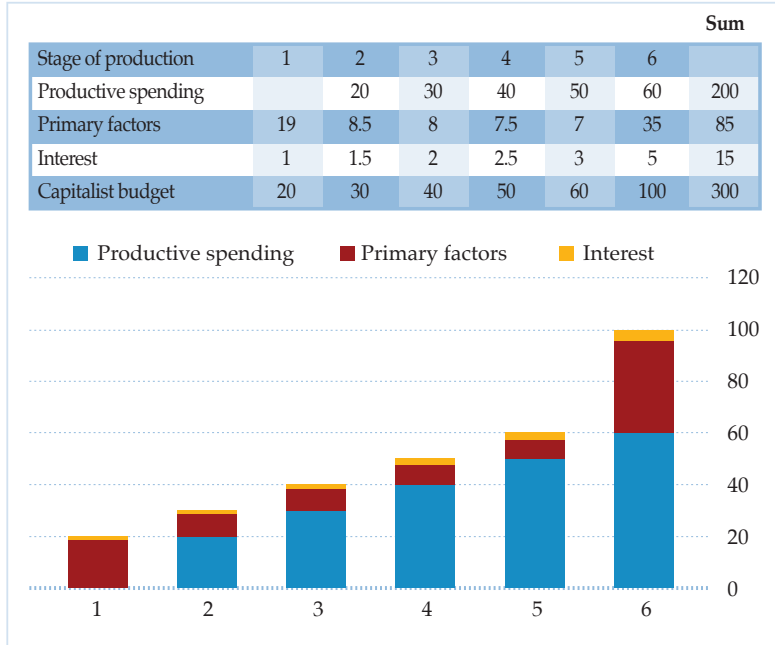
Consider three examples. The structure of production stays the same (still five stages):

**Figure 7: Lowered Interest Rate and No Change in the Length of the Structure of Production**



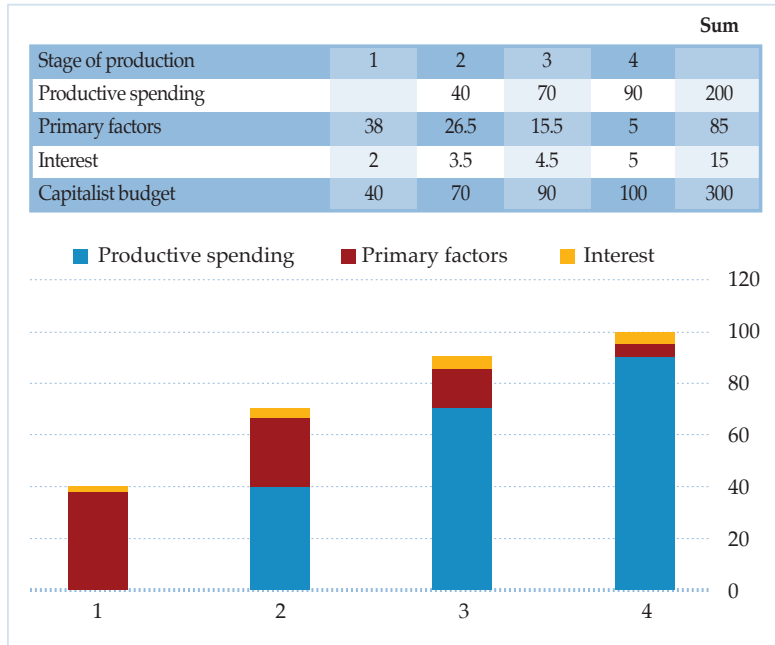
The structure of production is becoming longer (additional sixth stage):

**Figure 8: Lowered Interest Rate and the Lengthening of Production**



The structure of production is becoming shorter (only four stages):

**Figure 9: Lowered Interest Rate and the Shortening of the Structure of Production**



In all three cases, the interest rate is lower, roughly 5.26 percent. Yet despite the fact that it is lower, the structure of production may become shorter, longer, or stay the same. It is not the result of consumption staying on the previous level (100 units). We could draw three similar illustrations with both consumption lowered (for example to 90 units) and lowered interest rates. It would still be possible to present longer, shorter, or constant structures of production. The reason for the variety of consequences lies in something other than the interest rate—the *amount of spending on labor at each stage*.

Notice that in the example of the extended process of production (Figure 8), most of the money budgeted for primary factors is spent at the very last stage of production. In the opposite example, with only four stages of production (Figure 9), the budget for

primary factors is mostly consumed in the very early stages of production. In consequence, this is a vital factor for the length of the structure of production—how much money is being spent on labor at each stage. If more of the spending on labor happens closer to consumption, the structure of production is lengthened. If more of the spending on labor is in the earlier stages of production, the structure becomes shorter.

## 5. INTERTEMPORAL LABOR INTENSITY AND THE SUBSISTENCE FUND

The factor influencing the length of the structure of production discussed in the previous paragraph could be called *intertemporal labor intensity* (ILI). The labor intensity of any production process depends on how much labor is employed. The intertemporal aspect plays a role, because 50 units of labor hired in the first stage will influence length in a completely different manner than 50 units of labor hired in the last stage of production. If relatively more labor is being employed in the earlier stages of production, the length has to shrink. If laborers are moving towards the later stages, the structure becomes longer. What seems also significant for other reasons, this conclusion is inescapable even with growth in technology and extension of knowledge, so we can avoid an uncomfortable *ceteris paribus* assumption for those elements.

The empirical interpretation of the structure of production should go as follows. Capitalists are increasing their savings by reducing consumption. They are spending additional monetary units productively. Therefore the adjustment is necessary. Decisions to bid up wages of laborers versus to add supplementary capital goods (additional stages, together with decisions about when to do it) determine the length of the structure. Various final outcomes of this process are possible in this *purely theoretical framework*. Nevertheless, as an economic fact, though not a praxeological law, capitalists increase their productive spending in order to make production more productive, *ergo* capitalized in the earlier stages—since the purpose of additional investments is to increase productivity through additional capital equipment. As history demonstrates, during the process of development, intertemporal labor intensity decreases, which means relatively less labor is hired

in earlier stages, and more labor is hired closer to consumption in the service sector. As a result, in the development of the world economy, the structure was lengthened (even though consumer goods became more readily available).

A careful reader could see a slight resemblance to Richard Strigl's notion of the subsistence fund (Strigl, 2000, p. 57). Strigl argued that capitalists might be seen as supplying necessary consumption goods for the workers until the processes of releasing those goods are finished. Even though we do not subscribe to Strigl's view, the particular point on capitalists supporting laborers' wages is quite relevant. Higher intertemporal labor intensity means capitalist spending at each consecutive stage works like a larger subsistence fund. Therefore, most of the budgets are used to sustain the laborers at earlier stages, because their income is being capitalized at each consecutive stage. With longer processes and more stages, more of the limited money supply is used to capitalize those wages.

If ILI is decreased, which is equivalent to more labor (in monetary terms) being hired at later stages, capitalist spending supports production of capital goods, rather than supporting workers in the earlier stages. Empirical studies of growing economies clearly indicate that. After all, in most developed economies the workers are placed largely in the very last stages of the production structure in the service sector. Therefore most of the capitalist spending in the earlier stages is used to support increased capital investment, which on the one hand increases productivity (and wages) of (the fewer) workers in the earlier stages, and on the other hand allows the rest of the workers, in later stages (mostly in the service sector), to reap the benefits of a more productive economy (which is characterized by the lengthened structure of production).

With a fixed money supply and unchanged demand for money (in equilibrium), capitalists have limited choices about where to spend their money. Each unit spent on a particular factor of production reduces the opportunity to spend it elsewhere. If capitalists employ laborers in the very earliest stage of production, each consecutive capitalist indirectly supports those laborers' wages (and consumption), because those wages are capitalized in the subsequent stages. (In a sense, they are counted in the capital value of complementary goods.) At each stage those goods have a certain value that has to be paid for, which in turn consumes a



larger part of the existing and limited money supply. Therefore the notion of intertemporal labor intensity is important for explaining how interest rates, savings, and consumption influence possible structures of production. Without this notion it is impossible to decide whether a lowered interest rate leads to shortening or lengthening of the structure.

Henceforth in Hülsmann's illustration, an assumption of all labor hired in the first stage makes the structure always shorter with lowered interest. But it is precisely this assumption which shortens the production—not just the interest rate. How feasible is such scenario? How likely is it that capitalists use additional savings to employ most of the labor at the earlier stages? Empirically it is highly unlikely, though not unimaginable. It would have to mean some spontaneous development of new skills of laborers (probably a combination of human capital and technology), who can become more productive in the earlier stages while using smaller amounts of capital equipment than previously.<sup>5</sup>

The notion of intertemporal labor intensity in the environment of fixed total spending can also shed some light on the normative aspect of the "reswitching debate" over whether capitalist profits (related to interest) are a reward for waiting. The mathematical proof that interest has no relation to lengthening was seen as a basis for the argument that economic considerations cannot justify capitalist profits. As Samuelson (1966, p. 568) put it:

The simple tale told by Jevons, Böhm-Bawerk, Wicksell, and other neoclassical writers—alleging that, as the interest rate falls in consequence of abstention from present consumption in favor of future, technology must become in some sense more "roundabout," more "mechanized," and "more productive"—cannot be universally valid.

The "simple tale" in fact has to be modified by Striglian considerations: total productive expenditures (whole investment budgets)

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<sup>5</sup> In one of his lectures Professor Salerno gives this kind of fictional and extreme example. If people discover that without building nets for fishing their singing of Beatles songs causes the fish to jump out of the river, then the production will become shorter for human capital reasons. An example does illustrate how capitalists would be ready to bid for wages of laborers in the earlier stages at the expense of investments in the capital goods.

and intertemporal labor intensity. We generally have reservations about possibility of mixing positive and normative aspects, yet in the case of more intertemporally labor-intensive processes capitalists gain profits for financing laborers in the earlier stages, whereas in the case of less intertemporally labor-intensive processes they gain their profits for financing capital widening. The former case supports more consumption-oriented systems, whereas the latter supports more growth-oriented economic systems. In either case, capitalist profits are associated with either more current wage-support, or more economic growth (more remote wage support).

As we see, then, the length of the production process is linked with intertemporal labor intensity, not just the savings rate and the rate of interest, although those last two factors come into play through allocating labor. The influence of savings on length is bounded by two factors: how much of those savings finance workers' wages (and therefore consumption), and most importantly, where in the production process those wages are financed (whether more or less remote from consumption). Higher savings certainly allow for financing additional stages of production and can make the structure longer. Yet this influence cannot be properly scrutinized without reference to intertemporal labor employment, because with changes in ILI, production can become significantly longer or shorter even without changes in savings (or with changes in opposing directions).

We are not assuming that a decision how much to spend on labor at each stage—or how great intertemporal labor intensity is—is a completely arbitrary decision made by the capitalists. Capitalists are motivated by returns on their capital, henceforth their choice is aimed at choosing those methods of production which allow for higher returns. The successful route for bigger profits lies in the increases in productivity, which can be realized at most times by the investments in more capital equipment. Increases in real productivity, however, cannot be depicted in either of the presentations, because the framework is purely nominal.

The Rothbardian trapezoid/triangle approach could be seen as an additional example of how limiting a mathematical and graphical illustration can be. We cannot imply anything *logically* from such framework on how the lowered interest *has to* cause an increase (or decrease) in the length of production, since

mathematically (and logically) it can go either way. In order to make the framework sensible and reflective of reality, one should resort to the general empirical notion that higher productivity is reached by investments in capital goods.

## 6. THE ASSUMPTION OF FIXED ORGANIC COMPOSITION OF CAPITAL

Renaud Fillieule (2007) assumes explicitly that production is “proportional”—the relation of labor to capital is the same in all stages. Under this assumption, a lowered interest rate has to shorten the structure of production. Yet it is the proportionality assumption that leads to a shortening of production. To see this, compare Figures 6 and 9. A move from Figure 6 to diagram 9 represents capitalists decreasing their consumption and spending more money on production. The decision was to increase spending on wages, but the pool of additionally saved income was not distributed proportionally between the stages. More of it has been devoted to earlier stages of production; therefore the structure of production had to become shorter. Yet even if we assume the proportion between capital and labor always stays the same, with decreases of the interest rate the length of the structure has to shorten (as Fillieule has proven).

Is this correct theorizing about where the additional money goes? We should try using the notion of *ceteris paribus*. Here is where capital considerations get tricky—it is nonsensical to assume that nothing is changing, because additional causes have to lead us to some results differing from the initial equilibrium. The issue is: which things should we allow to change in the model? We can choose Fillieule’s way and assume the organic composition of capital has to stay the same, but this means assuming that (1) capitalists are more eager to bid for labor in the earlier production processes; (2) the structure of production has to shrink; (3) technological adjustments must happen (reduction towards a less-capital-intensive economy—would capitalists actually prefer such an investment adjustment?); and (4) production has to become more consumption oriented, because a bigger part of the budget will be spent supporting wage earners’ consumption. On the other hand, we could choose the *ceteris paribus* assumption

about intertemporal labor intensity, so that additional savings lead to disproportional bidding for laborers at each stage (the organic composition of capital is disproportionate), huge technological changes are not happening, the number of stages stays the same, and capital widening is not reversed, but sustained as is. Why should this choice be seen as less in the spirit of equilibrium than the previous one?

Any assumption can be used in pure theorizing, including the fixed organic composition of capital. However, nothing in this particular assumption would make it more compatible with the equilibrium state. Under equilibrium, or the evenly rotating economy, the organic composition of capital can differ between stages (and in reality it of course does differ). Equilibrium is characterized by lack of profits and losses and by equilibrated structure. Profits and losses can be arbitrated away, no matter how the proportion of labor expenditures to capital expenditures varies. Why should we assume that the organic composition of capital has to stay constant and not that intertemporal labor intensity should stay constant? The choice of fixed proportions in each process between capital and labor seems to be more in the spirit of neoclassical economics, where usually one global production function is used for depicting proportions of capital to labor.<sup>6</sup>

Putting the equilibrium issue aside, as we mentioned, the empirical content in any theory is also important. Historically, higher savings at lowered interest rates are mostly used for building capital goods. A firm can employ more capital to dominate the earlier stages of production, whereas it employs the labor force in the later stages of production. That is why, in reality, lowered long-term interest rates are most often associated with lengthening of the structure of production—because, empirically, with higher savings and lowered interest rates, the intertemporal labor intensity steadily decreases, so that a firm builds up capital for more production rather than workers' consumption.<sup>7</sup>

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<sup>6</sup> Filieule points to Hayek (1941, p. 124), who argued that it is reasonable to use the notion of fixed organic composition of capital. Nevertheless Hayek did that to simplify neoclassical considerations in order to shape an input curve into the form of an exponential curve.

<sup>7</sup> There is one additional benefit of the analysis. "Technological changes" cannot be separated from changes in the capital structure, as the Austrians always argued.

## CONCLUSIONS

Does a lower interest rate lead to an increase in the length of the structure of production? The universal strict answer is indeterminate. Other factors are in play.

Fillieule and Hülsmann's works are milestones in the recent development of capital theory. They open the field for new explorations. Our goal is to point to one key factor that they set aside—intertemporal labor intensity—that changes their conclusion that there is an inverse relation between interest rates and the length of production.

## REFERENCES

- Böhm-Bawerk, Eugen. 1959. *Capital and Interest*. South Holland, Ill.; Libertarian Press, 3 vols.
- Fillieule, Renaud. 2007. "A Formal Model in Hayekian Macroeconomics: The Proportional Goods-in-Process Structure of Production," *Quarterly Journal of Austrian Economics* 10, no. 3: 193–208.
- Garrison, Roger. 2001. *Time and Money. The Macroeconomics of Capital Structure*. London: Routledge.
- Hayek, Friedrich A. von. 1931. "Prices and Production" in *idem*. 2008. *Prices and Production and Other Essays*. Auburn, Ala.: Ludwig von Mises Institute.
- . 1941. *The Pure Theory of Capital*. Chicago: University of Chicago Press.
- Hülsmann, Jörg Guido. 2001. "Garrisonian Macroeconomics," *Quarterly Journal of Austrian Economics* 4, no. 3: 33–41.
- . 2011. "The Structure of Production Reconsidered", working paper. Available at [http://granem.univ-angers.fr/\\_resources/Cahiers/2011/DT\\_GRANEM\\_034.pdf](http://granem.univ-angers.fr/_resources/Cahiers/2011/DT_GRANEM_034.pdf)

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Technology can only be advanced by real capital extensions, and also the other way around: it is impossible to imagine capital extensions without changes in technological features of the production structure. Therefore, in capital theorizing, technological changes and additions of capital goods have to go hand in hand.

- Huerta de Soto, Jesus. 2006. *Money, Bank Credit, and Economic Cycles*. Auburn, Ala: Ludwig von Mises Institute.
- Jevons, William S. 1957. *The Theory of Political Economy*. New York: Sentry Press.
- Rothbard, Murray. 2004. *Man, Economy, and State with Power and Market*. Auburn, Ala.: Ludwig von Mises Institute.
- Samuelson, Paul. 1966. "A Summing Up," *Quarterly Journal of Economics* 80, no. 4: 503–517.
- Skousen, Mark. 1990. *The Structure of Production*. New York: New York University Press.
- Strigl, Richard. 2000. *Capital and Production*. Auburn, Ala: Ludwig von Mises Institute.