Of Triangles and Trapezoids. Hayek, Rothbard, and Hülsmann on the Structure of Production

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ABSTRACT: In this note we revisit some fundamentals of capital theory in light of recent debates. We argue that the standard Austrian account of the structure of production and the time market as developed by Rothbard is essentially correct and supplement it with an argument for how land factors can be formed out of net saving. The result is that a fall in time preferences always leads to capital formation and a fall in the rate of discount, but the rate of discount may rise again depending on how much capital is invested in new land factors. Some implications for the diagrammatic depiction of the structure of production as a triangle or trapezoid are discussed.

1. Introduction

One of the mainstays of Austrian capital theory is the depiction of the relationship between consumption, investment, and the rate of interest in the form of a triangle (Hayek 1935; Rothbard 2009; Garrison 2001). This "Hayekian investment figure" shows the monetary value of all services of capital goods used per year across the structure of production. At the final stage are consumer goods bought by final consumers and the services of all the capital goods in the higher stages are valued at a discount to final consumers' goods. This yields a triangular shape, as the higher stages become narrower and narrower, until all factor payments in the highest stage furthest from consumption go to original factors.

In recent years, a debate has developed on the proper shape of the Hayekian investment figure, with Hülsmann arguing that rather than a triangle, it is really a trapezoid (Hülsmann 2008; 2011). This debate is not only about matters of presentation, but touches on essential elements of capital theory. According to the standard theory, net saving leads to a lengthening and narrowing of the structure of production and a shift of productive factors into the higher stages of production, eventually yielding a higher output of consumer goods. This follows necessarily if the investment figure has a triangular shape; if instead it is trapezoidal, a lengthening of the structure of production does not necessarily follow, it is just one of several possible outcomes (Fillieule 2007; Hülsmann 2011). The orthodox Austrian understanding of the relationship between time preference, the rate of interest, and the proportion of investment to consumption has also been criticized, especially the way Rothbard

presented the time market (Rothbard 2009, chap. 6), since his proof for the causal role of time preference in setting the rate of interest and the amount of saving in the economy is flawed (Hülsmann 2008).

Defenders of the classic conception have criticized Hülsmann (Méra 2011; Newman 2014) and others have tried to expand on this new approach (Machaj 2015; Granot 2019). At the same time, recent literature on money and capital uses the trapezoid as a better depiction of the capital structure (Davidson 2014; Hansen 2023), a position that, as Hülsmann pointed out, can be traced back to Rothbard's own exposition (Rothbard 2009, 407).

In the present note, our goal is to re-examine the issue of the relationship between the rate of interest, the amount of investment, and the length and shape of the structure of production. We here follow Newman (2014) in his defence of Rothbard, but go beyond his focus on Rothbard's time market. Specifically, we argue that when we analyse the process of capital formation in detail, a rise in the supply of present money (net saving) can, in some circumstances, call forth a rise in the demand for money from original factors. This induces first a fall and then a rise in the rate of interest, but it does not mean that the amount of savings and the rate of interest are unconnected. Hülsmann is thus correct in introducing the trapezoid, but the classic understanding of capital and interest, correctly developed, still holds true.

2. Rothbard's Theory and Hülsmann's Critique

According to Rothbard, in order to invest in capital goods, an economic actor has to restrict current consumption (Rothbard 2009, 49). Capital goods are future goods that eventually mature into consumer goods. As such, they are always valued at a discount to present goods. What determines the height of this discount as well as the amount invested in capital is time preference, for each individual and in the aggregate for the economy as a whole. Higher time preference yields a higher rate of interest and a smaller amount of investment, and lower time preferences lead to a lower rate of interest and a larger amount of investment (Rothbard 2009, 400). The rate of interest is determined in the time market, where capital goods and claims to future money trade against present money. In a progressing economy, social time preference falls leading to increased saving. This increased saving enters time market as present money offered against future money (claims and capital goods), leading to a fall in the rate of interest and an extension of the structure of production, since the lower rate of interest makes investment projects in the higher stages or in wholly new stages of production even more remote in time from consumption possible. The result

of saving is thus a lower rate of interest, a higher amount of saving relative to consumption, and a longer, narrower structure of production.

Hülsmann (2008) argues that Rothbard overlooks a fundamental point: time preference explains both the supply of and the demand for present goods. When time-preference schedules rise, this implies reduced supply and increased demand for present goods at any given interest rate, so all we can conclude is that the rate of interest goes up with no systematic implication for aggregate investment (Hülsmann 2008, 17–19). The rate of interest does however determine the shape of the structure of production, as the slope of the triangle is steeper and the production structure shorter the higher the rate of interest. Additional saving, however, has no systematic impact. Net saving may be invested in lengthening the structure of production, which is the classic case of economic growth in Austrian theory. Net saving can however also be invested to "widen" the structure of production, adding processes of similar length to the already existing ones (Hülsmann 2008, 24). This is similar to Garrison's (2001) concept of secular growth, but with two crucial differences. First, Hülsmann is discussing one possible scenario of net saving, whereas Garrison is arguing for the possibility of growth in the absence of net saving; second, in Garrison's case the structure of production grows proportionally, lengthening and widening, whereas in Hülsmann's scenario it only widens. Hülsmann is therefore led to the trapezoidal shape by his argument: if savings increase, and if they are invested in such a way that the structure of production widens, then the Hayekian investment triangle central to Rothbard's exposition does not describe all possible production structures. Hence, various investment and growth scenarios become possible (Hülsmann 2011; cf. Fillieule 2007).

Newman (2014) provides so far the main counterargument to Hülsmann's critique. He argues that Rothbard's time market does not lead to Hülsmann's conclusion. Since capitalists are net suppliers of present goods across the capital structure, lower time preferences yield more investment. Newman is however focused on a specific numerical example rather than on the general logic of the argument. In the following we will therefore proceed on similar lines attempt a more general critique of Hülsmann's argument.

3. Time Preference, Saving, and Capital Formation

The connection between saving and capital building and the causal role of time preference was laid out by Mises (1998). In order to direct action to temporally more remote ends, it is first necessary to save, i.e., to consume less than current production. More time-consuming production processes are technologically superior, but even if this was not the case, there would be some saving. What

restricts the amount of saving is always time preference, the premium of present over future goods inherent in all valuation (Mises 1998, 487). Whether for the individual in isolation or under the division of labour in society, it is necessary to accumulate consumer goods in order to undertake longer production processes. Only thus can acting man satisfy those wants that are more urgent, i.e., higher ranked than the product of the longer process of production which he wants to undertake. The decision to save or consume is thus completely a matter of valuation, specifically of comparing temporally closer to more remote goods. Only if the capitalist is willing to forego some present enjoyment will there be any investment in longer processes of production. The amount of saving and investment is therefore always limited by time preference, by the fact that some consumption in the present is always ranked higher than future consumption.

This preference for present over future goods is for Mises also the source of interest. “Time preference manifests itself in the phenomenon of originary interest, i.e., the discount of future goods as against present goods.” (Mises 1998, 521) If time preferences fall, this means that the value of future goods as against present goods rise, and a higher number of more remote ends will be pursued. And so the rate of originary interest falls, as consumer goods are set free for longer-term processes. The rate of interest directs investment activity across the structure of production, determining the length of production processes, and a lower rate of interest will direct more investment to the higher stages of production more remote from consumption. It might then seem that there is a direct connection between the supply of capital goods and the rate of interest, since both are based in time preference. Mises, however, ends his discussion somewhat enigmatically by both affirming this and denying a clear quantitative connection: “Changes in the originary rates of interest and in the amount of saving are … two aspects of the same phenomenon… The quantity of the available supply of capital goods influences neither the rate of originary interest nor the amount of further saving.” (Mises 1998, 530)

This statement points both toward Rothbard’s development of capital theory and to Hülsmann’s critique of this development. In the following, we will try to spell out the meaning of Mises’s statement, since, enigmatic though it may be, it points the way to a correct understanding of the issue.

3.1 Capitalists in the Time Market

In order to see the dynamics of the time market, we need to disaggregate it into the original factor owners (landowners and labourers) and capitalists. We turn first to the capitalists.

Capitalists are the suppliers of present money across all stages of production. Capitalists in a lower stage of production purchase factor services from original factors and from capitalists in the higher stages. The capitalists in the highest stage, furthest from consumption, only supply present money to original factors. At one point in time, therefore, capitalists supply present money, while at a later point, when the product of their stage is finished, they demand present money, which in turn is supplied by the next-lower stage capitalists. The role of the capitalists on the time market must therefore be understood over two stages, over two sets of exchanges (Newman 2014). However, they are, in the aggregate, net suppliers of present money. Their demand for present money is, by definition, less than their income, whereas the demand of the original factors is equal to or higher than their incomes.[1]

When there is a fall in time preference, either for a few individuals or systematically across the economy, the valuation of future as against present money change. Future money rises on the value scales of some capitalists, so they are willing to give up more present money in exchange for it. Their supply of present money offered increases while their demand for present money falls. The rate of interest, the spread between the prices of factors in different stages, therefore falls. This must necessarily be the case, since there are no new supplies of factors of production (no new demand for present money) forthcoming in the short term. The overall supply of present money in the time market also increases, which is again clear when we look narrowly at the capitalists. Since their time preferences have fallen, they prefer to invest out of their net income to consuming all of it. A fall in time preference therefore simultaneously leads to a fall in the rate of interest and a rise in the amount of saving.

There is now more money capital available and capitalists bid up the prices of factors of production and especially so in the higher stages. Since the rate of discount has fallen, longer processes of production are now possible, and it is profitable to employ more factors in the higher stages of production. The product of these stages are now discounted to a lesser extent than before, so the prices paid to factors in these stages rise, inducing a shift of (non-specific) factors backwards or up the structure of production (Hayek 1935, 77, 80–83). New stages may open up, if capitalists employ original factors in the creation of capital goods in stages above the previous highest stage.

Looking narrowly at the role of capitalists in the time market, the standard Austrian account of the progressing economy thus appears correct. So far we have only discussed the changes in value and allocation of factors resulting from a fall in time preferences. In the long run, as more capital goods are produced and the longer processes of production come to fruition, the result will be an increase

1 We here as always deal with functional distinctions in the economy.

in the production of consumer goods. Looking at the Hayekian triangle, this is not immediately apparent, since it only depicts the value of capital in the different stages of production.

In order to fully understand the dynamics of the time market, however, we need to look more closely at the original factors of production. Labour and land only demand present money in exchange for future goods. Labourers and landowners can, of course, save and be the source of net saving in the economy, but insofar as they do this, they exercise the capitalist function. Original factors of production *qua* original factors always demand present money (cf. Rothbard 2009, 410–16).

3.2 Original Factors in the Time Market

An increase in the supply of present money raises income to original factors. Let us first look at how this affects labour.

A fall in the rate of interest means that labour receives higher wages, since the discount on their product falls. In the short-term, some labourers in the lower stages may see declining wages since capitalists are shifting their demand for labour services to the higher stages. In the aggregate, income to labour increases. Since there is a higher money demand for all productive factors, wages overall rise. In the long run, as new capital goods are produced, the productivity of labour increases, increasing real wages as well as money wages (Rothbard 2009, chap. 7). The effect of this increase is, however, indeterminate. It can induce a greater labour supply, as higher wages induce more people to work or to work longer hours, which on the time market would take the form of an increase in the demand for present money. Then, the rate of interest would rise again. But an increase in wages can also lead to more leisure consumption and a fall in the supply of labour on the market. This fall in labour supply is also a fall in the demand for present money on the part of labourers, and it thus reinforces the fall in the rate of interest. Whichever effect dominates will depend on the preferences of labourers for leisure as against money income.

Turning to land, the supply of land factors is usually considered inelastic, but this is only true in the short term (Hansen 2021, 47–50). When the rate of interest falls, the margin determining what is profitably employable land shifts. Submarginal land becomes supramarginal. These plots of land had been left out of productive activity because the complementary factors of production could be better, more profitably, employed elsewhere. With a lower rate of interest, returns on investment throughout the economy narrow, and it becomes profitable to cultivate some new land as the expected discounted marginal revenue product of these land factors exceeds the returns on alternative investments. At the same time, since net saving induces the formation of more capital

goods, the supplies of the complementary factors of production increase. Indeed, the prospect of creating new land factors may guide investment into producing capital goods specific to cultivating new lands. Production of new land factors is an ongoing activity in the changing economy, although it can be impeded by institutional barriers that make it impossible to claim and bring into production unused land areas.

An increase in the supply of land factors thus follows from net saving. This extra supply can in principle be employed at any stage in the structure of production, dependent on its own specificities. The lower rate of discount will, as in the case of labour, tend to make employment in higher stages more profitable, but additional land may also substitute for labourers in lower stages such as agriculture. The additional land, wherever it is employed in the structure of production, constitutes an extra demand for present money. In the long term, therefore, when the new land factors have been developed, the rate of interest may rise again after initially falling in response to the increase in saving. It cannot, of course, rise so far that the land factors become submarginal again. If this happens, we are dealing with a case of malinvestment, since capitalists invested in the formation of factors of production which ultimately proved unprofitable. What rate of interest would make the new land factors submarginal is not determinate, however. It may well be different from the initial rate of interest before saving and investment occurred. The accumulation of capital, the increase in productivity and the greater supplies of the different capital goods and land factors all contribute to make the new economic situation different from the old. The increase in the supplies of other factors of production leads to a rise in the marginal value product of land factors (Rothbard 2009, chap. 7), which may compensate the return to the initial or an even higher rate of discount. If net saving has induced a greater labour supply, this will especially tend to be the case.

Interestingly, when net saving finances the formation of land factors, we have a situation where the structure of production first lengthens and narrows, as the discount rate falls, and then widens and shortens once the land factors are completed and "detach" from the Hayekian investment figure. There are thus more productive factors available in the economy than the capital structure would suggest once the process is complete. How important this process is in the real economy is hard to judge, especially since institutional barriers likely limit the formation of land factors much below what would be the case. However, it is clear that a fall in time preference can lead to both an increased supply of present money from capitalists (in the short term) and an increased demand for present money from landowners (in the long term). This is the case because it induces a rise in the supply of land factors beyond what would otherwise have been the case. This process is largely hidden in the classic Hayekian triangle, however, where all new capital is invested in the formation

of capital goods “within” the triangle, so to speak. Thus, the trapezoidal shape, for this reason alone, appears more correct.

4. The Trapezoid

While the classic Austrian account of the role of time preference in determining the amount of savings and the rate of interest is correct, the structure of production does not necessarily have the classic triangular shape. The structure of production depicts the value of the services of producer goods per unit of time. By abstracting from the durability of capital goods it yields an elegant depiction of the yearly value of producer goods services and its distribution across the different stages of production and between capitalists and original factors. It is clear that the higher stages must be “smaller”, i.e., receive lower cumulative revenues, since time preference means there is always some positive discount on future goods. While the structure will therefore tend to slope, it does not follow that it will be triangular, as we have seen. It is more realistic to conceive of it as a trapezoid. In the highest stage of production, i.e., the first stage where capitalists hire factor services to work on a product, which they then sell on down the structure, they exclusively hire land and labour services. Thus, a trapezoid is a much more logical shape, since there is no reason to suppose that investment takes place in ever smaller amounts of capital goods higher in the structure before finally resolving into original factors.

While aggregate savings rise and the rate of interest tends to fall as social time preference falls, it does not necessarily follow that the structure of production lengthens. If the amount of net saving is small relative to the change in the rate of interest, then a shorter structure of production will result, but still one where more capital is invested than before. In other words, when the supply of present money is inelastic this scenario will follow. However, only over certain ranges of the supply schedule is the rate of interest likely to be inelastic. This will especially be the case when some quantity has already been supplied, since the utility of present money to the actor will then tend to greatly rise (Rothbard 2009, 386). In a progressing economy, this is unlikely to be the case and the case of shortened, but more capital-intense structure of production therefore appears to be of little interest. In analyses of the impact of money and finance on the capital structure, however, the trapezoidal shape has proven helpful. Davidson (2014) shows how loan maturity mismatching leads to a shorter, broader structure of production using Hülsmann’s trapezoid, and Hansen (2023) uses it to show the impact of money creation and financialization on the structure of production.

One short-coming of this approach to the structure of production is that it only shows the value of the periodic services of producer goods, the capital values of capital goods and land factors are

hidden from view. The process of land formation described above thus appears as an increase in the demand for present money and supply of future money, but we do not see how big the increase in the supply of land is. The case is obviously very different whether capitalists invest in a capital good that will yield its service worth *x* monetary units once, or in a land factor that will permanently yield a service worth *x* monetary units per year. In the former case, capital worth *x* discounted to the present (when its product is sold) has been created; in the latter case, capital worth *x/i* has been created. The case is similar for durable capital goods.

We could try to depict the whole capital value of the structure of production. Then we would show the discounted value of the various durable capital goods and land factors extend backwards in time from the point in the structure of production where they yield their services. Such a capital structure would be much longer and closer to the triangular shape. It would be an attempt to show the total capital accumulated in society, the social capital fund, rather than the value of yearly production. If we consider such a capital structure (mindful of the fact that "social capital" per Mises (1998, 264) is not really a meaningful concept), then we would see that accumulation of capital always leads to a lengthening of the capital structure. Alternatively, a three-dimensional depiction could show the location of durable capital goods and land factors in the structure of production.

5. Conclusion

The Austrian capital theory as developed by Rothbard is essentially correct. The easy inference, that capital accumulation and a reduction in the rate of interest go hand in hand since both spring from time preference, however, needs to be qualified. It may be that in the long run the rate of interest is more stable and less responsive to an increase in net saving and an increase in the supply of present money on the time market. The formation of new land factors, which naturally takes place in a progressing economy, constitutes an additional demand for present money and thus tends to push the interest rate upwards.

Hülsmann's critique is therefore partly justified, and his proposal of depicting the structure of production as a trapezoid rather than as a triangle is sound. Fundamentally, these issues in capital theory point to the problems of any graphic depiction of social capital and the structure of production. These are heuristic devices that help explain the concepts of capital theory and the processes of saving and capital accumulation, but they are no substitute for logical analysis.

6. Literature

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