

Vintage Capital, Putty-Clay Technologies, and Austrian Capital Theory
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Introduction

Throughout the history of economic thought, Austrians have had several distinctives which have separated their theories from those of the mainstream. Generally, these distinctives can be traced back to a common root: an unwillingness to make unrealistic assumptions for the sake of arriving at a simple result. In particular, this unwillingness tends to give birth to a hesitation toward (or outright rejection of) mathematical modeling, which, by its nature, requires a multitude of simplifying assumptions.

This devotion to realism in assumptions, and the resulting willingness to work with theories that cannot be easily dealt with in mathematical language, has allowed for many areas of Austrian economic theory to develop far more richly than the mainstream counterparts. In particular, Austrian capital theory (which rests at the heart of the Austrian theory of the business cycle) is an area where Austrians can easily claim far greater realism than the theory that rests behind the “K” that appears in neoclassical models. In particular, the neoclassical K is far too homogeneous and divisible to be considered a reasonable representation of actual capital goods in the economy.

However, there have been attempts “within” the mainstream to correct some of the more grievously unrealistic assumptions in the neoclassical K, in particular in terms of its relationship to technological advancement and to the variability of proportions between capital and labor. The need for a better model of technological advancement over the neoclassical model (where technology, when it appears, causes overall improvements in productivity) was expressed by Solow when he stated that the assumption of disembodied technological progress “conflicts with

the casual observation that many if not most innovations need to be embodied in new kinds of durable equipment before they can be made effective” (qtd. in Boucekine 2006, 1). In short, the model’s assumptions were blatantly contradicting actual experience. Similarly, concerns regarding the unlimited variability of proportions were born out of the casual observation that capital exists as actual machines and structures, and that such machines and structures can only be used by a limited number of laborers at a particular moment in time. The models which seek to incorporate these ideas are not new. However, they have recently been rising in interest in the mainstream.

The purpose of this paper, then, is to examine the corrective models offered by the mainstream in light of Austrian capital theory. The paper is divided as follows: first, each mainstream corrective concept is explained, then traits of Austrian capital (which will be found in Menger, Mises, and Rothbard) will be examined and the mainstream correctives evaluated.

The Concept of Vintage Capital

The concept that vintage capital attempts to capture is one that is somewhat obvious, especially in an age of rapid technological progress. In short, vintage capital attempts to account for the fact that particular capital goods embody the state of technology at the time that they were built. Thus, as technological progress occurs, older capital goods, even if they are of quite high quality (so that their absolute productivity does not diminish over time), will have lower relative productivity when compared with newer, more technologically advanced capital goods.¹ An

¹ It is interesting to note that various forms of state regulation can actually result in an opposite process occurring. For example, environmental regulations which result in decreases in productivity often only apply to new capital goods, which results in increased maintenance of old capital goods, as opposed to a potentially more efficient introduction of new capital goods.

obvious example is the computer industry. The Commodore 64 was the personal computer star of its era, but as technology has progressed, it has fallen out of use.²

The concept of vintage capital, then, clearly plays a large role in investment decisions. If it appears that technology is progressing quite rapidly, entrepreneurs may wait to invest until future technology becomes available.³ Naturally, this tendency will be offset, either partially or entirely, by time preference. The entrepreneur must compare a lower productivity starting today with a higher productivity starting in the future. Generally, the mainstream models account for the time preference effect by discounting future profits at the prevailing interest rate (or occasionally a subjective discount rate).

Vintage capital is certainly an improvement on the treatment of capital in most mainstream models. First, vintage capital introduces some heterogeneity into capital goods, as opposed to the commonly used homogeneous capital stock. This heterogeneity arising from different levels of embodied technology helps to explain why different proportions of different capital goods exist in an economy. Second, vintage capital introduces the idea of embodied technology. That is, technological advancement must be embodied in some concrete capital goods for it to increase production. Opposed to this idea is the common formulation where technology enters into production functions directly, so that, even using the exact same capital and labor, an increase in technological knowledge causes an increase in production. While there are certainly times when a new idea can allow for existing factors to be combined more productively (without the construction of significantly different capital goods), everyday

² This example brings to mind a potentially related area of study: the sale of mobile out-of-date capital goods to less technologically advanced economies. This area, however, falls outside the scope of this paper.

³ A similar phenomenon occurs with durable consumer goods. For example, one expects that demand for the Playstation 2 has dropped because the Playstation 3 will be launched on November 17.

experience suggests that many technological advancements require new capital goods for them to be implemented.

The Concept of Putty-Clay Technology (and other variants)

The concept of putty-clay technology is presented as an alternative to the usual mainstream assumption of variable proportions between labor and capital. The purpose of putty-clay technology is to capture the limits of capital-labor substitutability in real physical capital. In “putty-clay” terminology, capital exists in the form of machines, and three different types of machines are possible. The first has “putty-putty” technology. Putty-putty technology is typified by having variable proportions between labor and capital both before and after the building of particular capital goods. The second has “putty-clay” technology. Putty-clay technology is typified by having variable proportions between labor and capital before but not after the building of a particular capital good. The third has “clay-clay” technology. Clay-clay technology is typified by having fixed proportions between labor and capital both before and after the building of capital goods. With technologies that have a “clay” ex post component, the choice after a machine is built is simply whether or not to operate that given machine with the required labor.

Obviously, putty-putty technology is unrealistic in most cases. Some machines can only be used by a particular number of workers, no more and no less (one thinks, for example, of a computer terminal, which can only accommodate one operator at a time). Also, it is nearly impossible to imagine a case where a particular capital good can be operated from anything between zero and an infinite number of operators. But, typical putty-putty capital assumes that this is a reasonable approximation. Putty-clay and clay-clay technologies, therefore, are improvements, to a degree. However, these technologies seem to make the error opposite that of

putty-putty technology. While putty-putty technology assumes too great a degree of labor-capital substitutability, these technologies assume no labor-capital substitutability (at least after the capital good is built). Both errors appear to be implausible in most cases (though there are rare cases where putty-clay or clay-clay technologies do seem plausible). Rather, it seems that the most common case would be to have capital goods which can be used by different numbers of workers, but within some limited range. Despite this weakness of putty-clay and clay-clay technologies, it does seem to be an improvement, if only because it introduces the idea of concrete, potentially heterogeneous capital goods in a way that cannot be easily assumed away.

Vintage Capital, Putty-Clay Technology and Austrian Capital Theory

Having presented the concepts of vintage capital, and putty-clay technology, we may move on to a discussion of how these modifications to mainstream capital theory compare to the usual Austrian approaches to capital goods. In order to do so, it would naturally be beneficial to examine a few major Austrian theorists and consider their views on capital. Then, the possibility of comparing Austrian descriptions and assumptions regarding capital goods with those made by vintage capital and putty-clay technology theorists.

Carl Menger discusses goods of “higher order” (by which he often means capital goods) in his *Principles of Economics*. According to Menger, “it is never in our power to make use of any particular good of higher order for satisfaction of our needs unless we also have command over other (complementary) goods of higher order” (59). Here, it is clear that the heterogeneity of capital goods is an essential part of their being capital goods rather than consumer goods. However, throughout his book, Menger is unclear regarding the ability to combine higher order

goods in different combinations to produce first order goods, and he speaks little about technology.⁴

Ludwig von Mises's *Human Action* contains a theory of capital goods that advances far beyond what Menger presented. Mises identifies four major categories of capital goods, based on their ability to convert from one particular production process to another particular process. These categories are: those that are totally inconvertible, those that are convertible with alteration, those that are convertible without alteration but that are less efficient than those designed with the new purpose in mind, and those that are perfectly convertible (499-500). In addition, Mises considers how convertibility relates to technological progress. "The smaller the degree of convertibility, the more realization of technological improvement is delayed" (510). This statement must imply that, in Mises's system of thought, technology is embodied in capital goods. If it were not, then technological progress would be unimpeded by poorly convertible capital. Mises in fact refers directly to the idea of vintage capital just a few pages prior to this statement: "The plans which guided [existing capital goods'] production were an outgrowth of the then prevailing ideas concerning ends and technological procedures" (504). However, Mises also leaves open the possibility for technological progress that doesn't require new capital investment to take effect. He states that some increases in productivity will benefit "the owners of those capital goods already previously existing which, thanks to the improvement in technological methods of production, are now better utilized than before" (293). Thus, both "disembodied" and "embodied" technological progress occurs. Mises speaks very little of variations in the ratio of labor to capital, after the capital goods have already been built.

⁴ The word "technology" only appears twice in Menger's *Principles*. In the first chapter (68), Menger briefly mentions that technological progress shortens the time required for production. In the second chapter (84), Menger simply holds technology constant when discussing the relationship between higher order goods and first order goods.

However, Mises's statements about convertibility easily apply to this situation as well. For some capital goods, it is impossible to alter the number of workers that can use the good at a time. For others, such a change would require some alteration. For still others, such a change would not require an alteration, but would mean that some resources were wasted (ex post) in building a machine that could have been more efficient had the design had in mind the different number of workers that would be used. Finally, there are some machines where the number of workers can vary without any loss in efficiency.

In *Man, Economy, and State*, Murray Rothbard provides a good analysis of the relationship between capital and technology. He states, “[t]he reason that firms do not scrap their old methods immediately and begin afresh is that they and their ancestors have invested in a certain structure of capital goods...An old machine will be scrapped for a new and better substitute if the superiority of the new machine or method is great enough to compensate for the additional expenditure necessary to purchase the machine” (492). In short, it is clear that technology is embodied in capital. Rothbard is even clearer on this point when he states that “every increase in capital – even if unaccompanied by an advance in technological knowledge – leads to higher physical productivity per original factor” (478). From this observation naturally flows the conclusion that “the limits at any time on investment and productivity are a scarcity of saved capital, not the state of technological knowledge” (489). However, before we conclude too much, it is important to emphasize that Rothbard also affirms the idea of technology as a “recipe” (9). This idea implies that it is in fact possible by a more advanced recipe to improve productivity without a necessary investment in new capital goods, as a recipe may potentially be formulated which combines existing factors in a new, more productive way. However, it is clear from Rothbard's previous statement that he believes that, empirically, it is not a shortage of

knowledge which limits production. That is, he believes that there are relatively few undiscovered recipes which will, in themselves, increase productivity. Rather, it is the shortage of proper capital to carry out those recipes. In the terms used in this paper, the technology must be embodied in new capital. Finally, Rothbard clearly affirms the Misesian view of convertibility of capital (56).

Taking all these in view, it is clear that the vintage capital concept and the concept of putty-clay technology are both improvements in realism over the standard neoclassical theory. These two concepts capture matters of great importance: the embodiment of technology in capital goods and limitations on the variability of factor proportions. Both of these are left out of standard neoclassical models. However, there remains an extremely important, omitted concept: capital which produces specific, heterogeneous consumer goods, and which is partially convertible to the production of other consumer goods. This concept is emphasized both in Mises and Rothbard, but has remained absent from mainstream models.⁵ Ultimately, it is largely this fact of partial convertibility that rests at the heart of the malinvestment aspect of Austrian business cycle theory (which is the heart of the theory itself). Secondly, these models also omit an important observation regarding technological advancement and consumption: some goods would not be produced at all without capital embodying the appropriate technology. Thus, these models still omit an important motive for investment in developing new technological ideas: the development of new consumer goods which may better satisfy consumer desires. However, as vintage capital models and putty-clay models do allow for heterogeneous, discrete capital, they do not allow for heterogeneous consumer goods which arise out of different production processes. Thus, this concept is lost.

⁵ The reason for this omission is most likely related to the mathematical difficulty which would arise. Vintage capital models are, in themselves little used due to their computational difficulty.

Conclusion

Having examined the concepts of vintage capital and putty-clay capital, and then evaluating them in light of Austrian capital theory, I believe two different paths of study may arise: one for Austrians who are interested in more explicitly incorporating the motivating assumptions of the mainstream theories, and one for mainstream theorists who are interested in increasing realism in mainstream capital theory.

The research path for Austrians contains two major possibilities (each corresponding to one of the corrected mainstream theories). First, Austrians could use a more explicit examination of the relationship between technological progress and investment in capital goods. Of particular interest may be how the expected rate of technological progress can create opposing incentives for investment in capital goods.⁶ Secondly, one could examine more explicitly how limitations in variation of factor proportions may influence the decision to invest in capital goods, and also the impact that can have on issues such as firm (or plant) size during a business cycle bust.⁷

The research path for the mainstream also contains two major possibilities. First, one could examine the possibility of heterogeneous consumption goods with output-specific capital goods, and varying the degrees on convertibility between the various lines of production. Secondly, one could examine the process of introducing new products which require a particular technological advancement and capital investment as well before the product can be produced and sold. In particular, this should be in the context of a preexisting capital structure, and one

⁶ I would guess that the rate of time preference and, therefore, the market interest rate would provide interesting points of contact between the incentive to wait for future improvements and the incentive to invest now to replace old technology.

⁷ For example: when will it be more profitable to consolidate and shut down some plants/firms entirely, but increasing the capacity utilization at a few firms, rather than decreasing capacity utilization evenly, while keeping the number of plants/firms essentially constant? Naturally, there are conditions which would answer this question. Such conditions are where the potential future interest lies.

could derive conditions under which it is profitable to develop new products and invest in the required capital to produce those products.

In the end, capital theory is complex, regardless whether one is Austrian or not. However, given the important place of capital in economic growth and (at least in the Austrian theory) business cycles, it is an area well worth studying, as an enhanced understanding will improve both our explanations for observed economic phenomena and our ability to predict the consequences of various policies.

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