
9 Some implications of capital heterogeneity

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9.1 Introduction

A tractor is not a hammer. Both are capital goods but they usually serve different purposes. Yet both can be used to accomplish more than one goal. A tractor can be used to plow a field, pull a trailer, or any number of other tasks. A hammer could be used by a carpenter to build a house or by an automobile mechanic to fix a car. The fact that a tractor and hammer serve different purposes but yet each is capable of serving more than one single purpose should seem obvious. Yet the consistent application of this observation to economic theory is one of the unique aspects of the Austrian school and it has led the Austrian school to come to unique conclusions in areas ranging from socialist calculation, to business cycles and to economic development among others.

Capital goods are those goods that are valued because of their ability to produce other goods that are the ultimate object for consumption. Because these capital goods are heterogeneous and yet have multi-specific uses we must coordinate economic activity to best align the structure of capital goods to most efficiently produce consumer goods without leaving any higher valued consumption wants left unsatisfied. The coordination of consumption plans with the billions of ways the capital structure could be combined to satisfy those consumption plans is one of the major tasks any economy must accomplish. Yet, often formal economic models reduce capital to a single homogeneous stock “K” and by doing so they assume away one of the greatest coordination tasks an economy has to solve.

The following section briefly outlines Austrian capital theory. Sections that follow trace out the implications of capital heterogeneity in a variety of applied research areas. Socialist calculation, business cycles, economic development through the Solow model, World Bank aid for investment schemes, and industrial planning are all studied and the conclusions of the Austrian school are contrasted to those that are reached by theorists who fail to appreciate the importance of capital heterogeneity.

9.2 Austrian capital theory

Capital theory is an important area that makes Austrian economics unique. In fact, Horwitz (2000, p. 41) has argued that, “Although its

capital theory does not define Austrian economics, understanding that theory and its implications will give one a good grasp on precisely what is distinct about the Austrian approach.” Austrian capital theory draws on other key aspects of Austrian economics such as subjectivism, expectations, the role of time, and markets as a process of adjustment to illustrate the importance of capital heterogeneity. When these insights are applied to areas of inquiry, its capital theory is often what differentiates Austrian explanations of phenomena from other schools’ conclusions.

The first task of Austrian capital theory is to explain why capital heterogeneity is important. It is obvious that a hammer is not a tractor but why is that fact going to be important for economic theory? Why isn’t the simplifying assumption of capital homogeneity justified? First we must define in what ways capital is heterogeneous.

Of course a hammer and a tractor have different physical properties. However, that is not the only feature that makes them heterogeneous. They are also heterogeneous because of the different plans they will satisfy for a particular human actor. In fact, whether a good is capital or not depends crucially on the plans of its owner. A computer placed in a home to play video games is a consumption good, not a capital good. But if that same computer were placed in an office where a person planned to type economics articles on it then it would be a capital good. Goods are heterogeneous both because of their physical dimensions and also because of the different plans that they can satisfy.

This leads us to the problem of aggregating the capital stock. How can it be summed together? Lachmann famously wrote, “[W]e cannot add beer barrels to blast furnaces nor trucks to yards of telephone wire” (1978, p. 2). Since these are all different goods they obviously cannot be directly added together. A common denominator is required. Neoclassical economics typically sums the monetary value of these heterogeneous capital goods to arrive at a value of the capital stock.¹ However, this is justified only if all of the heterogeneous plans of all of the people using all of the capital goods are perfectly coordinated.

To see why, consider how capital goods get their value. Consumer goods are valued because they satisfy subjective desires of the individuals consuming them. Capital goods are valued because of their ability to produce the consumer goods that are the ultimate aim of production. However, because capital goods are heterogeneous they cannot be perfectly substituted for one another to produce the consumer goods. Yet capital goods are also multi-specific; each is capable of fitting into more than one single production plan for one consumer good. So capital goods derive their value from the entrepreneurs who bid on them with the aim of incorporating those capital goods into a specific plan to produce the

final consumer goods of ultimate valuation. The monetary value of capital goods will be the outcome of the bidding process of entrepreneurs that was based on their expectations of fulfilling particular plans to profitably produce particular final consumer goods.

Because the monetary value of capital goods was derived from the values placed on them based on expectations of incorporating them into individual production plans, the values for the various capital goods can only be summed together if all of the various individual plans are mutually compatible. If all of the individual production plans are not mutually compatible some of the capital used will not result in producing the final consumption goods it was intended to produce. Thus, it will not create the final value that its *ex ante* monetary price reflected. It is meaningless to add the monetary value of capital good A to the monetary value of capital good B if the only way the production plan for capital good A could be fulfilled is if it used other resources that precluded the possibility of the production plan for capital good B coming to fruition. The end result of these two plans would not create the intended consumer goods the plans called for. Hence adding their *ex ante* monetary values is still like adding blast furnaces to beer barrels.

The only time that capital can be summed up using monetary values is if all plans are perfectly coordinated so that all come to final fruition and produce the intended goods for final consumption. This only happens in equilibrium. But as Austrians have long recognized, the actual economy is never in equilibrium. An actual economy is always in a process of adjustment where we learn and discover new information and continually adjust our plans. We are always moving towards an equilibrium that itself is ever changing. Since we are never in general equilibrium, plans are never perfectly coordinated and prices of capital goods are not equilibrium prices that can be meaningfully summed.² Thus, Austrian capital theory does not focus on or measure “the” capital stock. Instead, Austrian capital theory focuses on the structure of the capital stock.

Because capital is both heterogeneous and multi-specific, Austrian capital theory focuses on how these individual units of capital fit together, or in other words, they study the capital structure. This is precisely where Austrian capital theory differs from the neoclassical mainstream. Austrians have to grapple with issues of capital complementarity and capital substitutability while these issues never arise if capital is modeled as homogeneous.³

Capital complementarity stems from the fact that it most often requires more than a single capital good to produce the final consumption good. Few cars will be produced if only the physical building for the assembly line is constructed but the individual assembly machines are not included

in the structure. The assembly machines and physical building complement each other and make greater production of cars possible. One of the tasks of entrepreneurs in the market economy is not just to invest and create new capital but to invest in creating the *right* capital that will best complement the existing capital. That means creating capital that fits into and complements other production plans.

All investment takes place in time. From the time the decision is made to invest, to when the actual capital good is created, time has elapsed and often revealed that original plans will need to be altered. Also, because capital is often durable, even if it at first serves its original purpose, later developments may indicate that the plan should be changed. Because investment decisions are made *ex ante* and the world is uncertain some plans will have to be altered as market conditions evolve. This raises the issue of capital substitutability. If all capital were perfectly homogeneous, substitutability would not raise any problems. Each capital good would be a perfect substitute for every capital good and changing plans would not involve any losses. If each capital good were perfectly specific (capable of fulfilling only a single function in a single plan) then substitutability would be impossible and when plans needed to change, existing capital would be useless. Because capital is both heterogeneous and multi-specific capital substitutability becomes an issue.

When an existing production plan changes to no longer require a capital good that was created to serve that plan the capital good must be integrated into another plan or else it will no longer be maintained. Substitutability is usually a matter of degree. It is a matter of how well an existing capital good serves a new purpose for which it was not intended and how large the adjustment costs are to putting the capital good into the new use.

Whether a society is prospering or stagnating does not just depend on how much capital it has or is in the process of creating because of capital complementarity and substitutability. Prosperity depends on both how much capital there is and how well fit together the existing capital structure is.

Horwitz (2000, p. 40) has labeled Austrian capital theory the “missing link” that bridges microeconomic foundations to macroeconomic analysis. Because of their different capital theory, Austrians ask different macroeconomic questions than other schools of thought. When capital is heterogeneous and multi-specific, economic growth theory doesn’t simply ask how to create more investment. It asks how to get the type of investment that best complements the existing capital stock. Policy-makers no longer have to stimulate aggregate demand to get out of a depression but instead have to deal with a situation where there were a cluster of errors in planning that created heterogeneous capital that now will have to serve

purposes other than what it was created for. Austrian business cycle theory asks how capital should be reallocated.

Before we turn to the role of capital heterogeneity and multi-specificity in long-run growth and in business cycles it is first worth examining the role it plays in one of the most important debates in the twentieth century – the socialist calculation debate.

9.3 Socialist calculation

The debate sparked by Mises' 1920 article, "Economic Calculation in the Socialist Commonwealth" is probably one of the most important debates that occurred in the economics profession in the twentieth century. In many ways the debate illustrated how the evolving neoclassical paradigm differed from the Austrian school. In fact, Boettke (2001) argues that economic calculation is *the* contribution of Austrian economics to political economy in the twentieth century, "[A]// the unique contributions of the Austrian school of economics to substantive economics can be traced back to the central importance of economic calculation for human cooperation" (p. 30; emphasis original). Yet for much of the twentieth century most economists believed the Austrians lost the economic calculation debate.

The mainstream of the economics profession failed to appreciate the Austrians' contribution to the socialist calculation debate both because of their preoccupation with equilibrium analysis and because of their tendency to model capital as homogeneous. The mainstream's preoccupation with equilibrium analysis led them to assume much of the information that it is the market processes' job to discover. This problem has been dealt with extensively in the Austrian literature and elsewhere in this volume (see Chapters 5 and 7) so it will not be further discussed here. However, the assumption of capital homogeneity is directly relevant for our purposes.

Mises ([1920] 1990) adopts the definition of socialism as collective ownership of the means of production. A postcard version of his argument reads:

- Socialism is the collective ownership of the means of production (MOP).
- Without private property in the MOP there is no market for the MOP.
- Without a market for the MOP there are no prices for the MOP.
- Without prices for the MOP there are no relative scarcity indicators for the MOP.
- Without relative scarcity indicators economic calculation is impossible:

- that is, you have no way of knowing which capital goods to combine in which proportions to produce the final consumer goods most economically.

Because socialism is defined as the collective ownership of the means of production, whether capital goods are homogeneous or heterogeneous is crucial because the economic calculation problem stems from the fact that we have no relative scarcity indicators for these capital goods.

If capital goods are all perfectly specific then no problem arises when you have no relative scarcity indicator for them. Each is only suitable to one task. An economy need only know the final consumer goods it wants and then the planner can choose to accumulate the capital necessary to make those goods. Similarly if all capital goods are perfectly homogeneous their relative scarcities do not matter. Each can be perfectly substituted for every other. A planner again only needs to know the desired type and quantity of consumer goods. Any structure of capital goods used to produce those consumer goods is equally efficient.

With perfect capital specificity or perfect homogeneity the economic calculation problem collapses into a technical production problem. Schumpeter (1942, p. 175) argued that an economy could have economic calculation for factors of production without private property for the MOP because “[C]onsumers in evaluating (‘demanding’) consumers’ goods *ipso facto* also evaluate the means of production which enter into the production of these goods.” However, the “*ipso facto*” does not hold precisely because capital is heterogeneous. If each capital good could only produce one consumption good then the valuation of consumer goods would suffice to value the capital good. But because capital goods are multi-specific we need to know the relative scarcity of the capital good in its alternative uses in order to have economic efficiency. Hayek (1945) pointed out that Schumpeter’s *ipso facto* only holds if all the facts are given to one mind. Alternatively it is also accurate to say that with dispersed knowledge the *ipso facto* would hold only if all capital was perfectly specific or all capital was homogeneous.

The economic calculation problem only exists because capital is heterogeneous and multi-specific. These same factors also drive the Austrian business cycle theory, much of which was developed contemporaneously with the socialist calculation debate.

9.4 Business cycles

Its capital theory is a distinguishing characteristic of Austrian business cycle theory (ABCT). Most macroeconomic schools of thought model capital (or investment) as homogeneous. Thus, when examining business

cycle fluctuations they can only talk about increases or decreases in the quantity of investment. ABCT integrates its capital theory to model the heterogeneous and multi-specific nature of capital. Therefore ABCT examines how misalignments in the structure of production occur. ABCT is sometimes characterized as a theory of over-investment but in fact it is better described as a theory of mal-investment because it addresses the dis-coordinated nature of the capital structure.

Austrian capital theory is both the microfoundation for macroeconomics (Horwitz, 2000) and the link between the short run and the long run (Garrison, 2001). Entrepreneurs make decisions based on the price signals from consumer goods, capital goods, and the interest rate to make investment decisions. The first of these signals what consumption goods are desired, the second signals the most economical way to produce them, and the third provides intertemporal coordination. Entrepreneurs' investments take the form of heterogeneous multi-specific capital goods. Because these goods are durable and have multiple uses they provide a bridge between the short and long run.

Not all *ex ante* entrepreneurial forecasts are correct. So capital goods will need to be reallocated *ex post* to alternative production processes. A business cycle occurs when there are a cluster of systematic entrepreneurial errors. Consistent with real business cycle theory (RBC) the cluster of errors could be created by a technological shock or an unexpected government regulation. However, unlike RBC theory, because Austrians believe money is non-neutral (see Chapter 8) the cluster of errors could also be created by monetary manipulations that distort inter-temporal coordination.

When the cluster of errors stems from artificially depressing the interest rate it will encourage a "lengthening" of the structure of production where more "round-about," or longer-term, production processes will be employed than is optimal. It is beyond the scope of this chapter to examine and evaluate all of the possible sources of the cluster of errors or go into depth on the nature of credit-induced boom (see Garrison, 2001). For our purposes we are interested in what the implications of capital heterogeneity and multi-specificity are once a cluster of errors have occurred.

Where Keynesians and Monetarists see a lack of aggregate demand, and RBC theorists see an optimal equilibrium given the shock, Austrian theorists see a mismatch between the heterogeneous capital goods structure and the structure of those capital goods necessary for satisfying consumer desires. There is no lack of aggregate demand; there is a lack of enough particular demand for the consumer goods produced by the existing combinations of capital goods. To recover from a depression Austrian theory shows bad investments must be liquidated and capital reallocated.

Depressions can persist as long as the structure of production is not in line with consumer preferences for consumption goods.

The policy implications of ABCT stem directly from the fact that capital is heterogeneous and multi-specific. Bad investments were made. The existing capital goods are imperfect substitutes for what capital should have been created but the capital goods, if transformed into another production plan, can still be useful. How best to do this? First, stop distorting the price system in a way that led to the cluster of errors in the first place. This means if it was an inflation-induced boom-bust, stop inflating the currency. Second, do not bail out bad investments in a way that would preserve the current structure of production. Business failure will not destroy the heterogeneous capital goods; it will free them up to be reallocated according to consumer preferences.

These recommendations stand in stark contrast to Keynesian and Monetarist prescriptions that call for attempts to stimulate aggregate demand through either monetary or fiscal policy. In fact, as a historic matter, government attempts at fiscal stimulus often serve to artificially create demand for goods produced by the existing structure of production and thus slow economic recovery. Rothbard's ([1963] 2000) *America's Great Depression*, forcefully argues that interventions starting with the Hoover administration maintained an existing structure of production and delayed economic recovery. Powell (2002) makes a similar argument about Japan's depression in the 1990s.

Because ABCT allows monetary distortions to change the capital structure away from consumer preferences it is also capable of explaining stagflation. During stagflation prior inflation distorted the capital structure away from that required for full employment and then continual inflation prevented the realignment of the capital stock and economic recovery.

Most macroeconomic schools of thought focus on aggregate levels of economic activity. In doing so they miss describing the ways capital combines and recombines to produce final consumer goods. Because of the Austrian school's unique capital theory they are able to focus on discoordination within an aggregate category such as investment. Austrian capital theory better enables Austrians to explain depressions, recovery, and stagflation.

9.5 Economic development

Capital goods have played a prominent role in Austrian explanations of the wealth of nations. Mises writes, "The heritage of the past embodied in our supply of capital goods is our wealth and the foremost means of further advancement in well-being" ([1949] 1998, p. 510). Perhaps even more forcefully, Rothbard refers to the "relative unimportance of

technology in production as compared to the supply of saved capital” ([1962] 1993, p. 490). Yet ironically the textbook neoclassical growth model demonstrated that capital was not the cause of long-run growth. It is capital heterogeneity again that explains the differing conclusions.

In the Solow growth model, output is a function of capital and labor. Savings is a fraction of total output but there are assumed to be diminishing returns to capital. So as the capital stock grows, the marginal increases in output become increasingly smaller eventually leading to a steady state with no more growth due to capital accumulation. Once this point is reached only technological change can cause long-run growth.

Homogeneous capital is one reason for the diminishing returns. When capital is heterogeneous there could be constant or increasing returns because of complementarity rather than the Solow model’s decreasing returns. Hayek (1937, p. 174), when writing on business cycles well before Solow’s model was created anticipates this:

The effect which the current production of capital goods will have on the future demand for investable funds will depend not so much on the quantity of capital goods produced, as on the kind of capital goods which are produced. . . an increase in the current output of capital goods will frequently have the effect not of lowering but of raising the future demand for investable funds, and thereby the rate of interest [marginal productivity].

Capital heterogeneity does not make the Solow model wrong in theory but it can make it irrelevant in practice. The model measures what happens to output when capital per worker is increased. Since the model is measuring income per capita, whatever the rate of population growth, the rate of capital accumulation must exceed it for there to be growth, so eventually diminishing returns must set in as more and more capital *per worker* is accumulated. The unit “worker” is essentially fixed so diminishing returns must eventually occur. However, the tacit assumption when the Solow growth model is invoked is that wealthy countries are now somewhere approximately near the steady state. Because capital is heterogeneous we could have capital complementarity and the growth that comes from accumulating more capital up to much higher income levels. If income levels in the steady state are \$1 billion per capita because of capital heterogeneity it does not mean the Solow model is theoretically wrong but it does mean that the model is not an accurate description of growth in the current state of the world. Capital heterogeneity allows Austrians to coherently claim that for the foreseeable future long-term growth can result from capital accumulation.

The Solow model was the leading theoretic growth model of the twentieth century but the World Bank’s financing gap model may be the most

implemented growth model during the last 60 years. The idea behind the financing gap model is that poor countries are in a low-growth equilibrium where they do not have enough savings to finance capital accumulation so aid for investment should be used to create capital accumulation.

The financing gap model fails to fully appreciate the importance of capital heterogeneity and economic calculation. In fact, it was even inspired by a former socialist central planning model! Poor countries do not simply need “investment.” They need investment in capital that complements the existing structure of production. Investments need to be made on the basis of expected profit and loss. Private investment accomplishes this. Aid for investment often takes the form of infrastructure investment or other projects that are not bought and sold on the market. Therefore, much of the investment financed by the financing gap model has been outside of the sphere of economic calculation. The impact of poor incentives created by aid for investment programs has been well documented. The epistemic problems associated with using aid to finance the right heterogeneous capital have been less emphasized but are no less real.

National economic development planning is another area where an appreciation of capital heterogeneity has led Austrians to conclusions different from the mainstream. Advocates of state development planning do not assume that capital is homogeneous. In fact, their rationale for planning is that capital is heterogeneous but that they can select the capital better than the market. But by selectively promoting some industries they enable those industries to bid capital away from other industries and by doing so they interfere with the very process that reveals the relative scarcity of the heterogeneous capital goods. Lavoie (1985, p. 95) summarizes the problem:

The same lack of knowledge on the part of any single person or organization which makes it impossible for comprehensive planning to replace the market also makes it irrational for a noncomprehensive planning agency to try merely to “guide” the market. If the guiding agency is less knowledgeable than the system it is trying to guide – and even worse, if its actions necessarily result in further undesired consequences in the working of that system – then what is going on is not planning at all but, rather, blind interference by some agents with the plans of others.

When the state actively plans development, it forces heterogeneous capital goods to particular industries. The decision-makers in the government planning bureau have no method to evaluate the opportunity cost of another industry’s potential use of those capital goods. The opportunity cost is the subjective loss suffered by the person who would have received resources if the government had not interfered with the market process.

Since the planning bureau has no way of evaluating this loss, it cannot determine if the loss in output from other industries caused by promoting one industry is greater or less than the benefit produced. The planning agency has no way to know if it is promoting development or retarding it. Because capital is heterogeneous and multi-specific whenever competitive market forces are not allowed to dictate the capital structure an economy will not generate the level of prosperity that it is capable of.

9.6 Conclusion

The fact that capital is both heterogeneous and multi-specific should be obvious. But economic models that have failed to incorporate this fact have done a poor job at explaining real world phenomena. Some of the biggest economic events of the twentieth century; the failure of socialist planning, the length and severity of the Great Depression, stagflation, and the failure of official development assistance, have been explained coherently by Austrian economists. In each case, the unique Austrian conclusions stemmed, in part, from the fact that Austrians were relying on realistic models of heterogeneous and multi-specific capital while competing theories modeled capital as homogeneous. Boettke claimed that all of the unique contributions to substantive economics made by Austrian economists stem from the importance of economic calculation. He may be right, but it is because Austrian capital theory seriously grapples with the fact that capital is both heterogeneous and multi-specific, that allows Austrians to reach unique conclusions about economic calculation and thereby reach similarly unique conclusions in other applied research areas.

Notes

- * I thank Jeffery Hummel and Andrew Young for helpful suggestions on an earlier draft. The usual caveat applies.
- 1. Austrians are certainly not alone in critiquing neoclassical capital theory. For an alternative critique see the Cambridge Controversies. A short retrospective summary of the debate appears in the *Journal of Economic Perspectives* 17(1): 199–214, “Whatever Happened to the Cambridge Capital Theory Controversies?” by Avi Cohen and G.C. Harcourt (2003).
- 2. Measurement inaccuracy can be a matter of degree. With a strong tendency toward equilibrium and a huge proportion of plans that do turn out to be ex post compatible then summing the monetary value of capital would yield an approximation of the capital stock. These arguments should also not be taken as a complete condemnation of equilibrium theorizing in Austrian economics. Hayek’s classics, *Prices and Production* (1931) and *Pure Theory of Capital* (1941) and more recently Garrison’s *Time and Money* (2001) all fruitfully begin with a macroeconomic equilibrium analysis of the capital structure and study deviations from that equilibrium.
- 3. This is not to claim that the issue of capital heterogeneity has not been raised in the mainstream. Certainly Solow and others involved in the Cambridge controversies did debate it and there are still attempts by some mainstream economists to incorporate

heterogeneity into their models. The point is that the main thrust of neoclassical growth theory, whether the Solow model, or later endogenous growth theory, has failed to adequately incorporate capital heterogeneity and usually chooses to assume it away.

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