Rediscovering the Burchardt-Lowe Post-Classical Model and Its Implications for Structural Modeling and Structural Economic Dynamics

Michael J. Murray, Ph.D.[a]

[a]*Department of Economics*
Bemidji State University
1500 Birchmont Drive #27
Bemidji MN, 56601

Abstract

The task here is to extract Fritz Burchardt's (1931-32) and Adolph Lowe's (1987; 1976) somewhat neglected, but albeit insightful contributions toward the development of a non-neoclassical theory of production. As such, the essay explores the contemporary relevance of the Burchardt-Lowe schema for modern approaches toward the structure of production and structural change. Reintroducing Burchardt's critique questions the appropriateness of separating the methods of production into two separate research agendas. For production modeling to be effective as a policy-tool, they must have a fair amount of abstraction to be manageable, while at the same time being detailed enough to include the behavioral functions of individual firms.

1. Introduction

The task here is to extract Fritz Burchardt's (1931-32) and Adolph Lowe's (1987; 1976) somewhat neglected, but albeit insightful contributions toward the development of a non-neoclassical theory of production. Fritz Burchardt and Adolph Lowe developed the Post-Classical production model which synthesized the Classical and Austrian models developed in the 19th century; most notably conjoining the two-department model formulated by Karl Marx in *Capital*, with the linear production models of Böhm-Bawerk and the Austrians. Given this back-drop, the essay re-introduces Burchardt's critique of the inadequacy of reducing production to models featuring only circular or linear components. By using Burchardt's critique of Böhm-Bawerk and Marx as a launchpad, the essay puts into question the continued separation of the methods of production into two research agendas (cite Hicks, Scazierri, Hagemann, Kurz). Along the way the essay decomposes the behavioral assumptions required for modeling production in a circular/Classical fashion, and emphasizes the definition of time, which is implicit in all models of a productive economy. Lastly, the final section of the essay re-introduces the Post-Classical model for today's theorists and describes situations in which modeling production in this manner is preferable. To this point, the essay argues that choosing among Classical, Austrian, or Post-Classical methods becomes dependent upon the level of economic investigation being conducted; yet, as we shall see the Post-Classical model is more robust then either Austrian or Classical models

Email address: mmurray@bemidjistate.edu (Michael J. Murray, Ph.D.)

because it is able to handle circular methods of production, the sequential nature of production, and importantly, structural bottlenecks that are 'basic' (to use Sraffa's term) or localized.

2. Historical Roots of Structural Production

Given the dichotomy of structural production modeling over the past two and half centuries it is appropriate to provide a brief survey of the historical roots of the separation of circular and linear production modeling and the current analytical context of each method's utilization. The purpose of this historical venture is twofold. One, it provides a frame of reference for the divergent methods. For example, Lowe criticizes Sraffa for taking the position that production is a circular process and ignoring time in production and sequential processes. But Sraffa's approach in *Production of Commodities by Means of Commodities* (PCMC) was not to devise an accurate methodology to study the time process of production. Rather, Sraffa's circular method in PCMC served as a critique to the Neoclassical marginalist method and served as a foundation to reignite the Classical approach, specifically that of Ricardo, and to provide a solution for the Classical theory of value.

The Classical approach itself served to cast economic theory in terms of the formation of the social surplus. Specifically for Ricardo, the primary analytical purpose of the corn model served to provide a theory of profits grounded in agriculture. Its secondary contribution is to base production upon opposing class division between landlords and farmers (Sraffa 1951a, pp. xxx-xxxvii). Beyond its analytical contributions, the larger purpose of the corn model provided a comprehensive account of the effects of capital accumulation and population growth and to use that account to direct Napoleonic post-war economic policy (Langer, 2011).

The production models of Karl Marx and Eugene von Böhm-Bawerk have competing purposes. Marx's circular model of production furthers Ricardo's method of class division between the capitalist class and the working class, and between worker consumption (productive consumption) and capitalist consumption (unproductive consumption). In brief, the Marxian production model ultimately served to cast capitalist production as an exploitative, class driven process, which provided Marx a basis for hypothesizing the eventual fall of capitalism and rise to communism.

On the contrary, Böhm-Bawerk (1921) linear production model initially served to refute Marx's theory of production –and thereby the theory of exploitation– because Böhm-Bawerk asserted that Marx's model ignores the time process of production. Böhm-Bawerk accounted for the time process of production by developing a one-way model of production and introduced the concept of roundaboutness to account for capital intensity and the return on capital. From Böhm-Bawerk standpoint, labor exploitation is not present because workers wages are governed by the present value of the expected return on the final consumer output. Given

the roundaboutness of production, the worker does not produce the entire value of the product at each step in the process. Therefore labor can only be paid a fraction of the estimated value of the future output, and a portion of the value is to finance capital. Given roundabout production, interest is not exploitative, rather it is the cost of capital. Thus the roundabout method of linear production serves as both a critique to Marx's theory of exploitation and to the labor theory of value.

The historical evolution of production theory and the purpose underlying the initial development of competing production models themselves are vitally important to understand the current division of circular and linear production models. This history contextualizes Burchardt's critique of Böhm-Bawerk and Marx and underpins the development of the Burchardt-Lowe Post-Classical model. Unlike their predecessors, the purpose of Burchardt and Lowe's model was to provide a framework that was both parsimonious enough to be useful to guide economic theory yet detailed enough so that it may be utilized for policy prescription. Out of Burchardt's critique formed a structural model of production that features elements from both Böhm-Barwek and Marx and corrected for the deficiencies Burchardt saw in each author's respective framework.

2.1. Background

The Burchardt-Lowe production schema originated with Fritz Burchardt as a solution to the deficiencies he saw in Böhm-Bawerk and Marx. Burchardt's schema depicts a two-sector model characterizing the production of capital goods and consumption goods respectively. Circular production is exhibited in the capital goods sector which produces capital goods for self-reproduction and towards the production of consumer goods. The production schema was unusual in its day as it became the first structural model to also incorporate linear stages to the circular flow model originating in the Classical economists and Marx.

Early adopters of Burchardt's production schema were Ragner Nurske (1935) followed by Adolph Lowe ([1955] 1987a). Credit is owed to Nurske for elaborating on Burchardt's original schema; that said, the title of this essay credits the origination of this schema to both Burchardt and Lowe. Burchardt (1931-32) acknowledges from the outset that his alternative formulation of the productive process "resulted from close collaboration with Prof. Dr. Löwe (*ibid.* p. 525 fn. 1)." Further Burchardt was introduced to Löwe as a graduate student in Löwe's seminar in economic theory at Kiel University. Following his schooling, Burchardt was appointed as chief research assistant and personal aide to Adolf Löwe at the *Kiel Institute for Global Economics* where Löwe served as the research director (Lowe, 1959, 59-60).

During his time at the *Institute*, Burchardt served as a conduit between the younger members of the Institute and the senior scholars. Given Burchardt's "theoretical gifts", he served as an "invigorating critic to the work of scholars who were far ahead of him in years and experience (*ibid*. pp. 61)". Burchardt was tasked to develop a theoretical model of circular growth that accounts for both historical variation but yet

general enough to be predictive. This "ambitious research" became a critique of both Böhm-Bawerk and Marx's theoretical schema which incorporated nicely into the research of business cycles that was being studied at the Kiel Institute during this time. As recollected by Lowe:

> "Burchardt's methodological position happily coincided with the basic working hypothesis on which the *Institut's* studies were founded, namely that a satisfactory explanation of industrial fluctuations must fit into the general framework of a theory of circular flow. At the time this hypothesis . . . ran counter to the prevailing fashions of theory (Lowe, 1959, 62)."[1]

In the 1950s Lowe reignited Burchardt's original schema which in 1976 culminated in the publication of Lowe's magnum opus *The Path of Economic Growth*. Here Lowe critiqued the "extreme position" adopted by Piero Sraffa (1960) echoing Burchardt's critique of Marx four decades earlier. These critiques led Burchardt and Lowe to integrate the circular surplus approach of the Classical economists and Marx (Carter, 2011) with the linear approach of the Austrians. This integration sets Burchardt and Lowe apart in the history of economic analysis as being the originators of a structural model of production that incorporates both circular and linear components.[2] As such, the Burchardt-Lowe schema allows for the integration of two contemporary research agendas, 1) the mapping of the institutionalized social provisioning process which is modeled utilizing circular models and 2) the modeling the transformation of capital and the sequential nature of production typically modeled utilizing a linear approach.

One key conclusion that is unique to the Burchardt-Lowe schema is of particular importance and as such it is worth highlighting here. The Burchardt-Lowe schema allows for investigations into structural rigidity and structural bottlenecks caused by varying degrees of capital specificity. At the outset a distinction can be made between what may be called *first degree capital specificity* and *second degree capital specificity*. First-degree capital specificity shall be defined as sector-specific capital, this is akin to a 'basic good' as used by Sraffa. Further, second-degree capital specificity refers to firm-specific (or industry-specific) capital which occurs as output moves through different stages of production. First-degree capital specificity may be found in the models used by Geoffrey Harcourt (1965) and Jan Kregel (1973) and second degree capital specificity is illustrated in the structural model used by Joan Robinson (1965, 63-84). However, through the integration of circular production and linear stages, the Burchardt-Lowe schema has the capability to model the outcomes of transformational growth[3] given first-degree *and/or* second-degree capital specificity. Most contemporary non-neoclassical theories of production have failed to embrace the Burchardt-Lowe synthesis. As such modern theory has not escaped the historical separation of structural production modeling. Thus contemporary circular and linear models of production are deficient to undertake a complete analysis of the

[1] The "prevailing fashions of theory" at the time was the Austrian linear model of production first developed by Böhm Bawerk and furthered by Friedrich Hayek's (1935) *Prices of Production.*

[2] An important inclusion into this select group is Mikal Kalecki, who explicitly adopted the Burchardt-Lowe schema in *Theory of Economic Dynamics*.

[3] For a summary of the theory of transformational growth see Nell 1978.

economic impacts of structural bottlenecks of production given capital specificity within historical time. A brief examination of the historical roots of the divergence may provide context for why this deficiency still exists. While many political economists attempted to model production, a concentration will be on the key players: Quesnay, Ricardo, Marx, and Sraffa who are the predecessors of modern circular models of production; Böhm-Bawerk and Hayek stand out as key participants for linear models. Much time will not be spent on this historical exercise, but it is important to for the reader to be somewhat educated on the purpose for the development of circular and linear production models to grasp Burchardt's critique of each and to appreciate the elegance, uniqueness, and practicality of the Post-Classical model of Burchardt and Lowe.

3. Circular Production: Francois Quesnay and David Ricardo

"It is of course Francois Quesnay's *Tableau Economique* that is found the original picture of the system of production and consumption as a circular process, and it stands in striking contrast to the views presented by modern theory, of a one-way avenue that leads from 'factors of production' to 'consumption goods'"
The origin of the circular flow model is found in Quesnay with circular exchange between agriculture, manufacture, and the State which levies taxes. Quensay's tableau represents the exchanges between the farmers and the merchants. Quensay's model simply represents the monetary flow of exchanges that must take place for the economic system to reproduce itself. Brewer (2005) presents a good explanation of Quensay's tableau which is adopted here for expository purposes (ibid. pp. 1-2, 16).

The system starts with the distribution of income between the three social classes and distribution of income that is as follows.

- Initial Position
  - State $2.00
  - Farmers: $2.00
  - Factory Workers $1.00

The process of reproduction starts with a series of exchanges.

- Exchange 1: The State spends one dollar on produce and one dollar on manufacture. Distribution of income after the first exchange:
  - State = $0.00
  - Farmers = $3.00
  - Factory Workers = $2.00
- Exchange 2: Factory Workers spend their $2.00 on food from the farmers.
  - State = $0.00

  - Farmers = $5.00
  - Factory Workers = $0.00
- Exchange 3: Farmers spend $1.00 on capital goods from the factory.
  - State = $0.00
  - Farmers = $4.00
  - Factory Workers = $1.00
- Exchange 4: The State levies $2.00 tax on farmers.
  - State = $2.00
  - Farmers = $2.00
  - Factory Workers = $1.00
- Initial position is returned.

Quesnay's system represents the material exchanges between farmers, manufactures, and the State to illustrate the requirements for the reproduction of society. There are exchanges being taken place between the agriculture and manufacture sectors above.

Following Quesnay, the historical roots of circular production shifts to David Ricardo's *Essay on Profits*. It was Ricardo who explicitly singled out corn as the commodity required for self-reproduction and the production of every other commodity in the system. Meaning, wages are paid out of corn and corn is classified as the capital good required for reproduction. Profits are simply the difference between the corn advanced and what is required for reproduction. The corn model is a simple abstraction from reality yet is used by Ricardo for delineating the surplus approach to production. If one accepts Sraffa's "Introduction" to Ricardo's *Principles*, the purpose of the corn model is to represent profits independent of value. Profits, here are measured in quantity of corn and are simply the remaining corn not needed as inputs (Sraffa, 1960, 93). As noted by Sraffa in his Introduction to Ricardo:

> "The rational foundation of the principle of the determining role of the profits of agriculture, which is never explicitly stated by Ricardo, is that in agriculture the same commodity, namely corn, forms both the capital (conceived as composed of the subsistence necessary for workers) and the product; so that the determination of profit by the difference between total product and capital advanced, and also the determination of the ratio of this profit to the capital, is done directly between quantities of corn without any question of valuation (Sraffa, 2010, xxxi)"

Ricardo's theory of profits came under frequent attack by Malthus who objected to Ricardo's held view that wages consisted of corn and corn alone. Because of such attacks, Ricardo abandons the corn model in his *Principles of Political Economy* and allows wages to consist of a series of commodities. But, Ricardo does not abandon circular production. Now rather than corn, labor served as both an input and an output.

In other words, the consumption goods produced must at least be sufficient enough to reproduce the labor force, and therefore represents a given level of labor. Labor may now be represented on both sides of the equation as an input and as an output. Circularity is represented in Ricardo's *Principles* but it is now labor that is the circular factor. The rate of profit is no longer expressed in terms of corn, but rather in terms of necessary total labor to produce the country's output to that of total labor of the country (Sraffa, 2010, xxxii).

4. Circular Production: Piero Sraffa

Piero Sraffa's production model is also of particular importance as his name –perhaps along with Wassily Leontief– is most associated with modern day approaches to circular production. Sraffa was highly critical of the marginalist method of Neoclassical economics. Further, Sraffa was editor of Ricardo's Collected Works, so it is not surprising to see traces of Ricardo and the Classical political economy as the basis for Sraffa's critique of the marginalist method.

Sraffa's economics centers on production and distribution (rather than exchange), and in doing so Sraffa provided a solution for the Classical problem of value and provided a critique to marginal productivity theory (and to Marx's labor theory of value). Thus the fundamental basis for PCMC was to rescue the Classical economic approach which has been "submerged or forgotten since the advent of the marginal method (Sraffa, 1960, v)" and in doing so, serve as both a critique of marginalism while providing the foundation in which an alternative method of production and distribution. The deficiencies with the methods of both marginal productivity and of returns (of any kind) are laid out first and foremost by Sraffa in the preface to PCMC.

> The marginal approach requires attention to be focused on change, for without change either in the scale of an industry or in the 'proportions of the factors of production' there can be neither marginal product or marginal cost. In a system in which, day after day, production considered unchanged in those respects, the marginal product of a factor (or alternatively the marginal cost of a product) would not merely be hard to find– it just would not be there to be found.

The investigation set out in PCMC is "concerned exclusively with such properties of an economic system that does not depend on changes in the scale of production or in the proportions of the factors (ibid.)" PCMC builds on Sraffa's (1926) scathing critique of Marshall that centered on non-proportional returns encompassed in the U-shaped average cost curve. The U-shape average cost curve determines the equilibrium size of the firm operating under competitive conditions. The decreasing portion of the curve is due to increasing returns and the increasing portion of the curve is due to diminishing returns. Yet, these are not twin concepts and come from different parts of economic theory. Increasing returns stems from economic progress in manufacture and therefore comes from the theory of production, and diminishing returns comes from the Ricardian theory of rent and therefore animates from the theory of distribution (see Forstater 2008). The outcome from Sraffa's analysis during the 1920s was an abandonment of perfect competition and partial equilibrium theory. This led to the writing of PCMC whose central insights took shape in the 1920s (Sraffa,

1960, vi).

The cornerstone of PCMC is to recast economic theory within the methodology of the Classical surplus theory of production. Thus we see an important lineage from the Classical thought from Quesnay, Ricardo, and Marx to Sraffa (Carter, 2011). The "core" (Garegnani, 1984, 292) of the surplus theory is the emergence of the social surplus and its distribution between wages and profits. The size of the economic surplus is known in physical terms, however the distribution of the surplus must still be determined. The surplus, as was said, is divided between wages and profits. The real wage in the surplus approach is seen as an independent variable, and it is determined separately from the size of the surplus and the technical conditions of production which are all determined independently. However this is not to mean that the wage can not be influenced by any one or more of these variables (Garegnani, 1984, 296). Sraffa's (1960) price equations depict just that. Let i be commodities produced in a given year requiring L_i laborers, and require constant capital of A_i, B_i, $\ldots K_i$; where i is equal to commodities a, $b \ldots k$ produced. Let w be the wage rate, and r be the rate of profit. The value of these commodities is equal to one, thus let $\lambda_a p_a + \lambda_b p_b + \ldots + \lambda_k p_k = 1$. Where λ_i represents the value of commodity i (Sraffa, 1960, 11). Sraffa's price-equation model is illustrated as:

$$\begin{aligned}
(A_a p_a + B_a p_b + \ldots + K_a p_k)(1 + r) + L_a w &= A p_a \\
(A_b p_a + B_b p_b + \ldots + K_b p_k)(1 + r) + L_b w &= A p_b \\
\ldots\ldots\ldots\ldots & \ldots \\
(A_k p_a + B_k p_b + \ldots + K_k p_k)(1 + r) + L_k w &= A p_k \\
\lambda_a p_a + \lambda_b p_b + \ldots + \lambda_k p_k &= 1
\end{aligned} \tag{1}$$

Represented in equations 1 is a depiction of the national economy, with k commodities. Equations 1 are $(k + 1)$ in number with unknowns p_a, p_b, $\ldots$, p_k, r, w. If the wage rate (or any other variable) was set to be the numeraire then there would be an equal number of unknowns as equations. The result of adding the wage rate as also variable is that the number of unknowns exceeds the number of equations by one. The objective to allowing the wage rate to be variable is to show the effect of changes in the wage rate on the rate of profit. Sraffa has shown that, for a given technique, that as the wage was gradually increased from 0 to 1, the rate of profit falls in direct proportion to the increase in the wage rate (Sraffa, 1960, 22-23). The Sraffian system is a return to the Classical economists and Marx (who we shall now turn to) in the determination of the distribution of the economic social surplus.

In contemporary times, Sraffa's (1960) "critique of economic theory" has laid much of the foundation for contemporary Post Keynesian economics (for example Post Keynesian Price and Production Models[4] Ian Steedman (1981) and Piero Garegnani (1984) are also important contributors as they reconcile Marx's the-

[4]see Lee (1998) especially and Lee (2011).

ory of wages, profits, and prices, with Sraffa's *Production of Commodities by Means of Commodities*.[5]

5. Burchardt's Critique of Marx

Marx's models of simple and expanded reproduction are well-known, therefore we need not spend time describing the models presented in the first two volumes of *Capital*. Rather we shall concentrate on Burchardt's critique of Marx's models of simple and expanded reproduction. Burchardt's critique of Marx's centers around the precedence that Marx places on conditions required for reproduction within the two departments while at the same time ignoring the process of production through sequential stages. As quoted by Marx in Volume 2 of *Capital* the transformation of capital through sequential stages of production is "immaterial":

> "So long as we looked upon the production of value and the value of the product of capital individually, the bodily form of the commodities produced was wholly immaterial for the analysis, whether it was machines, for instance, corn, or looking glasses. It was always but a matter of illustration, and any branch of production could have served that purpose equally well. What we dealt with was the immediate process of production itself, which presents itself at every point as the process of some individual capital. So far as the reproduction of capital was concerned, it was sufficient to assume that that portion of the product in commodities which represents capital-value finds an opportunity in the sphere of circulation to reconvert itself into its elements of production and thus into its form of productive capital; just as it sufficed to assume that both the labourer and the capitalist find in the market those commodities on which they spend their wages and the surplus-value. This merely formal manner of presentation is no longer adequate in the study of the total social capital and of the value of its products. The reconversion of one portion of the value of the product into capital and the passing of another portion into the individual consumption of the capitalist as well as the working-class form a movement within the value of the product itself in which the result of the aggregate capital finds expression; and this movement is not only a replacement of value, but also a replacement in material and is therefore as much bound up with the relative proportions of the value-components of the total social product as with their use-value, their material shape (Marx, 1992, 221)."

Marx refers to all unfinished goods as raw material because of his intended omission of sequential stages. Marx's reproduction models presuppose knowledge of the intended use of goods because it is not reflected in the technical specification (Burchardt, 1 32, 121). In contrast to *Capital*, Marx felt it necessary to highlight the sequential nature of production in *Theories of Surplus Value* (TSV). In *TSV*, Marx disaggregated the output of two departments into sequential stages. Marx (NEED CITATION HERE) provides the production of linen as an illustration:

Department I

[5]The reconciliation between Marx and Sraffa also included the transformation problem. In Marx, the rate of profit is said to depend on constant capital, variable capital (in terms of the labor necessary to produce them) and surplus value. However, competition distributes profits in terms of prices of constant and variable capital, not on values of labor embodied. Marx, in *Capital III* attempted to solve this transformation problem. However his solution was inconsistent and is later solved by (Steedman, 1981, 29-36).

Iron and Wood Producers	$\frac{2}{3}$f	+	–	+	$1\frac{1}{3}$v	=	2	Iorn and Wood
Machine Producers	$\frac{2}{3}$f	+	2z	+	$2\frac{2}{3}$v	=	$5\frac{1}{3}$	Machines
Σ	$\frac{4}{3}$f	+	2z	+	4v			

Department II

Flax Raiser	1f	+	–	+	2v	=	3	Flax
Spinner	1f	+	3z	+	2v	=	6	Yarn
Weaver	2f	+	6z	+	2v	=	12	Linen
Σ	4f	+	9z	+	8v			

Where 'f' represents fixed capital, 'z' represents circulating capital, 'v' represents variable capital.

The stage-schema represented by Marx in TSV represents the production of linen as a sequential process. The economy is divided into two departments, one producing capital goods and the other producing a sole consumption good. Each stage is segmented into there representative components of fixed capital, circulating capital advanced from the previous stage, and variable capital. The approach adopted in Marx in TSV makes explicit the distinction between fixed and circulating capital. Circulating capital represents the capital advanced in each stage of production and and at various periods. The physical requirements for the degree of circulating capital to be advanced is unique at each stage, dependent upon different degree of durability and times of reproduction. The capital advanced at each stage is also of qualitative difference (Marx, 1992, 262).

The output at each stage becomes an input in (equal to the value of circulating capital) in the sequential stage. The total product of Department I is $5\frac{1}{3}$ Machines. This output equals the fixed-capital requirements of four-thirds units of Machines in Department 1 and 4 Machines to Department II. The 12 linen is equal to the variable capital requirements for production. Of which 4 units is allocated to Department I and 8 units to Department II.

Marx's stage model represents the exchanges necessary for reproduction of the system. For Burchardt, what sets the stage model apart from circular production –including Marx's own reproduction models outlined in *Capital*– is the explicit distinction of the process of production in sequential stages. It is this omission of the sequentially of production in *Capital* that is the heart of Burchardt's critique of Marx. For Burchardt, production models need to include both circular production (explicitly incorporating both working and circulating capital) and sequential stages.

6. A Modern Day Critique of Circular Production Models (Needs Finishing)

The circular model as expounded by Sraffa can be considered a simple representation of the prices and income distribution required for the reproduction of society as a whole. Sraffa's system can be considered an example of a natural economic system. In other words, it abstracts from all the noise of actual economies and just investigates the fundamental relationships required for the reproduction of any economic system (Pasinetti, 2007, 274-281). Sraffa's simple model does serve a larger purpose. It identifies production as a socialized process. What this means is that firstly, commodities are not produced out of thin air by labor and labor alone. Labor is coupled with capital in specific ratios for a given state of technological advancement. Secondly, social links are established among producers and producers and consumers. The result is the level and composition of aggregate output is predicated upon existing technological know-how and driven by the demand for a given composition of consumption goods. Circular production details production as a social process. As concisely articulated by Frederic S. Lee:

> "[T]he social provisioning process is a continuous, non-accidental series of production-based production-derived economic activities through historical time that provide "needy" individuals and households the private and state goods and services (that is, the social surplus) necessary to carry out their sequential, reoccurring, and changing social activities through time. ... This means, in part, that the social provisioning process is embedded in the social surplus approach. It also suggests that social provisioning is affected by historically situated social norms, cultural values, by the social activities supported and by the decisions of acting persons (Lee, 2011, 1282-1283)."

Lee makes two important points, one the provisioning process is a social process. The circular approach to production directly links households to businesses and businesses to each other through the composition of final demand which partially guides exchanges between businesses as detailed in the inter-industry matrix. The composition of this matrix further governed by formal and informal contracts between businesses and then partially by the state of technology. Further, circular models indirectly link both consumers and businesses to governments. Governments impose formal restrictions the consumption of some goods and services (i.e. restrictions on the purchase of tobacco, alcohol, restrictions on gun purchases, etc.) and impose formal regulations to businesses on how products can be produced. For example governments regulate technology, the length of worker day, the number of workers legally required to perform a task, the qualifications required for workers. The behaviors of economic agents (producers, consumers, and the state) guide production. The outcome these institutional affects are mapped out by a quantitative depiction of economic production for a given point in time.

This outcome has real meaning. In the above quotation, Lee makes it clear that the social provisioning process is a continuously evolving process. Yet the circular model is a mere quantitative representation of

production and consumption decisions for a given state of behaviors in time. The structural model of circular production, say an input-output model, can tell us nothing about the behavioral process and economic change overtime because circular models are specified for a point in-time. They are a snap-shot of the social provisioning process and the requirements for social reproduction for that point in time. In contrast, studying change and transformation of a social provisioning process requires a dynamic methodology.

To this point, it should be noted that the pioneers of circular structural models (Quesnay, Ricardo, Marx, and Sraffa) had the sole purpose of specifying the actions of economic agents to reproduce the system and restore the initial position. It is a structural system of production representing given behaviors as opposed to forecasting economic activity when behaviors change. Burchardt's critique of Marx's reproduction models in *Capital* centered around Marx confounding the structural model with the behavioral model. The structural model shows the inputs required for the production of output regardless of who does it. In contrast the behavioral model shows the inputs that are *required by specific firms* given the circumstances surrounding the firm (Nell, 1984, 153). Burchardt's critical assessment and proposed solution delves nicely into shortcomings of contemporary circular model of production.

6.1. Structural Models and Behavioral Models

It is required to make a distinction, and separate, behavioral models from structural models. It has been conjectured that circular models of production illustrate the social/behavioral requirements of societies' participants. Thus circular models become the appropriate choice to model production within a heterodox framework; in other words circular models, such as input-output models and derivations such as the social-accounting matrix (SAM) As noted by Nell (1984) behavioral models show how economic agents react to changes in the world around them. Behaviors change (and creates a rippling effect) when consumers, producers, or governments alter their existing economic pattern. The question becomes when is the use of circular models appropriate? A circular model certainly cannot delineate continuous change in behaviors by economic agents as noted in Lee's quotation. This does not mean that circular models are not useful. The applicability of a circular model (or any production model for that matter) is predicated upon the relevant time period in question, and in turn, the relative persistence of behavioral relationships over that time period.

Notes to Finish up this section

- There needs to be a distinction between models that are "in time" (circular models); and models that are over time" (linear stage models).
- Circular model are static – they are not suitable for the analyzing the time of production, and therefore are of business cycles – Quote from Lowe's "Why is Business Cycle theory... etc". The one where he states static analysis is not useful for analyzing businessess cycles

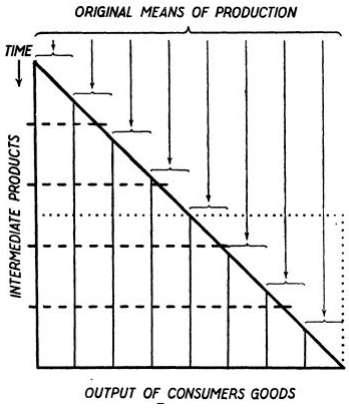

Figure 1: The Austrian Model of Production[6]

7. Linear Model of Production

In the modern era. the principle critique that have been lashed out on circular models of production are their inadequacy for dynamic analysis. Circular models are static snap-shots of the economic structure at any point in time. Whereas the production of output is a sequential process is *over time* which is omitted from the models of Ricardo, Marx, Sraffa, and contemporary interindustry models. Time in production became important in the production modeling of Hayek (1934) and later Hicks 1965. Both economists adopted the Austrian method of Böhm-Bawerk.

Böhm-Bawerk depicts the production process as a series of linear, sequential, stages. Production begins from the production of commodities by labor alone at the first stage and then moving through sequential lines of production toward consumer goods. Friedrich Hayek adopted Böhm-Bawerk method in *Prices and Production* and presents a useful flow model of the process. The triangle outlined in Figure 1 depicts production as a series of sequential processes through time.

Hayek's presentation of Böhm-Bawerk's method of sequential production is particularly useful for portraying production as a sequential process. From Figure 1 it is immediately noticed production begins from "Original Means of Production" to "Output of Consumers Goods" The "Original Means of Production" in the Austrian model is simply labor and labor alone. The production process to bring about the consumer goods at any moment of time is represented along the hypotenuse of the triangle. The value of the intermediate inputs is measured along the horizontal (x-axis) portion of the right triangle while progress of time is represented by the vertical (y-axis) dimension of the triangle. The original means of production are being continuously expended throughout the whole process of production. The bottom of the triangle represents the total value of consumer goods which is the summation of the value added of intermediate inputs. The area of the triangle depicts the totality of successive stages of production that was required for the output of consumer goods. This diagrammatic presentation portrays the production of output for any moment in time and represents the production as a process over time through sequential stages (Hayek, 1935, 37-40).

The Austrian production model constructed by Böhm-Bawerk and adopted by Hayek depicts production as a process of sequential stages. But it does not actually accomplish that. Which is acceptable because that is not actually what Böhm-Bawerk was attempting to accomplish. The purpose of Böhm-Bawerk production model was to devise an alternative to the Classical theory of value and the Marxian theory of class exploitation.[7] Böhm-Bawerk's model represents the economics of time. Where time is nothing more than a mathematical parameter to represent the degree of capital intensity, or roundaboutness of production (Hicks, 1984, 268). The number of stages in Böhm-Bawerk's method, or the degree of roundaboutness, represents the capital intensity required for the production of final commodities and therefore illustrates the return to capital.

That said, some general conclusions from the Austrian model can be made. Given that the area of the triangle represents the totality of successive stages of production before the commodity can become "ripe for consumption (Hayek, 1935, 40)". The ripening process represents physical intermediate capital goods being continuously developed and improved at each sequential stage. Thus the value of the output at each stage represents a capital good that is qualitatively different than the stage before or the stage after. The Austrian model represents second-degree capital specificity. (This may be thought of as firm or industry specific capital requirements or in Hayek's presentation stage-specific capital requirements.) Second-degree capital-specificity becomes prominent in Austrian models yet it is completely absent in the circular flow models of Ricardo, Marx, and Sraffa.

That said, the Austrian model *only represents second-degree capital specificity* and fails to incorporate first-degree capital specificity that can only be modeled utilizing circular production. The absence of circularity of production lie at the heart of Burchardt's critique of the Austrian method of production.

8. Burchardt's Critique of the Austrian Method

Burchardt embraced the Austrian's relevance of modeling the economy in sequential time. Burchardt considered the incorporation of vertical stages so important that the omission of sequential stages in Marx's *Capital* formed the central basis for his critique. Nevertheless, Burchardt also saw flaws in accepting the Austrian method of production at face value. Burchardt's critique of Böhm-Bawerk builds upon the latter's assumption that labor serves as the sole producer of commodities during the first stage of production. For Burchardt this simply does not have empirical support.

[7] While Böhm-Bawerk developed this model to articulate a non-Classical theory of value, he did not quite accomplish this task. If value can be represented by the degree of roundaboutness, than more capital intensive production (and in turn prolonging the time to completion) will result in a higher return to capital. Thus to achieve the highest return consumer products will move towards an ever greater degree of capital intensity and the time to production will move toward infinity. Thereby consumption goods will never be produced!

> The organization of the capital stock into concentric circles ultimately has its clear basis in the stage-wise production sequence of the goods from raw materials to the finished product. By means of grafting the notion of distance from consumption this linear sequencing of production has been applied consequently and inevitably led to the question of the starting point of the line [18]bb551"

The error that Burchardt saw in Böhm-Bawerk was the absence of self-reproduction of capital goods. Without partial self-reproduction of capital goods the beginning of production is with labor alone. The original factors of production, land and labor, do not stand in isolation. For continued reproduction to occur, land and labor must be combined with produced goods. The upshot of the Böhm-Bawerk's model is that intermediate inputs are classified by their intended purpose and by their degree of readiness. Burchardt saw the sequential process of production as being absent in the reproduction models in Marx. Thus the Post Classical model developed by Burchardt and Lowe attempts to correct for these twin deficiencies by introducing partial self-reproduction of capital goods –thus avoiding production of commodities by labor alone– and by introducing sequential stages of production –thereby accounting for the time of production missing in the model so Marx.

9. Post-Classical Model

Burchardt's solution to Böhm-Bawerk is an incorporation of Marxian elements depicting circular production. That said, adopting a circular model of production is inadequate because it abstracts from sequential stages thereby ignoring the time of production. Burchardt remedies both production models which depicts circular processes and sequential stages. Lowe adopted Burchardt's solution and slightly advanced it.[8] The Lowe Model depicts three sectors. Sector 1 produces primary equipment. Within Sector 1 includes a series of stages, where output moves through a sequential process for the production of Machine Tools. Sector 1 can self-reproduce, so Machine Tools are are used directly in Sector 1 to replace worn out machines. Sector 2 uses identical Machine Tools as are required in sector 1 and Machine Tools are used indirectly for the production of consumption goods in Sector 3. for the production of Intermediate Capital Goods. Sector 3 produces consumer goods which are bought by workers in all three sectors. As delineated in the Appendix provided by Nell (1976), Lowe's price-quantity equations are as follows:

Adolph-Lowe's Price-Quantity Sectoral Model

$$q_1[a_1p_1 + l_1w] = q_1p_1$$
$$q_2[a_2p_1 + l_2w] = q_2p_2$$
$$q_3[b_3p_2 + l_3w] = q_3w$$

Lowe stated the problem in very clear terms. The consequences of a disturbing factor, such as an exogenous increase in final demand, can not be emphasized in a static system. The problem does not only lie in static

[8] Lowe includes three sectors while Burchardt stuck with only two sectors.

input output models, but rather in input output models themselves. As a circular model the system does not incorporate linear stages of production which are necessary for considering capacity constraints. The linear stages of production are founded on earlier Austrian models of Böhm-Bawerk, and his Austrian followers which contends that all finished goods can be traced back to labor and land, and to treat fixed capital as intermediate stages of production (Hicks, 1973). It was Piero Sraffa's 1960 criticism of earlier Austrian models that generally fixed capital can not be traced back to dated quantities of labor (Hagemann, 1990). There is equal criticism of Hicksian vertical integration methodology of neo-Austrian processes put forth and utilized by Post Keynesian economists[9](Trigg and Lee, 2005). The critique is that the neo-Austrian model reducing everything back to labor, and the system is interconnected through final demand. Such an approach to modeling does not represent the system of production and distribution as a set of social relationships.

To remedy this situation Lowe includes vertical stages within each sector.

$$K_1 \oplus L_1 \oplus N_1 \rightarrow o_1 \qquad \textbf{Sub-Sector 1a:} \tag{2}$$

Four-Stage Process - Sector 1

1. $k_{11} \oplus l_{11} \oplus n_{11} \rightarrow o_{11}$ (Extractive Machinery)
2. $k_{12} \oplus l_{12} \oplus n_{12} \rightarrow o_{12}$ (Blast Furnaces)
3. $k_{13} \oplus l_{13} \oplus n_{13} \rightarrow o_{13}$ (Steel Mills)
4. $k_{14} \oplus l_{14} \oplus n_{14} \rightarrow o_{14}$ (Machine Tools)

$$K_2 \oplus L_2 \oplus N_2 \rightarrow o_2 \qquad \textbf{Sub-Sector 1b:} \tag{3}$$

Four-Stage Process - Sector 2

1. $k_{21} \oplus l_{21} \oplus n_{21} \oplus o_{11} \rightarrow o_{21}$ (Ore)
2. $k_{22} \oplus l_{22} \oplus n_{22} \oplus o_{12} \oplus o_{21} \rightarrow o_{22}$ (Pig Iron)
3. $k_{23} \oplus l_{23} \oplus n_{23} \oplus o_{13} \oplus o_{22} \rightarrow o_{23}$ (Steel)
4. $k_{24} \oplus l_{24} \oplus n_{24} \oplus o_{14} \oplus o_{23} \rightarrow o_{24}$ (Gin/Spindles/Looms/Sewing Machines)

$$K_3 \oplus L_3 \oplus N_3 \rightarrow o_3 \qquad \textbf{Sector 2:} \tag{4}$$

Four-Stage Process - Sector 3

1. $k_{31} \oplus l_{31} \oplus n_{31} \rightarrow o_{31}$ (Cotton)
2. $k_{32} \oplus l_{32} \oplus n_{32} \oplus o_{31} \rightarrow o_{32}$ (Yarn)
3. $k_{33} \oplus l_{33} \oplus n_{33} \oplus o_{32} \rightarrow o_{33}$ (Cloth)
4. $k_{34} \oplus l_{34} \oplus n_{34} \oplus o_{33} \rightarrow o_{34}$ (Dress)

[9]The development and utilization of vertically integrated production model stems from Pasinetti 2007; 1993; 1981; 1980.

Small cap letters in Lowe's analysis represents flow magnitudes which represents the amount of each factor stock that needs to enter into the production process each period to maintain the continuity of production. Machine tools are used in the production of all output in sectors one and two. Or mathematically $o_{14} = \sum K_{ij}$ where: i = 1,2 and j = 1,2,3,4. Machine tools are used directly in the production of all output in sectors one and two and indirectly in the production of all output in Sector 3. Machine tools therefore represents a *first degree capital specific good.* Production would come to a standstill without the steady, continuous, flow of machine tools throughout the production process. Besides machine tools, the working output (o_{ij}) represents the intermediate products required through sequential stages of production. For illustration, the production of Steel in Sector 2, requires as inputs for its production:

- Machine Tools of k_{23}
- Steel mills of o_{14}
- Pig Iorn of o_{22}
- Labor of l_{23}
- Natural Resources of n_{23}

In this particular illustration, the Steel Mills and the Pig Iorn represent second degree capital specificity. One of the primary purposes for the development of the Post Classical model was to illustrate

10. Further Implications of the Post-Classical Model (Needs Completing)

- In addition to correcting for deficiencies that Burchardt and Lowe saw in Marx and Böhm-Bawerk. The Post-Classical model has modern applications. First and foremost it depicts both first degree and second degree capital specificity. Therefore the Post-Classical model becomes useful for analyzing structural bottlenecks of the first or second degree. First degree capital specific goods are found throughout production. A contemporary example of this would be copper. Copper is used through the production of goods and services. Copper wire is used in power generation, transmission, distribution, telecommunications, electric circuits, and countless numbers of electronics that are used in the production of goods and services everyday. Second degree capital specificity comes out in the utilization of intermediate inputs (o_{ij}) (i.e. yarn, cloth, dress)
- Rethink the current division of structural modeling of production into two separate research methods: interindustry models for static analysis and vertically integrated models for dynamic analysis. The existing separation reintroduces Burchardt's critique of Böhm-Bawerk and Marx.
- Synthesis of circular and vertical production models introduces both first degree (basic commodities) and second degree (non-basics) capital specificity.

11. Implications (Needs Completing)

- STRUCTURAL BOTTLENECKS!!! *First-degree structural bottlenecks*. –Copper, fossil fuels, etc." This becomes important for the analysis of natural capital to our system of production. Its utilization formulates the capital (both qualitative and quantitative) requirements at each and every sector. Important for our understanding of the impact on our utilization of finite resources.

- *Second degree capital specificity* Second-degree capital specificity is less climatic than first degree, but it allows us to forecast structural unemployment given technological innovations and structural change.

References

Brewer, A. (2005). Cantillon, Quesnay, and the Tableau Economique. *University of Bristol, Discussion Paper No. 05/577*, 1–17.

Burchardt, F. (1931-32). The Schemata of the Stationary Circuit in Bohm-Bawerk and Marx. *Welrwirtschaftliches Archiv 34, 35*, 525–64; 116–76.

Carter, S. (2011). A simple model of the Surplus Approach to Value and Distribution. *American Journal of Economics and Sociology 70*(5), 1117–1146.

Forstater, M. (2008). Returns. In W. Darity (Ed.), *International Encyclopedia of the Social Sciences* (2 ed.), Volume 7, pp. 217–218. Detroit, MI: MacMillan Library Reference.

Garegnani, P. (1984). Value and Distribution in the Classical Economists and Marx. *Oxford Economic Papers 36*(2), 291–325.

Hagemann, H. (1990). The Structural Theory of Economic Growth. In M. Baranzini and R. Scazzieri (Eds.), *Beyond the Steady State: A Revival of Growth Theory*, pp. 144–171. Cambridge, UK: Cambridge University Press.

Harcourt, G. (1965). A Two-Sector Model of the Distribution of Income and the Level of Employment in the Short Run. *Economic Record 41*, 103–117.

Hayek, F. (1935). *Prices and Production*. New York, NY: Augustus M. Kelly.

Hicks, J. (1965). *Capital and Growth*. Oxford, UK: Oxford University Press.

Hicks, J. (1973). *Capital and TIme*. Oxford, UK: Clarendon Press.

Hicks, J. (1984). Time in Economics. In D. Helm (Ed.), *The economics of John Hicks*, pp. 263–280. Oxford, UK: Basil Blackwell Ltd.

Kregel, J. (1973). *The Reconstruction of Political Economy*. The Macmillan Press Ltd.

Lee, F. (1998). *Post Keynesian Price Theory*. Cambridge, MA: Cambridge University Press.

Lee, F. (Ed.) (2011). *Social Provisioning, Embeddedness, and Modeling the Economy: Studies in Economic Reform and Social Justice*. New York, NY: Wiley-Blackwell.

Lowe, A. (1959). F.A. Burchardt, Part I: Recollections of his work in Germany. *Institute of Statistics 21*(2), 60–65.

Lowe, A. (1976). *The Path of Economic Growth*. Cambridge, UK: Cambridge University Press.

Lowe, A. (1987). A Structural Model of Production. In A. Oakley (Ed.), *Essays in Political Economics: Public Control in a Democratic Soicety*, pp. 27–59. New York: New York University Press.

Marx, K. (1992). *Capital: A Critique of Political Economy*, Volume Two. London, UK: Penguin Classics.

Nell, E. (1978). The Simple Theory of Effective Demand. *Intermountain Economic Review 9*(2), 1–32.

Nell, E. J. (1984). Structure and Behavior in Classical and Neoclassical Theory. *Eastern Economic Journal XI*(2), 139–155.

Nurske, R. (1935). The Schematic Structure of Production. *Review of Economic Studies 2*(3), 232–244.

Pasinetti, L. ([1973] 1980). The Notion of Vertical Integration in Economic Analysis. In L. Pasinetti (Ed.), *Essays on the Theory of Joint Production*, pp. 16–43. New York, NY: Columbia University Press.

Pasinetti, L. (1981). *Structural Change and Economic Growth*. Cambridge, UK: Cambridge University Press.

Pasinetti, L. (1993). *Structural Economic Dynamics*. Cambridge, UK: Cambridge University Press.

Pasinetti, L. (2007). *Keynes and the Cambridge Keynesians*. Cambridge, UK: Cambridge University Press.

Robinson, J. (1965). *The Accumulation of Capital* (Second ed.). New York, NY: St. Martin's Press.

Sraffa, P. (1926). The Laws of Returns under Competitive Conditions. *The Economic Journal 36*, 144.

Sraffa, P. (1960). *Production of Commodities by Means of Commodities: Prelude to a Critique of Economic Theory*. Cambridge, UK: Cambridge University Press.

Sraffa, P. (2010). Introduction. In *Principles of Political Economy and Taxation: Volume 1, Works and Correspondence*. Liberty Fund.

Steedman, I. (1981). *Marx after Sraffa*. London, UK: Verso.

Trigg, A. and F. Lee (2005). Pasinetti, Keynes and the Multiplier. *Review of Political Economy 17*(1), 29–43.