

Production Structure in the Context of International Trade

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Published online: 8 August 2008
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Abstract This paper deals with the recent empirical phenomenon of intra-industry trade, i.e., trade in similar goods between similar countries. It treats this phenomenon from the point of view of the theory of the structure of production, highlighting the importance of the sequential nature of production and the heterogeneity and specificity of factors of production, as developed by Carl Menger, Eugen von Böhm-Bawerk and their followers of the Austrian School of economics. The reader is first exposed to the historical development of production and capital theory. A simple theory of production structure, along the lines of Austrian economics, is afterwards presented and a useful tool for the analysis of intra-industry trade is developed. In the following discussion of existing theories of intra-industry trade, we make the case for vertical intra-industry specialization, complex manufactured goods and sliced-up production chains across countries. The reader immediately observes the importance of Austrian production structure theory for the analysis of intra-industry trade. We accordingly apply the concepts of the structure of production to intra-industry trade and analyze, in particular, the time- and place-aspects of international production. The concluding section shows the relevance of our approach to intra-industry trade for the analysis of business cycle synchronization across countries, and for the optimum currency areas theory.

Keywords Production structure · International trade · Intra-industry trade · Capital · Austrian School of Economics · Intra-industry trade · Sliced-up value chains

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Introduction

After the Second World War, international trade theorists¹ observed a particular phenomenon occurring in the trade between developed countries. It was realized that developed countries do not only import raw materials and export manufactured goods, but rather they trade in differentiated consumer goods and/or intermediate goods belonging to the *same* industry. This empirical generalization began to be called *intra-industry trade* (Grubel and Lloyd 1975). Economists produced a number of theories to explain the *causes* of this phenomenon. Every one of these *competing* theories describes one aspect of intra-industry trade and approaches it from a different perspective. The present paper attempts to add to the existing set of explanations another, complementary one.² Most of the existing theories of intra-industry trade deal with *distinct, final products*. The approach adopted in this paper sees consumption as a consequence of production and therefore deals with the phenomenon of intra-industry trade from the point of view of *production chains* and describes *how* production is organized in our modern world. This perspective allows us to see that the aggregation of various traded goods within a particular industry conceals the vertical integration of production across countries, which is what we believe a satisfactory theory of intra-industry trade should explain in the first place. The approach to production and its application to international trade adopted in this paper are based on the analysis of production undertaken by Carl Menger, Eugen von Böhm-Bawerk and their followers. It was these economists who emphasized the role of *time* in production and saw production as a *process* consisting of *stages* and, accordingly, treated capital as *heterogeneous*. Understanding production as a process consisting of stages allows us to highlight time and place aspects of production, or rather the *intertemporal* and *interspatial* aspects of production. We believe that these aspects will prove essential for the analysis of intra-industry trade. The school of economics beginning with Carl Menger that later began to be called the Austrian School of economics is methodologically rooted in *subjectivism* of human action and methodological *individualism*. In the present paper we will work within this methodological tradition and we will, following Menger (1994), focus on individual human action rather than on any aggregate concepts. Since, as noted above, intra-industry trade is an *empirical* observation with a number of competing theories attempting to explain this observation, we do not fear any methodological clashes with rival explanations. Rather, as noted above, we distinguish our approach from the competing theories in looking at production structure rather than at distinct, final products.

The paper is structured as follows. The “Structure of Production and Capital in Historical Perspective” roots our approach in a historical perspective and tries to highlight important steps in the development of the theory of production and capital.

¹ See in particular Grubel and Lloyd (1975), Krugman (1995), and Feenstra (1998).

² See “Intra-industry Trade and the Structure of Production” for more details on these competing theories of intra-industry trade.

Emphasis will be on the structure and process of production and the heterogeneity of capital. Next “A Simple Theory of the Production Structure” develops a simple Austrian theory of production structure, highlighting time and place aspects of production. This section provides us with an analytical tool that will be of help in “Intra-industry Trade and the Structure of Production” when dealing with sliced-up production chains across countries. “The next section” starts with a review of existing explanations of intra-industry trade and analyzes their strengths and weaknesses. It then tries to explain intra-industry trade through considering sliced-up production chains across countries. Applications of the theory of production structure and the stages approach to production may help us to highlight various international aspects of production, especially the time and place aspects of internationally organized production. Finally “Implications and Conclusions” concludes and puts forward some implications of our approach for optimum currency areas theory and business cycle synchronization within the European Union.

Structure of Production and Capital in Historical Perspective

The purpose of this section is to briefly outline our approach to production and capital in a historical perspective. The theory of production and the theory of capital developed in parallel ever since economists began to write about these issues. This is hardly surprising since any understanding of advanced methods of production without the use of capital is impossible.

Our theory of production structure will be based on the Mengerian approach to capital and production; a simple exposition of production structure along Mengerian lines will be developed in the next section. First, let us highlight some other features of the Mengerian approach that, besides those mentioned earlier when dealing with the contributions of Menger and Böhm-Bawerk,³ distinguish this approach from the two competing approaches. The first further distinguishing characteristic of the approach adopted here is the emphasis on the *difference* between equilibrium and dynamic analyses of production and capital. The main interest of the Austrian School is capital as such and its place in the production structure. *Time* aspects of production and the *heterogeneity* of capital is of central importance in Austrian

³ Hayek (1962) put forward several aspects that distinguish the *Anglo-American* views of capital from the *Continental*, and in particular Austrian, views of capital. The Anglo-American view, highly influenced by Alfred Marshall, deals most of all with fixed capital. This is mostly apparent in the production-function approach of the neoclassical school. Durable goods are key to the analysis. Supply of capital is assumed to be given. The time element is brought forth only as far as the durability of fixed capital goods is concerned. Additional increases in the supply of capital are treated as a duplication of the existing capital stock. On the contrary, the *Continental*, and in particular the *Austrian*, approach concentrates on circulating capital and its nonpermanence. Capital is constantly used up and needs to be reproduced. Time is treated in the sense that what matters is that the production takes place in time. It is not the durability of capital that is important but its position in the time structure of production. Additional increases in the supply of capital imply a change in the structure of production.

capital theory. Since production is an ever-changing process and since capital assumes various forms, the *static, steady-state method of the Neoclassical School* is not suitable for the analysis of production. A *dynamic* approach to production and capital was emphasized by all economists in the Austrian tradition. On top of this, Robinson (1953–1954) of the neo-Ricardian School ridiculed the neoclassical equilibrium analysis by pointing out that *comparisons* of long-run equilibrium positions are ill-suited for the theory of capital, where dynamic analysis of the *process* of transitioning from one equilibrium to another is required. There is, however, a similarity between the Neoclassical School and the neo-Ricardian School in that both of these schools adhere to the long-run approach, and this puts them both into sharp contrast with the Austrian theory.

Austrian capital theory has been, on the other hand, criticized by both the neo-classical economists and the neo-Ricardians⁴ for its primary focus on *circulating capital*.⁵ Austrian capital theory was said to lack any tools for incorporating *fixed capital* in its theory of production structure when faced with the *joint-supply* complication pointed out by Sraffa.⁶ Therefore, we must agree, there are some aspects of the Austrian approach to capital and production, e.g., the simplified view of production structure⁷ or the flow-input/point-output analysis of production, that have to be amended or even abandoned altogether. However, in the words of Hicks,

what we must not abandon are Böhm-Bawerk's (and Menger's) true insights—the strength of the “Austrian” approach. Production is a process, a process in time....[T]he characteristic form of production is a sequence, in which inputs are followed by outputs. Capital is an expression of sequential production. Production has a time structure, so capital has a time structure. All these things stand; they are not affected.⁸

And, we must add, all these things, nothing less and nothing more, will be used in our analysis of intra-industry trade in what follows. These problems of fixed capital and the joint-supply complication will have to be dealt with elsewhere at

⁴ See especially Sraffa (1932, 1960) and see also Lachmann (1986) on the Hayek-Sraffa duel.

⁵ See the last footnote of this section.

⁶ See Sraffa (1960) and Hicks (1973).

⁷ For more details see the following section.

⁸ See Hicks (1973, pp. 193–194). Also, John Hicks, in the first chapter of his *Capital and Time: A Neo-Austrian Theory*, reveals the following:

I have proclaimed the “Austrian” affiliation of my ideas; the tribute to Boehm-Bawerk, and to his followers, is a tribute that I am proud to make. I am writing in their tradition; yet I have realized, as my work has continued, that it is a wider and bigger tradition that at first appeared. The “Austrians” were not a peculiar sect, out of the main stream; they were in the main stream; it was the others who were out of it. (Hicks 1987, p. 12)

considerable length.⁹ Therefore, we do not need to worry about these criticisms here and we may proceed to the analytical part of our paper.

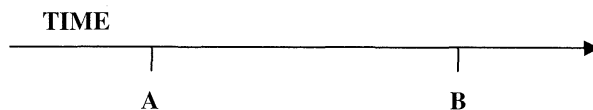
Simple Theory of the Production Structure

Production and Its Structure

Production, according to Menger (1994), is an act of transformation of goods of higher order (goods further from consumption) into goods of lower order (goods closer to consumption). The eventual goal of every production activity is consumption goods. Every human action aims at supplementing a less satisfactory state of affairs for a more satisfactory state of affairs. In doing so, every human action necessarily implies *change*.¹⁰ This is also true for every act of production. Furthermore, change implies

⁹ Three points however deserve our attention at this place since they will be useful for our simple theory of production structure to be developed in the next section. The alleged problem of fixed capital could be dealt with using the following argument. (a) As was deeply rooted in Menger (1994) and highlighted by Hayek (1962), the durability of capital is not of importance when we try to ascribe time to the concept of capital. What is, however, important, is the position of various capital goods in the time structure of production. According to this position, capital goods are classified as lower or higher order, based on their distance from the final product. This point is explicit in Menger (1994) and went a bit unnoticed. As was later expressed by Mises (1998), each capital good, whether regarded as fixed or circulating, is, in a sense, fixed in the particular production process. This means that as long as the production process lasts, a particular combination of intermediate goods is specific to that process and is fixed in that process, no matter whether these goods are regarded by an outsider as fixed or circulating capital goods. These capital goods cease to be fixed in this process as soon as the production is finished or ended due to other reasons. A classification of intermediate goods that really matters in this sense is their convertibility to other uses as soon as they are freed from their current use (no matter the reason of their being freed). (b) Economists very easily forget about the individual aspects of human action. Each production process is an individual process. For the sake of this process, each entrepreneur uses the *services* of the factors of production. History of these factors of production is of no interest for the entrepreneur, thus there is no difference for him between the natural and man-made factors of production when it comes to their usefulness. Also, there is no difference as to whether he owns these factors of production or just hires their services. What is important is that he *uses* a combination of their individual services for the purpose of each individual production process. An economist trying to work out a theory of value imputation needs to account for the fact that all capital goods are, in the end, a product of labor and land. This is not true for an entrepreneur and not a problem for analysis of individual production processes. Thus, as is a common practice in accounting, an entrepreneur assigns (on whatever basis) all relevant services of all factors of production used to the particular production process at stake. The fact that he can use services of some factors of production even for the next production processes in no way complicates our analysis of an individual production process. (c) If the joint-supply complication applies to fixed capital, it necessarily needs to apply also to durable consumer goods. Nobody has ever questioned the fact that it is a common practice that one durable consumer good is usually never used for the satisfaction of one need only, the one that it was originally aimed to satisfy. It usually satisfies various needs of various people in various times and at various places. Does this mean that we are unable to account for these particular individual needs-satisfactions and that we need to throw our whole theory of consumption away? Clearly not. The analysis of individual phenomena, as described in this footnote, sees no problems with this issue as well.

¹⁰ See Menger (1994) on causality, change, and time. See also Mises (1998).

Fig. 1 Period of production

time (Menger 1994; Mises 1998). The concept of time cannot be separated from the concept of change. Since production is an act of transformation, i.e., an act of change, it has to proceed through time as every other action does. Figure 1 illustrates in general terms the role of time in production.¹¹

Since every action necessarily has to take place in time, there also has to be time *before* and *time* after the action. Point *A* illustrates the start of the act of production. Point *B* illustrates the completion of production. The arrow line represents *time*. The area to the left of *A* represents time before the act of production and so the area to the right of *B* represents time after the act of production. The distance *AB* will be called the *period of production* (Rothbard 1993) and will comprise all the activities that need to be undertaken from the start of the act of production, point *A*, until consumer goods are produced, point *B*. As production takes time, it can be, and in the modern world necessarily is, divided into *stages* (Hayek 1967). Each stage represents particular *production processes* that need to be undertaken in order to complete the whole act of production. These stages vary as to length and number. All these individual production processes are synchronized through the *production plan* (Lachmann 1978), which is, according to Austrian economics, the mental act of the entrepreneur facing the uncertainty and complexity of the world around him and trying to supplement one state of affairs for another one.

Austrian economics thus argues that all goods of higher order, capital goods, land, and labor, i.e., the *factors of production*, are *heterogeneous*.¹² When speaking of heterogeneity, what we have in mind are not any physical qualities that make various production factors differ from each other, but their heterogeneity in *use* (Lachmann 1978). Various production factors can be put to various uses based on the subjective valuations of the acting individual. Heterogeneity of production factors is tied up with *factor specificity* (Lachmann 1978). Some production factors can be put to one use only—*highly specific factor*—while other factors can be easily used in various production processes—*multiple specificity*. Furthermore, hardly any production factor can be used for production just on its own. Every factor of production requires a complementary factor of production in order for the production to be possible (Menger 1994; Lachmann 1978). What we can observe in day-to-day production activities are factor combinations that are put together in production processes. Without the availability of a *complementary factor* of production, the single production process would not be possible.

As was noted earlier, as long as a particular production process lasts, every factor of production, whether it is regarded by the outsider or the entrepreneur-accountant

¹¹ This figure is taken from Rothbard (1993).

¹² There is no reason for not assuming also that land and labor are heterogeneous in use, specific each to some purposes and convertible, if at all, to only various specific uses and only after some adjustments, which take time.

as fixed or circulating, is *fixed to the particular process for the whole duration of that process* (Menger 1994; Mises 1998). Were it to leave the process before its completion, the whole production process would fall apart. The Mengerian approach¹³ to production essentially took over Ricardo's proposition¹⁴ that the distinction between *fixed* capital and *circulating* capital is that of *degree* and not of *kind*. This distinction is especially important for an entrepreneur for his accounting purposes. Thus, everything that is valid with regard to fixed capital is valid also with regard to circulating capital, though to a lesser degree.¹⁵ *Factor convertibility*¹⁶ is especially important for our analytical purposes. As mentioned above, each factor combination is put into use with regard to some *goal* in mind—production of a particular consumer good. If this goal or the data of the market *change*, these production factors need to be *shifted* to other uses. Their *ability* to shift to these other uses is termed factor convertibility. Hence, there are various degrees of convertibility among factors of production. Some factors of production can change production process immediately, however other factors need to be adjusted or altered to various degrees before being useful for other production processes. Some factors of production are so specific to a particular production process that they become useless as soon as this process ceases and needs to be scrapped. *We can notice a general rule here, that with increasing factor specificity and their closeness to the consumption, their convertibility to other uses declines* (Mises 1998)!

A careful reader has already noticed that we implicitly used a distinct approach to factors of production during the preceding paragraphs.¹⁷ It is now the right time to make our intentions explicit. Let us for the sake of this paper suppose that from the point of view of the producer-entrepreneur, there is *no* difference among land, labor, and capital goods with regard to their usefulness (Mises 1998). All are used by this producer as *inputs* to his production process and he does not pay any attention to their *historical* origin. Therefore, we call land, labor, and capital goods factors of production, without any further classification. For each individual production process, the producer uses a combination of services (Lachmann 1978) of these factors of production. *Some of them transform through their services their whole physical form to the good of lower order, while some transform through their services only some part of their total serviceability and leave the residual part of their total serviceability to the next production processes.* Whether the producer owns these factors of production or hires their services thus makes no difference for the outcome of our analysis. On the basis of accounting practice, the producer-

¹³ See Mises (1998).

¹⁴ See Lachmann (1978) and Lewin (1996, 1999) for more details on Ricardo.

¹⁵ Even the so-called fixed capital goods decline in value through use and through the passing of time. They are perishable because of the ever-changing state of technological development. And since no good of higher order can be put into productive activities without the use of a complementary good of the same order, even fixed capital goods would be useless without the required complementary goods (mainly in the form of the so-called circulating capital). See Strigl (2000) on this point.

¹⁶ On this point see in particular Mises (1998).

¹⁷ This approach is implicit in Menger (1994) and more explicit in Lachmann (1978). See also Strigl (2000) and Mises (1998).

accountant assigns the contribution of services (whether full or partial) of each factor of production to the particular production process.¹⁸ This treatment¹⁹ of factors of production is, on one hand, realistic, and on the other hand, allows us to deal in our analysis with what is regarded as fixed capital as well. Because, what we actually analyze are various *individual* production processes (Lachmann 1978) that make up the whole structure of production. These processes do not look to the past but are *forward looking* (Mises 1998) and take place in the realm of *uncertainty* (Lachmann 1978).

Let us now proceed with a simple illustration of the structure of production, based on the preceding discussion. We will use a simple diagrammatic exposition first used by Jevons²⁰ and later on developed by Hayek (1967). Our exposition is based on a simplified diagram provided by Garrison (2001). Figure 2 depicts the so-called Hayekian triangle.

The triangle pictures the structure of production in a simplified, flow-input/point-output, case. The horizontal leg of the triangle depicts *production time*. The vertical leg of the triangle depicts the *value of output of consumer goods*. The vertical distance from the time axis to the hypotenuse measures the *value of goods in progress* as they approach the finalization of production. The further the goods in progress are processed, the higher value they acquire in the indirect causal connection with need satisfaction. Although there are many nonlinear elements in the real-world production processes, as we will see below, for the sake of illustration and clarity, our linear form is sufficient.

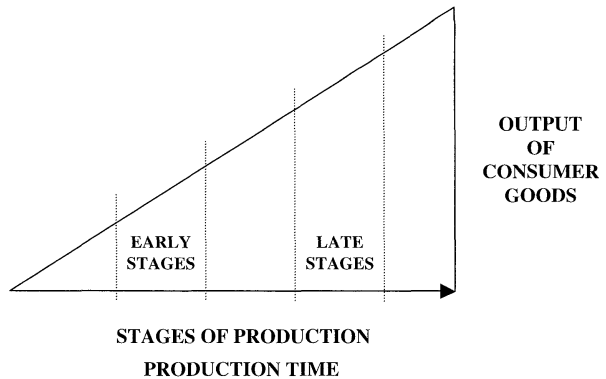
To highlight some of the points mentioned above, let us focus on the time axis of the triangle. The horizontal *time axis* depicts *both* the consequent movements of the goods in process in time (their becoming mature consumer goods), and various stages of production they need to cross, which exist in the present. This two-way looking at the horizontal axis proposed by Garrison (2001), allows us to see that *not only* does production take time, it also reflects a particular structure, a *time structure* of production formed up by the existing stages. These stages, if they are kept alive, guarantee a continuous flow of production activities. Garrison calls the five depicted stages, from left to right: mining, refining, manufacturing, distributing, and retailing (Garrison 2001). Herewith, he highlights a particular production structure and shows how higher-order goods (mining, refining, etc.) contribute through the passing of time to lower-order goods (manufacturing, distributing, etc.) and lead eventually to

¹⁸ This does not at all mean that the value of consumer goods is based on the costs of production!

¹⁹ For more details and implications of this treatment see above the last footnote in “Structure of Production and Capital in Historical Perspective.” By this treatment of factors of production, we do not mean, however, that division of factors of production into land, labor, and capital is not important. On the contrary, the understanding of advanced methods of production can be possible only with this distinction and a careful analysis of the origin of capital. Every time we speak of capital we need to bear in mind that originally, every capital good stems from the combination of land and labor. Additionally, an economist willing to work out a comprehensive theory of value, imputation, or prices, needs to account for these differences between land, labor, and capital. See Mises (1998) on this point. For our point about intra-industry trade, however, this distinction has only secondary importance.

²⁰ See Hayek (1967) and Garrison (2001) for more details.

Fig. 2 The structure of production



the production of final goods. As Garrison (2001) emphasizes, this way of looking at production is valid not only for the old-time, so-called *smoke-stack industries* but also for the modern *information-technology* and *services industries*. As he notes, what brings about the universal applicability of the concept of structure of production as depicted in Fig. 2 is the underlying principle of using certain *means* to attain certain *ends* through the passing of *time*.

In the original presentation of a similar diagram by Hayek,^{21,22} he assumed fixed capital goods away and so did Garrison (2001), for the sake of simplicity. Garrison (2001) however pointed out that careful use of the Hayekian triangle can incorporate fixed capital also. We only need to realize, as we did above, that it is the services of various factors of production that are gradually transformed to goods of lower orders, some of them transforming through their services their whole physical form to the goods of lower order, while some transforming through their services only some part of their total serviceability. This is what we need to look at when analyzing *individual* production processes, and therefore we can think of each stage

²¹ In his original formulation, Hayek (1967) claims that in *real* terms, there is no problem, as we noted, with reckoning with durable capital goods. The problem only arises, according to Hayek, when we try to bring *money* into the question, since then we would have to assume that durable capital goods change hands with every stage of production, when they clearly do not. But since we account for the *services* of various production factors being gradually transformed to consumption goods, we need not worry about the durable-capital-goods complication.

²² In his original formulation, Hayek (1967) also tried to put his argument into *mathematical* terms. Looking back at the triangle from Fig. 2, we may describe the quantity of all intermediate goods at any point in time by a function of time $f(t)$, depicted by the hypotenuse of the triangle. This function in no way has to assume linearity as we did in the diagram. Total quantity of all intermediate goods (goods in progress, i.e. the whole area of the triangle) is the integral of $f(t)$ over a period r . This integral equals also to the total length of the particular process of production. If we assume that the production process begins at point x , then the total quantity of intermediate goods in process equals $\int_x^{x+r} f(t)dt$. Furthermore, the output of consumer goods at a moment of time equals $f(x+r)$ and is depicted by the horizontal leg of the triangle. Since in our case, where Hayek assumed only intermediate goods, we assumed all factors of production, the above equation extends to all factors of production. We will not deal with this mathematical formulation further, since we are afraid of losing the clarity of exposition and we would need to construct an appropriate methodology before attempting at such a functional construction. Hayek himself did the same and replaced the continuous-flow-approach by a stages-approach. See Hayek (1967) for more details.

in the Hayekian diagram as representing a combined input of various services of various factors of production. Also, various production processes can take place simultaneously at one hypothetical stage depicted in Fig. 2, but we will deal with these issues below.

The Hayekian triangle depicted in Fig. 2 may be regarded as a very *aggregated*²³ description of production, and therefore we need to move further and imagine a more detailed view. As we already noted, the Hayekian triangle was criticized for purportedly dealing only with *circulating* capital (Hicks 1973). Thanks to Sraffa²⁴ it was also realized that it does not pay enough attention to *joint-production*, a phenomenon so common in developed economies. Figure 3²⁵ provides an illustration of a more complex and detailed production structure that may resemble reality, in a less aggregated form, more than the triangle from Fig. 2. It tries to account for the *complexity* of contemporary production processes and their *interdependence*. It also attempts to address the criticism of the joint-supply complication, particularly to the extent necessary for our analysis of intra-industry trade.

Figure 3 represents a more complex example of production structure. The whole process goes from the top down to the bottom of the table as pictured by the arrow. The arrow depicts the passing of time from point n , where our production example begins, till point $n+t$, where the final good is produced. The arrow also depicts the Mengerian order of goods, from higher to lower order ending with the final good. The rows of the table illustrate four stages of our hypothetical production structure, going from the first stage to the fourth. Each equation in the table represents a particular *process*, i.e., a particular *combination* of factors of production leading to a particular outcome of each production stage. Letters $A, B, C \dots P$ represent various inputs to a particular production stage, being the outcome of the previous stage, circulating capital, fixed capital, land or labor.

Coefficients $a, b, c \dots p$ reveal our particular way of looking at production. They represent the intensity of each input's serviceability being *transformed* to the output of each stage,²⁶ resulting from the choices of the entrepreneurs. Hypothetically, in absolute terms they acquire value between 0 and 1. This means that the value of these coefficients for fixed capital, land, and labor will be always less than 1, since their serviceability continues for the next production processes using these particular factors of production. On the other hand, the value of these coefficients for the outputs of preceding stages and circulating capital will always equal 1, since they are fully transformed, through change of physical form, to the output of the particular stage, i.e., to the good of lower order.

This approach allows us to deal both with fixed and circulating capital, highlighting the fact that producers use only a fraction of available serviceability of each item of fixed capital during each production process and are able to account

²³ See Hülsmann (2001) for a review of Garrison (2001).

²⁴ See Harcourt and Massaro (1964, 1975, 1979), Hicks (1973), Sraffa (1960), and Holman (2001).

²⁵ The example in Fig. 3 was inspired by Lachmann (1978). For more details on the process analysis as conducted by Lachmann see below.

²⁶ See below on coefficients of production.

TIME	ORDER	PRODUCTION PROCESSES	STAGES OF PRODUCTION
n	high	$aA + bB + cC = \alpha$	(1)
		$d\alpha + eE + fF = \beta$	(2)
		$g\beta + hH + iI = \chi$ $jJ + kK + lL = \delta$	(3)
$n+t$	low	FINAL GOOD: $m\chi + n\delta + oO + pP = \varepsilon$	(4)

Fig. 3 Structure of production: a more complex example

monetary value to these services through accounting methods (as we see in reality!). Greek letters $\alpha, \beta, \dots \varepsilon$ represent particular outputs of each production stage.

The solid bold line divides the third and fourth stages, highlighting that the fourth production stage in our example produces consumption goods. Our example implies that the output of each production process is an input of at least one further production process in a particular production plan. It is also clear that all inputs of a particular stage belong to a particular order (higher or lower) in the production structure. It also allows us to analyze the multiple production processes taking place simultaneously. This is depicted by stage 3, where two production processes take place simultaneously, one of them using the output of the preceding stage, the other one producing a complementary good for the next stage. The inputs of this other production process come from other related production processes, which also may be part of completely unrelated production plans.

These two outputs of the third stage are then combined in the fourth-stage production process in order to produce a final good. It needs to be pointed out that there are many simultaneous production processes taking place during each single production process to ensure both continuity of production and attainability of consumer goods. These simultaneous processes may even last for *several* stages of another production process. This view of production allows us to see the multiple interdependence of many production processes guided and synchronized by a number of production plans and the price system. There also exists what we may call sub-stages that include transport and other relevant services that are also part of the production structure.

Let us now be more explicit and present a more concrete illustration, though not a comprehensive one, of the production of cars. As noted above, the entrepreneur does not account for the past history of the factors of production. His decisions are always forward looking. Our car production illustration is comprised of four stages, each stage being served by one or two producers. The first stage of car production produces chassis. Its output is designated α in our example production structure from Fig. 3. The most important inputs for a firm serving this stage are, following the notation from Fig. 3, A = labor, B = steel, C = machinery. The value of coefficient a for input labor is between 0 and 1, meaning that its total serviceability is not fully transformed to the output of this production process. The value of coefficient b for input steel equals 1, meaning that this input is fully processed to the

output of this stage. (Assigning values to the remainder of the coefficients follows the same principle.) The value of coefficient c for input machinery is between 0 and 1.

The second stage of our car production processes the output of the previous stage, i.e., chassis, and adds to it wheels and engine, which are outputs of other related processes that we are not, for the sake of simplicity, going to deal with at present. Inputs for a firm serving this stage are α = chassis, the output of the preceding stage, which enters the present stage, E = wheels, engine, and F = labor. We implicitly acknowledge that labor services are combined with capital services from the machinery. The value of coefficient d for input chassis equals 1. The value of coefficient e for input wheels, engine equals 1, too. The value of coefficient f for input labor is between 0 and 1. The processed output of this stage can be designated β , following the notation from Fig. 3.

Our third stage consists of two sub-stages which proceed simultaneously. The first sub-stage represents further processing of the output of the second stage and adds interior equipment, e.g., seats, steering wheel, gear shift lever, etc. Inputs for a firm serving this sub-stage are β = processed output of second stage, which enters the present stage, H = labor, and I = interior equipment, e.g., seats, steering wheel, gear lever, etc. We implicitly acknowledge that labor is assisted with machinery. The value of coefficient g for input β (processed output of second stage) equals 1. The value of coefficient h for input labor is between 0 and 1. The value of coefficient i for input interior equipment equals 1. The processed output of this stage can be designated γ , following the notation from Fig. 3. The second sub-stage produces the body of a car. Inputs for a firm serving this sub-stage are J = labor, K = machinery, L = lamination, plastic, synthetic materials, plus further interior equipment. The value of coefficient j for input labor is between 0 and 1. The value of coefficient k for input machinery is between 0 and 1. The value of coefficient l for input lamination, plastic, synthetic materials, plus further interior equipment equals 1. The processed output of this sub-stage, i.e., a car's body, can be designated δ , following the notation from Fig. 3.

Our illustration culminates in stage 4, where the final product—a car—is produced. In this sense it resembles reality, since the reader can at least conceive of half-finished cars being transported on trains to the final production stage, where these are made a final good. Today, many components are manufactured in Japan and China and imported to North America or elsewhere for final assembly. Inputs for a firm serving this final stage are γ = processed output of first sub-stage of third stage, which enters the present stage, δ = processed output of second sub-stage of third stage, which enters the present stage (car's body), O = labor, P = machinery. The value of coefficient m for input γ (processed output of first sub-stage of third stage) equals 1. The value of coefficient n for input δ (processed output of second sub-stage of third stage: car's body) equals 1. The value of coefficient o for input labor is between 0 and 1. The value of coefficient p for input machinery is between 0 and 1. This whole production structure may be integrated within one firm or may be divided into even more firms than in this illustration. Production stages necessarily take place over time and may be located at different places.

This illustrative structure of production from Fig. 3 hopefully provides additional clarity to the Mengerian approach to production and a useful tool for our analysis of intra-industry trade and sliced-up production chains across countries. This approach

accounts also for the existence of fixed capital goods, joint-production, and the multiple interdependence of a large number of production processes. We have to stress in particular that Fig. 3 is to be viewed as an example only, *not* as the construction of a model. We do not try to abstract human action and entrepreneurial activity away in any way, since it is human beings with their freedom to choose that stand behind every one of our hypothetical production processes. Nor are we trying to incorporate static relationships into the realm of human action or to ascribe any functional relationships to individual human actions. In doing so, we would lose the very spirit of the Mengerian approach, its reliance on individual human action!²⁷ Our example is aiming only to illustrate the complexity of modern-day production structures and the multiplicity of both the factor-of-production combinations and their resulting production processes. Let us now continue with a brief exposition of the dynamics of production structure and the importance of the existence of change in human endeavors to the dynamics of intra-industry trade.

Complementarity and Substitution: A Note on Dynamics and Change in the Structure of Production²⁸

Introducing *dynamics* into our analysis of production structure implies introducing the phenomenon of *change*—a change in production plan—to our simple theory of the structure of production that we worked previously. As was mentioned, no heterogeneous factor of production can be put into productive uses without at least one *complementary* good of the same order. Therefore, what we see in reality are *combinations of complementary* factors of production at each of the production stages. However, according to Lachmann (1947), the traditional approach to *goods substitutability versus complementarity*, from the point of view of consumption goods, cannot be so easily applied to factors of production (Lachmann 1947), since this approach to a large extent disregards complex combinations of heterogeneous factors of production, which are the main characteristic of advanced production methods (Lachmann 1947).

It was Hicks and Lachmann who showed the importance of the *producer's point of view* on the substitution versus complementarity issue in factors of production,²⁹ since factor complementarity and product complementarity cannot be treated in the same level of analysis. In treating factors of production, especially capital goods, as *homogeneous*, we are inclined to regard them more as substitutes than complements. On the contrary, in treating factors of production as heterogeneous, we will immediately observe more complementarity than we observed with the previous view. As soon as we realize that factors of production are *heterogeneous* in use, we will notice that each of them is specific to at least one or more uses and that each performs a particular function in the particular production process. These functionally specific factors of production are complementary to each other—they

²⁷ See Mises (1998).

²⁸ This section is to a large extent based on Lachmann (1947, 1978).

²⁹ See especially Lachmann (1947) and references to Hicks therein, which will be the foundation of our treatment of this issue.

make up one production process—with regard to that particular production process, but are substitutes to other factors of production with regard to the same production process.

What we need to realize when applying complementarity and substitution on factors of production is that when we refer to complementarity or substitution of factors of production, we do not refer to one and the *same* situation (Lachmann 1947). *Complementarity*³⁰ of factors of production means that all the factors at stake are directed to one and the same concrete end with respect to a given *production plan*.³¹ It is an equilibrium concept. *Substitution*,³² on the other hand, is a reflection of *change*. It is brought about whenever a *prior* plan had to be changed for whatever reason. Substitution in factors of production represents the ease with which a factor can be turned into an element of a new plan.³³ The difference between factor complementarity and factor substitution is the difference between *planned action* and *plan revision* (Lachmann 1947). However, a change in plan, from the prior plan to the current plan, does not imply a change in the end sought. For drawing a dividing line between factor complementarity and factor substitution we only need to isolate a change in plans with respect to a given (not necessarily changed) end. Furthermore, if all the changes were predictable, there would be no need for substitution. This implies that our distinction makes sense only in the *real* dynamic world where uncertainty of any kind and degree prevails. It is also clear that the more complex the plan and the larger the number of complementary goods there are put together, the more vulnerable the whole structure is in a case of unforeseen change. Factor substitution may thus be regarded as a bridge between the old and new plans—between the old and new sets of complements. The old set of complements needs to be *disintegrated* and *regrouped*, where some factors remain, some are changed for others, and some are abandoned altogether, until *integration* toward the new set of complements is reached.

If one factor needs to be substituted for another, the resulting effect on the rest of the factors within the same plan depends on the substituted factor's *substitutability* to the factor removed. On condition that the new factor is not a perfect substitute to the factor abandoned, an adjustment of other factors follows suit. This change of proportions in which the various factors are combined will be referred to as a change in the *coefficients of production*.³⁴ It also follows that a change in the coefficients of production in one production process has a resulting impact on connected production

³⁰ See Lachmann (1947) for this definition.

³¹ Note that this point clearly follows from Menger's (1994) highlight that each production factor's combination is fixed in a particular production process for the whole duration of that process. See also Mises (1998).

³² See Lachmann (1947) for this definition.

³³ See Lachmann (1947). Also notice that the concept of factor substitution is rooted in the concept of factor *convertibility* described above. See also Mises (1998) for more details.

³⁴ See Lachmann (1947). Lachmann also points out that similar coefficients of production were used by Walras. Also see the similarity between the coefficients of production and the coefficients from our more complex example of production structure above (Fig. 3).

processes in the whole production structure. This *repercussion* effect on other firms will be gradual as the effects of the change influence each connected process in the passing of time, and will depend on the degree to which a given plan depends on the one changed. *Equilibrium* situations are hence characterized by the consistency of a given set of factor complements within a given plan. *Disequilibrium* situations are, on the other hand, characterized by continuous transformation of production plans and by ever-changing coefficients of production (Lachmann 1947, 1978). Since every production process takes time, when we referred to factor complementarity, we always had to refer to *complementarity over time*.

Let us now briefly illustrate the preceding discussion with an algebraic formulation.³⁵ Let us assume that a change occurs only after a given production period, not during it, i.e., after all the factors of production are no longer fixed to the production process being adjusted. Also, let the combination of factors of production with respect to a given plan be manifested by our coefficients of production.³⁶

During a period t_1 let us have the following—complementary—factor combination,

$$aA + bB + cC \quad (1)$$

where A, B, C are the concrete manifestations of complementary factors of production used in process 1, i.e., particular equipment, piece of land, number of workers, etc., and a, b, c represent coefficients of production of process 1 and are constant during the duration of the process.

At the end of period t_1 an unexpected change in technology or market situation occurs that drives the entrepreneur to change the former production process to a different one for period t_2 —substitution occurs. The resulting factor combination for period t_2 is as follows,

$$b'B + c'C + dD \quad (2)$$

where $b < b'$ and $c > c'$. D is a new factor, that was either substituted for (if the end sought remained the same) or changed for (if the end changed) factor A . The preceding

³⁵ A methodology that we follow in this sub-section and the one that we followed in Fig. 3 is that of process analysis. As we study a dynamic phenomenon in time, what we need is a sequence analysis to track all the changes that occur during that period of time. Equilibrium methods that imply consistency of plans prove insufficient to the study of ever-changing production structure, we need to apply a method that is suitable to deal with the phenomenon of change. See Hayek (1962) and Robinson (1953–1954). Production structure is characterized by a sequence of periods, during and after each of them a change may or may not occur. This sequence of periods is governed by a production plan and since the production is a process taking place in time, the chosen method of our analysis is process analysis. Our interpretation of this method is based on Lachmann (1978) but his work is directly drawn from the famous contributions of Hicks, Lindahl, and Lundberg on process analysis (see Lachman 1978, for more details). To use process analysis to describe production structure does not, however, imply that we are going to build dynamic models with behavioral functions using differential equations. “Our reason for this refusal is that to assume that entrepreneurial conduct in revising plans at the end of successive periods is, in any objective sense, *determined* by past experience and thus *predictable*, would mean falling into a rigid determinism which is quite contrary to everyday experience” (Lachmann 1978, p. 14; italics original).

³⁶ This illustration is based on Lachmann (1978).

illustration shows that with a change in a production plan, there is a resulting change in the coefficients of production and/or the factors of production in use.³⁷

In any case, what happens in period t_2 is not the mere result of what happened in t_1 , nor the result of what happened in t_1 plus the decision made at its end. It will be the combined result of events during t_1 , plan revisions at its end, and the success with which these decisions met before t_2 even began.” (Lachmann 1978, p. 48)

After illustrating both the static and dynamic concepts of structure of production and the repercussion effects within these concepts, we may now proceed and integrate these concepts to the analysis of intra-industry trade and sliced-up production chains across developed countries. In doing so, we are about to illustrate international aspects of integrated production structures and their implications.

Intra-industry Trade and the Structure of Production

The Nature and Origin of Vertical Intra-Industry Specialization

The aim of this sub-section is to apply our understanding of production structure to intra-industry trade, in particular to vertical intra-industry specialization,³⁸ and to the phenomenon of sliced-up production chains across countries. As was apparent from both Grubel and Lloyd (1975) and especially from Krugman (1995), a large magnitude of intra-industry trade occurs in *intermediate goods* of the same industry, i.e., along a number of stages of the same production structure leading to a particular kind of consumption goods. Grubel and Lloyd (1975) termed this phenomenon “vertical intra-industry specialization.” Another thing that we can observe is changes in the nature of the manufactured products, i.e., modern manufactured products, when compared to the manufactured products of the pre-war period, get more *complex* (Krugman 1995). The production of these products no longer requires only a few stages of production. Production structures are *longer*, amounting to a *larger* number of stages (Krugman 1995). A corollary observation is the emergence of sliced-up production chains across countries, i.e., not only has production become more complex comprising more stages, but the whole production structure is sliced up across various countries. As the number of stages heading toward production of particular consumption goods increases, and as soon as these stages are placed in *different* locations, slicing up of the production chains across countries is a logical outcome of this phenomenon (Krugman 1995). We therefore believe that the simple

³⁷ We will not deal here with cash reserves needed for acquiring factor D . Neither are we going to deal with the way factor D was acquired nor with the way factor A was abandoned. For more on these points see Lachmann (1978).

³⁸ Whether there is more horizontal intra-industry specialization, which is very successfully explained by the economies-of-scale literature on intra-industry trade, or whether there is more of the vertical intra-industry specialization, which we try to explain in this paper using the structure of production theory, remains an *empirical question*. We will follow the view of Krugman (1995), saying that most intra-industry trade is in intermediate goods, accounting for vertical intra-industry specialization. This view is in accordance with our basic prediction about the *origin* of vertical intra-industry specialization that follows.

TIME	ORDER	PRODUCTION PROCESSES	STAGES OF PRODUCTION
n  $n+t$	$high$ low	$aA + bB + cC = \alpha$	(1)
		$d\alpha + eE + fF = \beta$	(2)
		$g\beta + hH + iI = \chi$ $jJ + kK + lL = \delta$	(3)
		$FINAL GOOD: m\chi + n\delta + oO + pP = \epsilon$	(4)

Fig. 4 Structure of production and intra-industry trade

theory of structure of production as developed in this paper is a useful tool for the analysis of modern vertical intra-industry specialization.

The *basic prediction* about the origin of vertical intra-industry specialization that intuitively follows from our simple theory of production structure is as follows. The more *advanced* societies get,³⁹ the longer the individual periods of production, i.e., the individual structures of production get longer, production gets more complex consisting of an increasing number of stages. And as soon as *free trade* is permitted, *division of labor* brings about *differentiation* and *specialization*, where every individual is active—according to his comparative advantage—in a particular *stage* of production. If these stages are located in *different* countries and free trade remains, what follows is an increase in trade in general, and an increase in vertical intra-industry specialization along each particular production structure (i.e., industry) in particular.

To see why there is an increase in intra-industry trade with economic progress and freer trade, let us illustrate this with an example. Let us have a world of two countries, country *A* and country *B*. Looking at Fig. 3, which is reproduced here as Fig. 4, all the production processes taking place in country *A* are represented with shaded areas and all the production processes taking place in country *B* are represented with un-shaded areas. Imagine that the figure represents, for instance, the automobile industry (similarly to our example above) and let us suppose that the production chain is sequenced as follows. The first production process producing output α is located in country *A*. The following stage of production, the process producing output β is located in country *B*. The first thing we can observe is a trade within the automobile industry between countries *A* and *B*, when country *A* exports its product for further processing to country *B*. Afterward, country *B* exports its product, belonging still to the automobile industry, to country *A*, where we suppose the third stage of production takes place. In our example, this stage comprises two processes. Let us suppose that the process producing output γ is located in country *A* and the process producing output β remains in country *B*. Country *B* exports its product δ belonging to the automobile industry to country *A* for its further processing, while producing product δ that will be a complementary input for the following stage of production. Finally, let us suppose that the final product is put

³⁹ According to Mises (1960, chap. 8, sect. 4), “economic progress in the narrower sense is the work of the savers, who accumulate capital, and of the entrepreneurs, who turn capital to new uses.”

together in country *B* again, therefore observing an export of product γ belonging still to the automobile industry from country *A* to country *B*. Country *B* produces the final product ε and consumes part of it and may even export part of it to country *A*, amounting again for intra-industry trade within the automobile industry. In the real world, there are a number of production structures similar to the one just described, taking place among a number of advanced countries amounting to an overall increase in intra-industry trade.

Inter-temporal Aspects of Production

The aim of the following two sub-sections is to outline the dynamic behavior of vertical intra-industry specialization in time and place. We have to note first, however, that the type of *dynamics* we are interested in for this paper does not follow from the change in the rate of savings or the rate of increase in the money supply. These types of changes are the realm of the *Austrian theory of the business cycle*,⁴⁰ to which our theory of production structure is a *predecessor*. Hence, the dynamics introduced in this paper follow from changes *within* existing production structures, leaving aside issues of savings, investment, and money.

As we mentioned in the section on the simple theory of production structure, production takes *time*, consisting of stages that include various production processes that also take *time* to accomplish. The more complex the production structure is, the more stages and the more production processes it includes. This complex sequence of production processes that each take *different* lengths of time requires a rational coordination based on production *plans* in order for production to be completed in the sense of yielding final consumption goods used to satisfy consumer wants. Since each production process depends on a series of production processes and is itself an input in another series of production processes, and since some of these processes may be *simultaneously* sequenced in time, a case can be made for *repercussion effects* throughout the production structure following a change in a particular production process. These repercussions show themselves in *different* points in time as they make their way through the structure of production. For example, in our Fig. 3, which is reproduced here as Fig. 5, if we would have to replace factor *E* in stage 2 for factor *Z* and if factor *Z* were not a perfect substitute to factor *E*, adjustment of other factors would follow suit and production coefficients *d*, *e*, *f* would change. These changes will amount to repercussions onto the connected production processes (i.e., at least those production processes producing output γ and ε , represented by the shaded areas in Fig. 5) in different moments in time, as they make their way throughout the production structure (Lachmann 1978).

Interspatial Aspects of Production

Our simple theory of structure of production holds that production consists of stages. If production activities get more complex, the number of stages increases. If these

⁴⁰ For the exposition of the Austrian theory of the business cycle see Hayek (1967), Mises (1998), and Rothbard (1993).

TIME	ORDER	PRODUCTION PROCESSES	STAGES OF PRODUCTION
n  $n+t$	high low	$aA + bB + cC = \alpha$	(1)
		$d\alpha + eE + fF = \beta$	(2)
		$g\beta + hH + iI = \chi$ $jJ + kK + lL = \delta$	(3)
		FINAL GOOD: $m\chi + n\delta + oO + pP = \varepsilon$	(4)

Fig. 5 Structure of production: inter-temporal aspects of production

stages are *locally differentiated* and all belong to one industry and are connected through a sequence of production plans (i.e., are on one production chain), there is an increase in international trade (between these stages) and what it eventually causes is an increase in intra-industry trade among these countries. What we mean when we say that production is locally differentiated is that every stage of the production structure from our Fig. 2 is located in a different place, or more particularly, each production process from our Fig. 3 is located in a different country. Since these countries' productive activities belong to one industry, in our case the automobile industry example from above, this results in vertical intra-industry specialization among countries.

When we try to describe the *interspatial aspects* of production and the behavior of vertical intra-industry specialization, we need to account for at least five issues:⁴¹ First, factors of production are *heterogeneous* in use. Second, these factors of production are *specific* to some uses, some to more uses, others to fewer. Third, every production process requires a *combination* of factors of production, which, fourth, makes these factors *complementary* to each other with respect to each production process. Fifth, these factors of production possess various degrees of *convertibility* to other uses as soon as the present use ceases. These five points need to be the foundation of *every* analysis of a change of location of a particular production process. A corollary issue is the issue of *repercussion effects* throughout the stages of production being *located* on various places. This issue is evident from an amendment to our example above from our Fig. 3 reproduced here as Fig. 6. In Fig. 6, for example, if we replaced factor *E* in stage 2 for factor *Z* and if factor *Z* were not a perfect substitute to factor *E*, adjustment of other factors would necessarily follow suit and production coefficients *d*, *e*, *f* would change. These changes, as they make their way throughout the production structure, will amount to repercussions onto the connected production processes (i.e., at least those production processes producing output γ and ε) not only in different *times* but is also on different *places* (Lachmann 1978). This is illustrated with Fig. 6, where each different shade represents a different location for each production process.

⁴¹ For a detailed treatment of these five issues see above.

TIME	ORDER	PRODUCTION PROCESSES	STAGES OF PRODUCTION
n	high	$aA + bB + cC = \alpha$	(1)
		$d\alpha + eE + fF = \beta$	(2)
		$g\beta + hH + iI = \chi$ $jJ + kK + lL = \delta$	(3)
$n+t$	low	FINAL GOOD: $m\chi + n\delta + oO + pP = \varepsilon$	(4)

Fig. 6 Structure of production: inter-spatial aspects of production

As soon as we incorporated *factor convertibility*⁴² into our analysis, there is an inescapable *influence of the past upon every productive activity*.⁴³ Let us now analyze this influence with respect to *changing locations* of particular production processes. This change of location would require a movement of some factors of production to another location, or the use of new factors of production, which are already present in the new location. Let us suppose that there is a change in conditions determining the location of a particular stage of production, or, more concretely, of a particular production process, and that there is *limited factor convertibility*. The introduction of change will be as follows.

When more propitious natural conditions of production are made accessible, plants change their location only if the difference in net proceeds exceeds the costs of moving. What makes this a special case is the fact that obstacles standing in the way of the mobility of labor are also involved. If the workers do not also migrate and if there are no workers available in the regions favored by nature, then neither can production migrate.

However, we need not go into this further, since we are interested here only in the question of the mobility of capital. We need merely establish the fact that production would change its location, even if labor were perfectly mobile, only if the conditions described above were met. This too is confirmed again and again by experience. (Mises 1960, chap. 8, sect. 1). It is now clear that a production process is moved from one location to another, e.g., from one country to another, only *if the difference in net proceeds exceeds the costs of moving*. If this is not the case, the entrepreneur must, for example, wait until the inconvertible factors of production are used up and then move the more convertible factors of production to the new location and build or purchase the inconvertible machinery anew in the new location.

Even trade policy using tariffs or subsidies would not change the fact of profitability of moving a production process to a new location. Factors of production are hence *not*

⁴² Again, it does not matter whether we are concerned with fixed or circulating capital, as soon as we realize, as we did above, that each factor of production is inevitably *fixed* to a particular production process for the duration of that process. The influence of past investment on current productive activities is, though, *less* strong on circulating capital.

⁴³ This part is based on Mises (1998, 1960) and Rothbard (1993).

located in the *most efficient locations*, from the point of view of a visionary engineer, but are located in the *most profitable locations*, from the point of view of the entrepreneur, when taking the influence of the past on inconvertible factors of production into consideration. This conduct of the entrepreneur is fully *rational*, weighting the costs versus the benefits of an action, and it is not a market failure.

All material wealth is a residuum of past activities and is embodied in concrete capital goods of limited convertibility. The capital goods accumulated direct the actions of the living into lines which they would not have chosen if their discretion had not been restricted by binding action accomplished in the past. The choice of ends and of the means for the attainment of those ends is influenced by the past. Capital goods are a conservative element. They force us to adjust our actions to conditions brought about by our own conduct in earlier days and by thinking, choosing and acting of bygone generations. (Mises 1998, p. 503)

Furthermore, according to Mises (1998, p. 506):

[T]here prevails a universal tendency for all industries to move to those locations in which the potentialities for production are most propitious. In the unhampered market economy this tendency is slowed down as much as due consideration to the inconvertibility of scarce capital goods requires. ...In the absence of tariffs, the migration of industries is postponed until the capital goods invested in the old plants are worn out or become obsolete by technological improvements which are so momentous as to necessitate their replacement by new equipment.⁴⁴

This implies that if a location of a production process is not changed, even though from the point of view of a visionary engineer it would seem “most” efficient, it is so because the change of location simply *does not pay* yet.

“The present distribution of human abodes and industrial centers over the earth’s surface is to a certain degree determined by historical factors. The fact that definite sites were chosen in a distant past is still operative” then, in the end, adds that, “what slows down technological improvement is not the imperfect convertibility of capital goods, but their scarcity. We are not rich enough to renounce the services which still utilizable capital goods could provide” Mises (1998, p. 510).⁴⁵ It becomes clear, in the end, that our simple theory of structure of production incorporating heteroge-

⁴⁴ In light of the treatment of factors of production in this paper, we need to add that the same influence of the past on today’s productive activities accrues to land and labor as well, though to a lesser *degree* and partially of a different *nature*.

⁴⁵ Also, according to Mises, when we talk about mobility of capital, we have to be clear that it is only the money capital that is mobile.

Whatever the various capitalists and entrepreneurs may do, they can never make mobile and transferable inconvertible capital goods. While this, at least, is admitted by and large with regard to fixed capital, it is denied with regard to circulating capital. ... However, the process of capital flight is in both instances the same. It is a change in the person of the investor. The investment itself is not affected; the capital concerned does not emigrate.” (Mises 1998, p. 515)

Therefore, most of the factors of production stay (if they are not moved according to the process described in this section), it is the investor and his money capital that changes places.

neous factors of production brings a *new light* and a whole new set of *limitations* to the analysis of the dynamics of vertical intra-industry specialization.

Implications and Conclusions

Implications: Optimum Currency Areas and Business Cycles Synchronization

There is an ongoing debate among economists, using the predictions of *optimum currency areas (OCA) theory*,⁴⁶ as to the trade-offs between closer *trade relations* among countries and the following larger or smaller *real divergence*.⁴⁷ The basic prediction of the OCA theory is that there is a positive relationship between closeness of trade relations and increasing real divergence. Policy discussions have centered around two views. One of them, held by Krugman (1990), maintains that with closer trade relations there is an increase in specialization among countries, implying an increase in divergence following an asymmetric demand shock.

The other view, held by the Commission of the European Communities (1990), maintains that with closer trade relations, the single market gets deeper, and this integration causes a smaller real divergence among the member states following an asymmetric shock. This twofold picture is nevertheless far too simple and too aggregated, as we will see below. The *endogenous OCA theory*,⁴⁸ on the other hand, makes things more realistic, and predicts that with increased trade relations there is an increased *synchronization of business cycles* within the currency union. Since most of the trade relations among advanced countries are of the intra-industry type of trade, and as Fidrmuc (2004) notes, it is not trade relations as such that induce synchronization of business cycles in a currency union, the endogenous OCA theory formulated by Frankel and Rose (1998) underlines, according to Fidrmuc (2004), that trade relations causing synchronization of business cycles in a currency union are mainly *intra-industry* trade relations among advanced countries forming a currency union.

It is here where our treatment of intra-industry trade comes into play. The basic prediction about the origin of vertical intra-industry specialization that follows intuitively from our simple theory of production structure maintains that the more advanced societies get, the longer the individual periods of production become, i.e., production gets more complex consisting of an increasing number of stages. And as soon as free trade is permitted, division of labor brings about differentiation and specialization, where every individual is active—according to his comparative advantage—in a particular stage of production. If these stages are located in different countries and free trade remains, what follows is an increase in trade in general, and

⁴⁶ See the pivotal works on optimum currency areas theory by Mundell (1961), McKinnon (1963), and Kenen (1969).

⁴⁷ Where *real divergence* is defined as the degree to which growth rates of output and employment tend to diverge as a result of asymmetric shocks. See Krugman (1990).

⁴⁸ Two of the criteria mentioned, namely *openness* and *similarity in shocks and business cycles*, are regarded as *endogenous*. For a pivotal work see Frankel and Rose (1998) and for an application on the European Union see Fidrmuc (2004).

an increase in vertical intra-industry specialization along each particular production structure (i.e., industry) in particular. So there emerges *both specialization*⁴⁹ and *trade* along the sliced-up production chains across countries. Since there are more locally differentiated stages of a number of the same industries, there is also an increase in intra-industry trade. Therefore, countries become more *interdependent* along existing production chains and these *trade links* contribute to synchronization of business cycles. Hence, it eventually turns out that *both* Krugman and the European Commission were right and that they each grasped one side of the *same* coin.

In going further, we can make a *case for new international aspects of business cycles*. Alongside the internationally integrated monetary systems,⁵⁰ there are some new international aspects of business cycles, as the various stages of production processes are located across *different* countries and the business cycle can thus be *spread* among these countries *along* these integrated production chains. The introduction of the structure of production with heterogeneous, specific, and inconvertible factors of production to the analysis of sliced-up production chains across countries nevertheless brings about a whole *new* set of limits to business-cycle synchronization and shows that the whole story of business-cycle synchronization is not as *simple* and *mechanical* as it seems to be. With heterogeneous, specific, and inconvertible factors of production, the spread of a boom or a bust (and the implied synchronization of the business cycle) from one country to another is not as simple, proportional, and most of all, immediate as one would imagine! On the contrary, we would expect business-cycle synchronization to be characterized by *complexity*, *disproportionality*, and *lags*. As we see, there remains a lot of space for research on international aspects of business cycles that the present author ventures to undertake in the future.

Making a case for business-cycle synchronization with an increase of intra-industry trade does *not* imply that a politically ordered monetary union is beneficial for individual members of society, or whether there potentially exist “*optimum*” currency areas, or that there needs to be a special kind of trade policy *promoting* intra-industry trade in order to increase the synchronization of business cycles within the currency union. We believe, on the contrary, that it is the *market forces* that prove a certain area to be an “*optimum*” currency area and that unhampered intra-industry trade has many other *benefits* for consumers besides bringing about business cycle synchronization within a currency union. *With the introduction of intra-industry trade theory into the existing economics of international trade, the long lasting case for free trade among international trade economists remains unshaken.*

Concluding Remarks

Our treatment of vertical intra-industry specialization and sliced-up production chains across countries is, we believe, both (a) *realistic* and (b) possessing a strong *predictive* power. One, it is *realistic* in the sense that it describes the day-to-day

⁴⁹ But not of countries but of individuals, since it is *individuals*, according to Austrian economics, and not countries, that actually engage in trade.

⁵⁰ Hayek received the Nobel Prize exactly for the Mises-Hayek *monetary* theory of business cycles.

activities of entrepreneurs on the international scene. Plus it regards production as a sequence of stages taking place in time with the factors of production being heterogeneous and specific. These features reflect the real life of both production in general and the international organization of production in particular. Two, our treatment, we believe, is capable of providing us with reasonably good behavioral *predictions* for the pattern of vertical intra-industry specialization and sliced-up production chains across countries, which, nevertheless was not the original aim of the present paper.

However, the main aim of this paper was to outline *in general terms* the international aspects of production and apply them to intra-industry trade. Space did not permit us to develop any definite model or to undertake any empirical study or applications with definite quantifiable predictions. Before undertaking such an empirical study we would, however, first have to sort out data compatibility. Second, before doing any empirical work on our treatment of international organization of production, we would have to solve a few methodological questions as well, which, however, falls outside the scope of the present paper.

We introduced the reader to the Austrian theory of production and capital, which was set in an historical context of the development of economic thought. A simple theory of production, along the lines of the Mengerian approach to economics, was put forward, highlighting the temporal aspects of production and the specificity and heterogeneity of factors of production. In doing so, we constructed a tool that was used to analyze the phenomenon of intra-industry trade. We showed that the phenomenon of intra-industry trade and sliced-up production chains across countries can be very lucidly dealt with using the insights of the Mengerian production theory, reflecting the modern international organization of production as discussed by Grubel and Lloyd (1975) and Krugman (1995). Our paper culminated with a detailed analysis of inter-temporal and inter-spatial aspects of production and concluded with important implications for further research in optimum currency areas and business cycle synchronization.

Acknowledgment The author would like to thank Paul Downward for his help throughout the writing of this paper and for his insightful comments and suggestions. Also thanks to Jörg Guido Hülsmann, Roger Garrison, Robert Holman, Joe Salerno, and anonymous referees for helpful comments.

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