

Measuring Intangible Investment

Intangible Investment from an Evolutionary Perspective

by

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TABLE OF CONTENTS

INTANGIBLE INVESTMENT FROM AN EVOLUTIONARY PERSPECTIVE.....	3
1. Introduction.....	3
1.1 Treatment hitherto by the OECD	3
1.2 Criticisms of the definitions proposed hitherto	4
1.3 Alternative ways forward	5
2. Various ways of explaining growth and change	5
2.1 Neo-classical approaches	5
2.2 Evolutionary approaches	7
3. Classification within an evolutionary approach	8
3.1 The picture of the firm from an evolutionary perspective	8
3.2 A taxonomic classification of intangible investment	11
3.3 Comparison with the OECD classification of intangible investment	17
4. Recording data in a satellite account	19
4.1 Flow account	19
4.2 Stock account	20
5. Conclusion	21
REFERENCES	22

INTANGIBLE INVESTMENT FROM AN EVOLUTIONARY PERSPECTIVE

1. Introduction

Economics traditionally portrays economic activities in terms of processes in which physical inputs are transformed into physical outputs. The concept of the production function provides the theoretical framework. Deeper insight into the nature of economic activities and the advent of new information technologies have altered the picture: Intangible inputs (such as R&D, human capital, etc.) have increased in importance in relation to physical inputs, and the manner in which the production function is viewed has also changed.

This shift in emphasis has led to interest in the intangible components of economic activities. By analogy with physical investment, they have provisionally been termed “intangible investment”, although the investment nature of the activities is rather questionable. What cannot be disputed, however, is the growing volume of intangible investment; it rose from 14.6 per cent of total investment in five major OECD countries in 1974 to 20.9 per cent in 1984 (OECD, 1992, p. 121). Despite this, at present there is no exact definition of what the term comprises, nor precise guidelines for recording the activities involved.

The importance of intangible investment can be seen primarily in the role it plays in economic change and growth. For example, the TEP report by the OECD emphasizes that “investment of both a material and an intangible nature thus has a central mediating role in the creation and diffusion of innovations and in transforming new technologies into *economic growth*” (OECD, 1992, p. 18).

1.1 *Treatment hitherto by the OECD*

The starting point for the OECD concept of intangible investment is an extension of the notion of investment to include components that are not reflected in physical capital. The feature common to both tangible and intangible investment is the payment flow: expenditure occurs in the present, and returns are generated in the future. The definition used in the OECD’s TEP report is therefore also based on payment flows and arrives at intangible investment by the deduction of tangible investment: “Intangible investment covers all long-term outlays by firms aimed at increasing future performance other than by the purchase of fixed assets” (OECD, 1992, p. 114). The flaw in this definition lies in the lack of substantiality, in other words it does not say what actually constitutes an intangible investment.

Vosselman (1992) attempts to instil substantiality into his suggested definition: “Intangible investment comprises the cost of intangible products that become available in the period under review and that remain in use for more than one year”. This definition suffers from being too similar to that of physical investment, and above all defines a concept that is difficult to comprehend (“intangible investment”) with the aid of an even less comprehensible term (“intangible product”). It remains unclear

whether this “intangible product” is a service, which by definition cannot constitute a stock, a lasting effect of this service, a stock of knowledge, and so forth.

In view of these conceptual difficulties there is no satisfactory classification of intangible investment, only a list of a few activities deemed to be important. Originally these were research and development, education and training, and advertising and software; the TEP report tries to extend the list to include organisation, design, etc. Vosselman (1992), who presents draft guidelines for the collection of data on intangible investment, concentrates on the four original points, for reasons of data availability. The other main types of intangible investment he lists are rights, patents, licences, copyright and trade marks.

1.2 Criticisms of the definitions proposed hitherto

A number of fundamental criticisms can be levelled at the concept of intangible investment used hitherto:

1. *The problem of heterogeneity*

Intangible investments do not form a uniform group, but are a collection of highly heterogeneous elements. If the object is to record the effect of intangible investments, it may be more useful to consider the components individually than to work on the basis of an overall figure for intangible investment.

2. *The problem of differentiating between tangible and intangible*

The dividing line between tangible and intangible cannot always be drawn clearly; some types of intangible investment are practically hardware, or physical investment goods. The attribution of certain parts of software to tangible and intangible goods is particularly problematic. On the other hand, many physical capital goods incorporate intangible elements (know-how, etc.), and intangible investment sometimes also includes material components. If R&D is recorded in accordance with the *Frascati Manual*, expenditure on equipment and physical investment will also be included. This leads to the following question: must every single component be intangible, or is the deciding criterion that the end result be intangible (such as new technological knowledge in the case of R&D)?

3. *The problem of distinguishing between stock and flow concepts*

The distinction between stocks and flows is equally unclear. Flow variables, such as expenditure on publicity, are sometimes found alongside items such as trade marks, patents or goodwill, which are unquestionably stock variables. A clear distinction is essential, however, if these elements are to be portrayed in the accounts.

4. *The problem of the theoretical foundation*

The final, and perhaps most serious, criticism is that, despite recognising the growing importance of intangible investment, the OECD has failed to elucidate the theoretical background, the basis in theories of change and growth. In the view of the authors, there is an urgent need to establish a theoretical foundation.

1.3 *Alternative ways forward*

Taking as a point of departure the status of research described above and the problems that are known to exist, there are two possible ways forward: to adopt a step-by-step approach or to make a completely fresh beginning. In a step-by-step approach, such as that which the OECD is currently pursuing, the aim is to build on the existing categories – despite all the problems of data acquisition, differentiation and definition – and to draw up guidelines for the uniform recording of data. In this way, intangible investment should be incorporated into the conventional statistics, so that lessons can then be learnt for accounting purposes.

The alternative radical approach consists first in carrying out a fundamental overhaul of the theory and then, once a sound theoretical basis has been established, in attempting to formulate a new definition, a new classification and, following from that, criteria for data capture.

As will be evident from the above remarks about the lack of a theoretical foundation, the authors prefer the second route as, although it involves greater effort, they consider it more likely to achieve the objective. They will therefore first examine in detail different ways of explaining growth and change, and the place that investment, and especially intangible investment, occupies or can occupy in that context. As there are difficulties fitting intangible investment into the neo-classical growth theory, an attempt will be made to adopt an evolutionary approach.

2. Various ways of explaining growth and change

2.1 *Neo-classical approaches*

The most widely used approach to growth theory is undoubtedly the neo-classical approach, on which the so-called “new” growth theories are based. This section will therefore describe the objectives to which such “orthodox” approaches are geared, how they view the production process, and the role of investment in growth. These points are summarised in Table 1.

The neo-classical theory (e.g. Solow, 1956) is based on the concept of the production function, which depicts the transformation of inputs into output. Growth is attributed to the increase in the inputs of labour and capital; the part of growth that cannot be explained by an increase in production factors constitutes a residual and is interpreted as a time-related shift in the production function in models of unembodied technical progress. Technical progress, with which the residual is often equated, is an exogenous variable. Tangible (net) investment plays a part to the extent that it leads to an accumulation of the production factor capital.

The empirical application of neo-classical growth theory -- “growth accounting” (e.g. Denison, 1967) -- attempts to find the sources of growth by breaking down the residual not explained by growth in labour and capital into discrete contributions from individual growth factors. The part not accounted for by these individual factors (e.g. education) is attributed to technical progress. Intangible investment can also be understood to be factors of this kind; an allocation of resources to such investment would then generate an independent, separately identifiable contribution to growth. Abramovitz (1989) points to the interaction between individual sources of growth (technology, accumulation of physical capital, human capital).

In contrast to models of unembodied technical progress, vintage models abandon the assumption of a homogeneous capital stock; technology is embodied in machines. As it is assumed that new capital vintages embody the latest technology, new machines are more productive than old ones; investment therefore becomes the vehicle of technical progress, in that (gross) tangible investment raises the quality of the capital stock.

An essential characteristic of the so-called “new” growth theories is the treatment of technical progress as an endogenous variable, now seen as the result of long-term and costly investment. The investment concept of the new growth theories is much wider than the traditional concept and in some cases (e.g. Scott, 1989) includes elements that from the standpoint of the TEP are recorded neither as tangible nor as intangible investment. Scott sees investment as the cost of changes in economic arrangements and interprets this as including any improvement in “assets” over and above necessary maintenance.

Table 1. Neo-classical growth theories and their derivatives

Theory	Object of interest	Input/output process	Role of investment
Neo-classical growth theory in general (e.g. Solow, 1956)	Growth as change in inputs of labour and capital and in technological progress, viewed as exogenous	Portrayal of input/output process by means of the production function	Investment (of a physical kind) increases the stock of the production factor capital
Growth accounting (e.g. Denison, 1967)	As above, plus division of residual into sub-factors	As above	As above, plus classification of intangible investment in residual variable
Vintage theories	Abandonment of the assumption of a homogeneous capital stock; technical progress is embodied in machines	Abandonment of the neo-classical production function	Investment as a “vehicle” of technical progress; physical investment enhances the quality of the capital stock
New growth theory (e.g. Romer, 1990)	Technological progress endogenised by subdividing the labour factor into skilled and unskilled	Depicted by means of the production function (production of goods and know-how) plus abandonment of the assumption that factors can be separated	Investment decisions generate technological change (and hence growth)

“New” growth theories differentiate between two types of labour: unskilled and skilled; the latter can be used both to produce physical products and to create new knowledge. In view of the fact that technical knowledge can to some extent be acquired, search mechanisms exist. External effects and the nature of knowledge as a quasi-public good offset the declining marginal productivity of capital. An equilibrium rate of growth at full employment of resources is calculated; the rate of technical progress is determined by the endowment with skills and the incentive to search.

According to Dosi (1992), the essential difference between new and evolutionary growth theories lies in the fact that the former set out from the *allocation of limited resources*, while the latter regard *progresses of learning and discovery* as central.

2.2 *Evolutionary approaches*

In recent years, a group of evolutionary theories has emerged to compete with the neo-classical approaches. They do not confine themselves to explaining growth, but extend their interest to the entire process of change, innovation and technological progress. Before examining the details of the individual theories (see also the synopsis in Table 2), the common features of the evolutionary school will be described briefly.

Proponents of the evolutionary growth theory deny the premises of neo-classicism in three regards. First, in their view, technological progress is not determined exogenously, but must be treated as an endogenous variable in the process of economic development. Secondly, they dispute the assumption that individual production factors can be separated, and hold that, on the contrary, they influence one another to a high degree. Finally, they consider that growth and economic dynamism are determined by the processes of learning and discovery, and not by the results of resource allocation.

Nelson and Winter (1982) portray the firm as a hierarchy of activities governed by rules or “routines”. As their approach explicitly serves as the basis to classify intangible investment, it will be discussed in the next chapter.

Dosi and Orsenigo (1988) attempt to elaborate the link between technological and economic change. Change is set in an economic environment that is described as follows. It is evolutionary in the sense that change occurs as a process of selection among heterogeneous agents. These agents compete among themselves and, above all, are able to learn over time. In addition, the economic environment includes an irreversible element (previous developments determine the currently available options and selection mechanisms) and it also organises itself autonomously. This means that the course of evolution in the economic environment is the result of the dynamics of technological progress, economic activities and the operation of institutions, which cannot be determined in advance. In their model, investment is regarded as a part of economic activities, i.e. it is endogenously determined.

Dosi (1988) has also studied the importance of innovation for economic and technological change. In his view, based on the “cumulativeness” and “tacitness” of knowledge, the innovative process follows “trajectories” within the firm.

In their evolutionary model, Amendola and Gaffard (1988) emphasize the importance of qualitative change and advocate a new picture of the production process that already incorporates the innovation process. Here, technology is seen not as a precondition for the (exogenous) innovation process, but as its result. The use of specific resources plays a central role.

Traditionally, the production process is regarded as the transformation of generic resources into final goods. Generic resources exist in their own right, are independent of any particular production process and can be used in different combinations in a variety of production processes. The mix (technical coefficients) determines the capacity; quality and availability are all -important.

By their very nature, specific resources acquire a significance only in connection with the production process; the relationships between them are decisive. They embody a qualitative element.

The production process will then also include the recognition and solution of specific problems. By specific resources, Gaffard (1991) means essentially specific human resources.

Carlsson and Taymaz (1991) identify two reasons for economic growth: technological progress (as an endogenous factor) and economic competence (as an additional component). By economic competence, they mean a firm's ability to derive advantage from the opportunities offered by technological progress. Economic competences have exceeded technological progress in importance, or "... the distribution of investment and production among plants inside the production frontier is more important than shifts of the frontier ..." Carlsson and Taymaz (1991, p. 3). Differences in investment behaviour represent economic competence.

Table 2. Evolutionary growth theories

Theory	Object of interest	Input/output process	Role of investment
Nelson and Winter (1982)	Explanation of processes of change and growth	Departure from production processes, portrayal of the enterprise by hierarchy of activities governed by rules	Physical investment determines growth and contraction of firms (intangible investment is not elaborated)
Dosi (1988) and Dosi and Orsenigo (1988)	Link between technological and economic change; explanation of the innovation process (tacit knowledge, cumulativeness)	Firm is characterised by processes of learning and discovery and not by resource allocation	Investment is a part of economic activities (restricted to physical components)
Amendola and Gaffard (1988)	Explanation of innovation; technology is the result of the innovation process and not its precondition	Production process is no longer the transformation of generic resources into final goods by a particular configuration of production facilities, but is shaped by specific resources	Investment is not explicitly mentioned; intangible investment can be interpreted as part of the specific resources that influence the production process
Carlsson and Taymaz (1991) and Carlsson and Eliasson (1990)	Explanation of growth as the result of technological progress and economic competence	Allocation of resources in connection with processes of learning and selection	Differences in investment behaviour represent economic competence

3. Classification within an evolutionary approach

3.1 *The picture of the firm from an evolutionary perspective*

A variety of approaches are used in the literature to portray the firm from an evolutionary standpoint. Dosi and Orsenigo (1988) identify what they term basic functions that govern the firm:

They distinguish between the following:

- procedures to co-ordinate, direct and monitor the performance of individual members;
- criteria and procedures of resource allocation;

- incentive structures;
- information processing networks; and
- procedures for problem solving, learning and the recording or reproduction of specific competences.

The key point in this representation of the firm is the inclusion of problem solving and learning procedures, which admittedly do not take the place of resource allocation procedures (embodied in the production process) but give them a new quality.

3.1.1 *The basic model of Nelson and Winter*

Nelson and Winter (1982) adopt a similar view of the firm that is paralleled by some approaches in organisation theory [e.g. Kieser (1989), Segler (1985)].

According to their evolutionary theory the organisation/firm is characterised by particular, relatively constant patterns of behaviour (“routines” in Nelson and Winter (1982), “comps” in Segler (1985) and McKelvey and Aldrich (1983)) that obey particular rules. “Comps” (“competences”) are organisational rules that produce the problem-solving behaviour of organisations. These include both rules that are observed by individual members of the organisation and those that are recorded in an impersonal form.

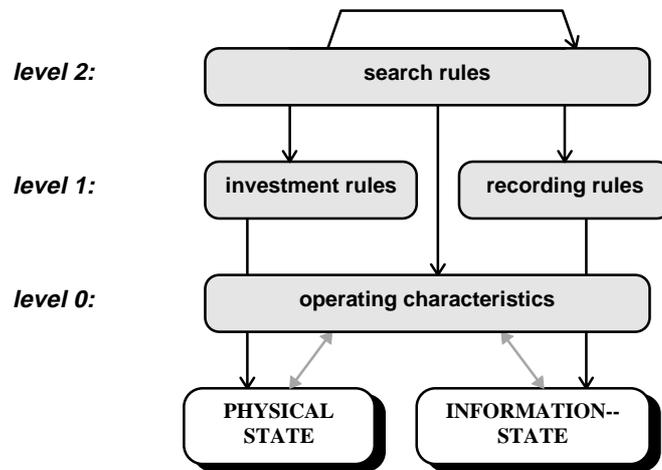
Individual routines/comps constitute, as it were, the genes of the organisation; taken together, they represent the genotype of the organisation, the individual organisational form. They are subject to evolutionary processes; they are evaluated, reproduced, eliminated, varied and selected (Kieser, 1989, p. 182).

The processes of this change (“search processes”) are also governed by rules; Nelson and Winter speak of routine-changing routines or routines of a higher order. Change therefore arises partly from within the firm as a result of search processes and internal selection and partly as a result of the selective effect of the environment, which causes the firm to contract or expand. Hence, the firm is seen as the platform for rule-determined processes and activities, which are arranged at different hierarchical levels.

Nelson and Winter’s basic model describes firms in terms of a “firm state”: “We may think of a ‘firm state’ as comprising descriptions of the firm’s physical state (plant and equipment), information state (contents of file drawers and human memories), operating characteristics, investment rules (affecting transitions of physical state), recording rules (affecting transitions of information state), and search rules (affecting transitions of operating characteristics, recording rules, and search rules)” (Nelson and Winter, 1982, p. 20; see Diagram 1 below).

Accordingly change is the transition from one firm state to another.

Diagram 1. A graphical representation of the firm state according to Nelson and Winter



States

- **physical state:** physical capital stock (machinery, plant and equipment);
- **information state:** the “contents of file drawers and the human memories”.

Types of routines

- **operating characteristics:** relatively fixed rules governing short-term behaviour;
- **investment rules:** rules that determine the increase or diminution of the firm’s capital stock;
- **recording rules:** rules that change the knowledge state;
- **search rules:** rules that modify all lower-ranking rules and themselves.

If one assumes that each category of rules corresponds to operational activities or processes that give rise to costs, activities (and hence costs) can be identified on three different hierarchical levels.

Costs associated with activities corresponding to the operating characteristics can be regarded as current expenditure (level 0); costs associated with activities on levels 1 and 2 correspond to tangible and intangible investment.

3.1.2 An expansion of the basic model

The arrangement shown in Diagram 1 can be expanded in two ways: First, the information state can be seen to be really a knowledge state that also comprises tacit components that are difficult to communicate. Hence a fundamental distinction must be made between knowledge and information.

Second, it seems necessary to introduce an additional state variable to represent the external state of the firm.

3.1.2.1 Knowledge and information

Knowledge is a far broader concept than information, and Dosi (1988) makes a fundamental distinction between the two. Information comprises those parts of knowledge that are public, codified and easily communicable. Knowledge, by contrast, also includes components that are difficult or impossible to communicate (“tacit knowledge”). According to Polanyi (1987), it includes those items of knowledge that are poorly defined, uncoded and unpublished, differ from person to person and cannot be fully described even by those who possess them. “Tacit knowledge” is to a high degree local or firm-specific and essentially determines the knowledge base from which innovation springs. Dosi (1988, p. 1126) uses the term “knowledge base” mainly with regard to technology and understands thereby “the set of information inputs, knowledge and capabilities, that inventors draw on when looking for innovative solutions”.

According to Eliasson (1990), the reason for the non-transferability of knowledge lies not only in the fact that the cost of communication (transaction costs) would be prohibitive, but also and above all in the recipient’s lack of competence.

The information state in Diagram 1 is therefore really a knowledge state comprising both technological and economic competences (“competence base”).

3.1.2.2 Influencing the environment

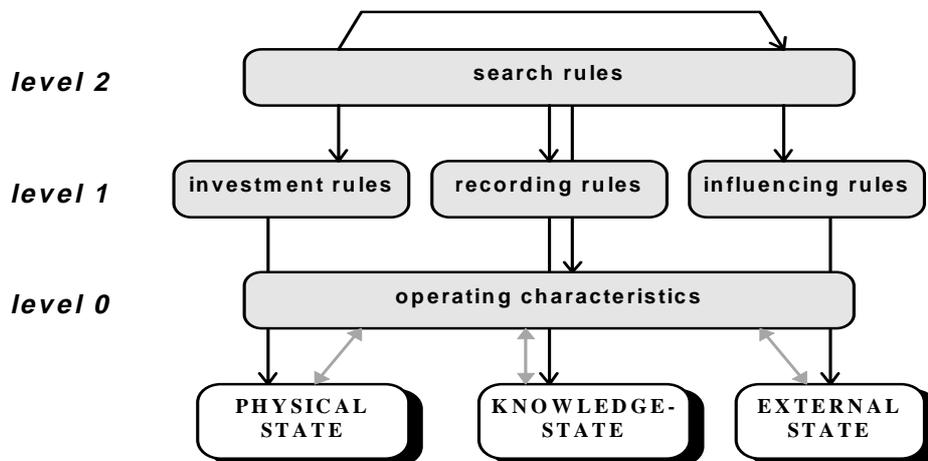
One category of activities (associated with intangible investment) does not easily fit into the knowledge/information framework: all activities aimed at influencing the environment (customers, competitors, the public, etc.). Activities such as public relations or advertising change the attitude of the environment towards the firm. It therefore seems appropriate to introduce an additional state variable into the above framework, an external state that embodies the attitudes of the environment towards the firm and is changed by equally rule-governed influencing activities, which in turn are modified by search processes (Diagram 2).

3.2 *A taxonomic classification of intangible investment*

3.2.1 *Routines, processes and (intangible) investment*

In short, the picture of the firm is described by three state variables (the physical state, the knowledge state and the external state) and a number of routines (operating characteristics; investment rules, recording rules, influencing rules; search rules), which alter the state variables at various hierarchical levels.

Diagram 2. The firm state: an extended view



States

- **physical state:** physical capital stock (machinery, plant and equipment);
- **knowledge state:** the “contents of file drawers and the human memories”, including tacit knowledge;
- **external state:** the attitudes of the environment (customers, competitors, the public) towards the firm.

Types of routines

- **operating characteristics:** relatively fixed rules governing short-term behaviour;
- **investment rules:** rules that determine the increase or diminution of the firm’s capital stock;
- **recording rules:** rules that change the knowledge state;
- **influencing rules:** rules that change the external state;
- **search rules:** rules that modify all lower-ranking rules and themselves.

Different processes/activities can be allocated to the different routines at the relevant hierarchical level:

- operative processes to level 0,
- processes of quantitative change to level 1,
- and processes of qualitative change to level 2.

Finally, current expenditure, tangible and intangible investment are viewed as the cost of these processes, which can be classified according to state and level (Diagrams 3 and 4).

Whereas current expenditure corresponding to the operating characteristics serves to maintain the *status quo*, investment, which responds to routines of a higher order, always contributes to change in one form or another.

Investment rules correspond to physical investment in the traditional sense, while recording rules relate to a particular kind of intangible investment involving the acquisition of existing knowledge or information. Both represent forms of quantitative adjustment, and thus lead to quantitative change.

Investment (whether tangible or intangible) in conjunction with search processes is a higher class of expenditure; its purpose is the acquisition or building up of new knowledge and thus it aims at qualitative change.

The hierarchical classification of (physical and intangible) investment proposed here is based on the type of activity involved; hence in distinguishing between current expenditure and investment there is no need for a time criterion (e.g. effect spread over more than one year). Intangible investment is again intrinsically heterogeneous, not only in content but also as regards ranking. The heterogeneity of intangible investment has effects both for the recording of data and for its incorporation in company accounts. To make allowance for this, intangible investment should be recorded in “satellite accounts”.

Nelson and Winter point out that a strict hierarchical separation between their routines is not always easy, and the same applies to the classification proposed here for intangible investment, but it appears useful from an analytical point of view.

Diagram 3. Routines, processes, and investment

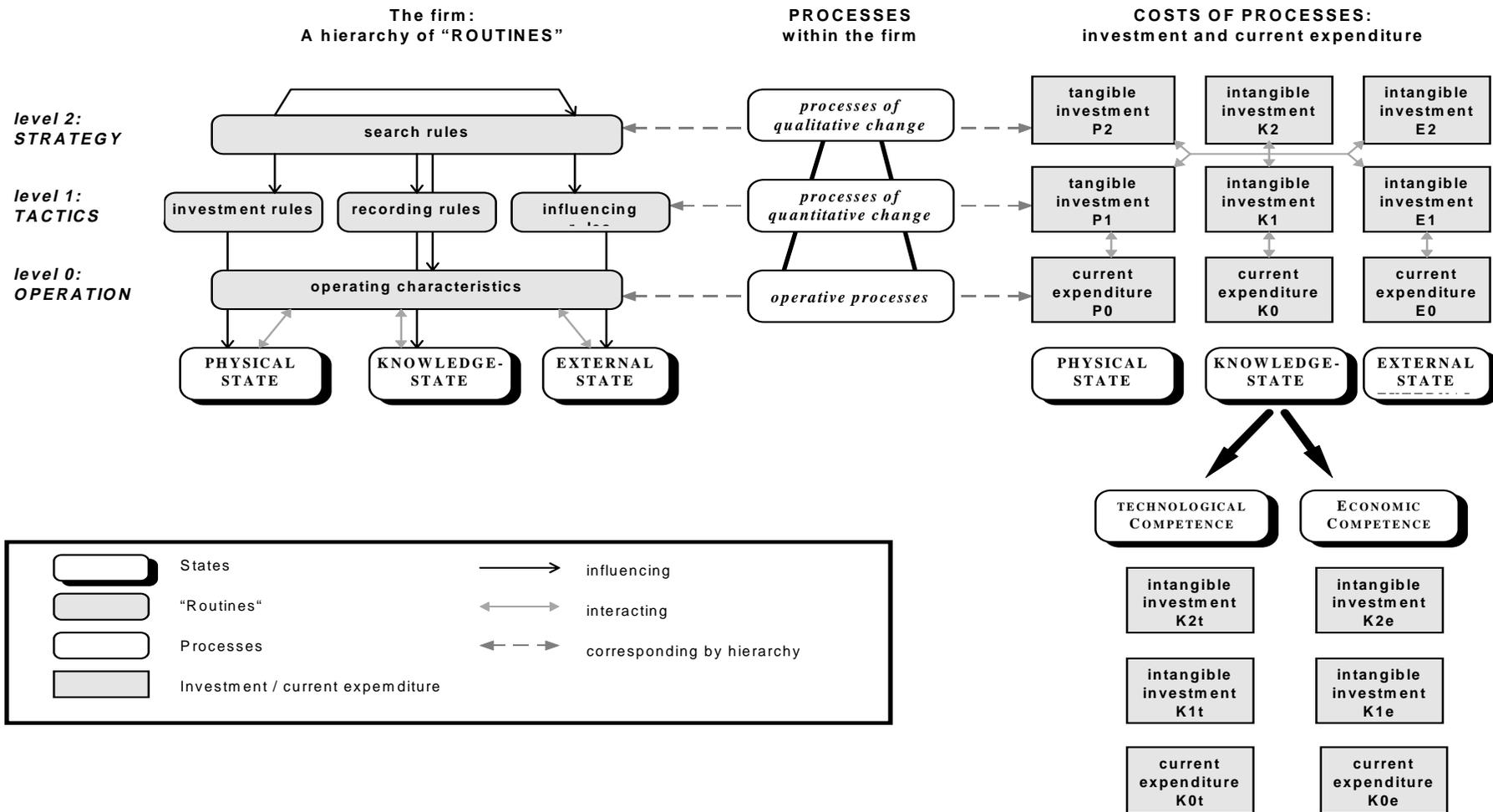


Diagram 4. **Examples for individual classes of investment**

	PHYSICAL STATE	KNOWLEDGE STATE technological competence	KNOWLEDGE STATE economic competence	EXTERNAL STATE
level 2	P2: new plant to produce a new product line	K2_t research and development	K2_e further education and training organisational development	E2 Public relations, lobbying
level 1	P1 machinery, equipment	K1_t patents, licences	K1_e basic training. market research	E1 advertising
level 0	P0	K0_t	K0_e	E0

3.2.2 *A closer look at the knowledge state*

One major category of intangible investment is associated with activities that alter the knowledge state. These activities can be broken down more finely according to the following criteria.

3.2.2.1 Hierarchical subdivision

Although routines cannot be broken down along strictly hierarchical lines, as far as the knowledge state is concerned it is nevertheless possible to distinguish between: *i*) a quantitative extension of knowledge -- the acquisition of existing knowledge (information) according to relatively fixed acquisition/recording rules; and *ii*) the search for qualitatively new knowledge.

This is associated with intangible investment of a lower (first) and higher (second) order (levels 1 and 2 in Diagram 3).

The type of uncertainty associated with this acquisition or learning process can be seen as a further distinguishing criterion between quantitative and qualitative. Dosi (1988, p. 1134) makes a fundamental distinction between uncertainty and strong uncertainty. He defines uncertainty as the known fact that information is imperfect when selecting from a known list of events, while strong uncertainty refers to a situation in which even the list of possible events is unknown.

In relation to the acquisition of knowledge, the former means selection among several (externally) available or accessible items of knowledge or information, while the latter aims to create new knowledge and is the objective of truly innovative activities.

3.2.2.2 Technological knowledge and economic competence

The concept of knowledge as used in innovation theory relates primarily to technological knowledge or know-how. Non-technological, purely economic competencies are also of the utmost importance for the successful application of new technological knowledge and hence for successful innovation. Carlsson and Eliasson (1991) define economic competence as the ability of a firm to create and exploit business opportunities; it encompasses strategic (selective) abilities, organisational (co-ordinating and integrative) abilities, and functional and adaptive (learning) abilities. The concept of “competencies” is also to be found in Dosi, Teece and Winter (1991). They understand the term to mean “being good at doing certain things and being good at learning certain things”, with the emphasis on learning processes. This aspect, namely learning as part of economic competence, is elaborated further in the portrayal of the knowledge state (cluster K1e and K2e in the knowledge state)

The knowledge state can therefore be subdivided in a second direction into technological knowledge and economic competence. (If one considers the allocation of resources, this corresponds to the breakdown of intangible investment in the TEP into “intangible investment in technology” and “enabling intangible investment”.)

3.2.2.3 Components of the knowledge state

This section attempts to subdivide the knowledge state on the basis of the characteristics of the components of knowledge. The subdivision can take the following matrix form (Diagram 5)

Diagram 5. **Subdivision of the knowledge state into knowledge clusters**

	Technological knowledge	Economic competences
Quantitative	<p>Cluster K1t</p> <p>acquisition of existing technological knowledge;</p> <p>e.g. co-operation with universities, patents, application software</p>	<p>Cluster K1e</p> <p>acquisition of existing economic competences;</p> <p>e.g. basic training, market research</p>
Qualitative	<p>Cluster K2t</p> <p>search for new technological knowledge;</p> <p>e.g. R&D within the firm (especially basic research)</p>	<p>Cluster K2e</p> <p>search for new economic competences;</p> <p>e.g. further education and training, organisational development</p>

The purpose of the above classification is to depict knowledge systematically by grouping similar areas of knowledge into so-called knowledge clusters.

Cluster K1t describes processes leading to quantitative extension of technological knowledge. The term “quantitative extension” refers in this context to the acquisition of existing knowledge in accordance with relatively fixed acquisition rules. Associated with this is the character of knowledge as a quasi-public good; knowledge is codified and hence transferable. Examples of this would be universally accessible results of university research, patents, licences and application software.

Processes of quantitative extension of economic competencies are grouped in cluster K1e, These include learning processes of individuals (learning by doing and by using, such as (basic) training within the firm) and market research (the acquisition of knowledge about the current market situation). This and cluster K2e are closely linked with the quantitative and qualitative extension of knowledge (Carlsson and Taymaz, 1991).

Cluster K2t groups together processes of the qualitative extension of the technological knowledge state, i.e. the creation of new knowledge within the firm. This type of technological knowledge is in the nature of “tacit knowledge”; it is difficult to comprehend and is embodied in the carriers of the knowledge. The creation of new technological knowledge occurs in trajectories and builds on existing knowledge [“cumulateness”, see the works of Dosi (1988 and 1992) and Amendola and Gaffard (1988)]. Individual R&D projects within the firm are particularly good examples of activities in this cluster.

Cluster K2e (qualitative extension of economic competencies) relates to change in the components of knowledge that have the ability to apply new knowledge (cluster K1e). Here in the terminology of Nelson and Winter, it is a question of search processes or learning processes of a higher order. In concrete terms, it includes investment in further education and training and in organisational development.

A special case that cannot be easily attributed to a single cluster of the knowledge state is knowledge created by co-operation of firms or generated in a network of firms. These components of knowledge are also linked with the external state of a firm.

The strict division between the market and the firm (hierarchy) on which above all the transaction costs theory is built (Coase, 1937; Williamson, 1975) is beginning to blur. Innovations and qualitative extensions of technological knowledge are now less the results of a single firm’s efforts than the outcome of co-operation among several firms (“They are ... created, developed, brought to market and subsequently diffused through complex mechanisms built on inter-organisational relationships and linkages”, OECD, 1992, p. 68). Generated in networks of firms, this knowledge about the creation and application of new technologies also enhances the knowledge state of the individual firm. Co-operation among several firms also leads to more rapid diffusion of the created knowledge, and is therefore to be welcomed from the point of view of social benefits.

3.3 *Comparison with the OECD classification of intangible investment*

A comparison of the categories of intangible investment listed in the OECD’s TEP-report (OECD, 1992) and the breakdown proposed above clearly shows their similarities and differences (Table 3).

Table 3. **Comparison of the OECD layout with an evolutionary classification**

OECD “classification”	Classification from an evolutionary perspective
Intangible investment in TECHNOLOGY · R&D · Patents and licences · Design and engineering · Scan and search	Technological knowledge · R&D projects within the firm; cluster K2t of the knowledge state · Patents and licences: cluster K1t of the knowledge state · Product development and design: cluster K1t of the knowledge state · “scan and search”: cluster K1t of the knowledge state
ENABLING intangible investment · Worker training · Information structure · Organisational structure	Economic competencies · Basic training: cluster K1e of the knowledge state · Further education: cluster K2e of the knowledge state · ??? · Organisational development: cluster K2e of the knowledge state
MARKET · Exploration · Organisation	External state or economic competences · Market research; cluster K1e of the knowledge state · Advertising: quantitative extension of the external state (E1) · Public relations: qualitative extension of the external state (E2)
SOFTWARE	Tangible investment or technological knowledge · System software: part of tangible investment (P1) · Application software: cluster 1 of the knowledge state (K1t)

It will be seen that “investment in technology” corresponds broadly to clusters K1t and K2t of the knowledge state (technological knowledge). R&D within the firm is classified as the search for new knowledge in cluster K2t. The acquisition of patents and licences comes under the acquisition of existing knowledge, and similarly “scan and search” activities are aimed at obtaining information that is already available; hence, both are classified in cluster K1t as a quantitative extension of technological knowledge. The hierarchical classification of design and engineering is not clear at first sight, but activities of this kind tend to belong in cluster K1t.

The category of “enabling intangible investments” corresponds largely to economic competence. The essential difference lies in the hierarchical subdivision of “worker training” into basic training on the one hand and further education and training on the other. Whereas basic training is allocated to cluster K1e as the acquisition of existing economic competences, further education and training belongs in cluster K2e of the knowledge state as the search for new economic competences. The sub-category “organisational structure” is similar to organisational development, which is also classified in cluster K2e. The sub-category “information structure”, which the OECD subsumes under enabling intangible investments, is not mentioned in the above layout, as more concrete information of the scope of this type is not available.

In the proposed classification, activities relating to the highly heterogeneous field of marketing are divided between the knowledge state and the external state. “Market exploration” can be included in cluster 2 of the knowledge state as the acquisition of external information. By contrast, marketing activities that influence the environment, such as advertising and public relations, constitute a quantitative or qualitative extension of the external state and therefore have their place outside the knowledge state

(clusters E1, E2). The sub-category market organisation proposed by the OECD, which comprises activities such as advertising or public relations, appears to the authors to be too heterogeneous to be included as a single item in a classification.

Software, the last category in the OECD classification, is a special case in that it is closely associated with physical investment (hardware). Here the question arises as to how far software should be regarded as a tangible or intangible good.

A pragmatic approach would suggest that the parts of software that control the basic functions of a computer (system software) should be classified as tangible investment (P1). The part of software that can be classified as intangible investment (application software) leads to a quantitative extension of technological knowledge (cluster K1t of the knowledge state).

To summarise, the main advantage of the layout proposed here is the clear light it throws on the fact that the categories advocated by the OECD are heterogeneous and comprise components at different hierarchical levels.

4. Recording data in a satellite account

The practical conclusion of this is that traditional accounting must be complemented by an additional exercise in the form of satellite accounts depicting this knowledge state and investment that alters it. Such an exercise in accounting for knowledge and innovation has to be divided into a flow account and a stock account.

4.1 Flow account

The flow account is certainly the easier part. In its simplest form, it serves to group together certain categories of expenditure; in other words, to break down expenditure on components of knowledge according to individual knowledge clusters and to explain them verbally. Expenditure affecting the external state is treated in the same way. The following outline of an activity account attempts primarily to elaborate the hierarchical components, to identify investments as the costs of various processes at various levels (Diagram 6).

It is more difficult to depict the benefit or impact of such intangible investment; here a verbal description is appropriate. Moreover, the benefit or impact is not confined to the firm making the investment. Knowledge is a quasi-public good, characterised by non-rivalry (Romer, 1990). Knowledge created in the firm can also be used by third parties, and the firm has very limited scope for restricting or preventing the diffusion of such knowledge. The benefits that stem from an intangible investment often have external effects (e.g. research spillovers); there is a social benefit. A description of the benefits must therefore take account not only of the private benefits (for the firm) but also the social benefits (for the community at large).

Diagram 6. Hierarchical activity accounts

Knowledge state		External state
<i>Acquisition of existing knowledge - activities of the first order</i>		<i>Influencing activities of the first order</i>
<i>technological knowledge</i>	<i>economic competence</i>	· advertising
· patents	· (basic) training	
· licences	· market research	
· application software		
<i>Creation of new knowledge - activities of the second order</i>		<i>Influencing activities of the second order</i>
<i>technological knowledge</i>	<i>economic competence</i>	· public relations
· R&D projects within the firm	· further education and training	
· co-operation in the R&D field	· organisational development	· lobbying
	· co-operation in the economic field (market identification, market development)	

The social benefit needs to be examined more closely, however. The transfer of knowledge involves a diffusion process that presupposes not only that the knowledge within the firm cannot be acquired entirely but also that the recipient/user or the knowledge is capable of assimilating it. In the view of the cumulative nature of knowledge, the latter presupposes a particular competence, an “absorptive capacity”. Firms operating in the same field are more capable of exploiting such diffusion processes and spillovers. The external effects, and hence the social benefits, are therefore not universal, but in a sense are local, industry-specific, etc. Consequently, the portrayal of private and social benefits must be widened by the addition of a third category that extends beyond the firm but is local in that it is confined to a few potential beneficiaries; this third category should be described as benefits for networks or “clusters” of companies (Porter, 1990). This is especially true for benefits deriving from technological knowledge generated in technological networks of companies (OECD, 1992, p. 226ff).

4.2 Stock account

The disadvantage of the flow account is that it is difficult to compare companies according to the contribution intangible investment makes to their knowledge state. This can be done only by means of stock accounting, which shows the level of the knowledge or external state. As the stock of knowledge cannot be measured directly, initial attempts at measurement have to rely on indirect methods (e.g. Permanent Inventory Method, Vosselman, 1992). The level of annual investment (flow) is first determined, and this is discounted using assumptions about useful life/period of effectiveness of investments and a depreciation calendar in order to calculate the stock of intangible capital.

This approach is intrinsically correct, but it leads to problems in some areas of the knowledge state. For example, expenditure on patents, licences, and so forth, can be translated relatively easily into a stock variable, but it is difficult to formulate stock variables for investment in basic and further training or in advertising and public relations. These problems take two forms.

First, it is extremely difficult to estimate the useful life or period of effectiveness. To give two examples, some knowledge has an infinite life span (e.g. basic research), while other knowledge becomes obsolete in a relatively short time (e.g. application software that has been overtaken by technological development). It is equally difficult to estimate how long knowledge acquired through further education and training will bring benefits to the firm, or how rapidly a stock created by advertising expenditure loses its effectiveness. For lack of alternatives depreciation formulae must rely on firms' past experience.

A second problem area relates to the question of whether a stock of intangible investment, however calculated, is owned by the firm or by the employee. In the case of company basic and further training, it could be argued that employee qualifications gained by intangible investment cannot be attributed to the firm's knowledge state, for the simple reason that the qualifications are specific to the employee, who is at liberty to leave the firm, so that the firm has no rights over them. This opinion can be endorsed only up to a point; despite the obvious difficulties involved, the authors advocate attributing such investment to the firm and hence its inclusion in a satellite account. The justification for doing so is that as long as the employee is working for the firm his knowledge can also be ascribed to the firm; if he leaves, an extraordinary write-off must be made. Moreover, a satellite account that left out stock variables for basic and further training would be lacking in an important respect and would therefore lose significance.

5. Conclusion

To summarise, evolutionary theories offer a theoretical framework in which to set intangible investment and can serve as a basis for formulating a coherent classification. The task for the future is therefore to elaborate further the link between the evolutionary theory as a theoretical foundation and its practical application for accounting and statistics (Industriewissenschaftliches Institut, 1993).

As regards accounting, it makes sense to depict intangible investment first in a satellite account. A theoretically justified classification has been proposed that could also serve as a basis for official statistics.

A theoretical basis must be established before intangible investment can be integrated into a system of national accounts, however. The objective is not served by treating intangible investment by simple analogy with physical investment in plant. Evolutionary theories could provide an important starting point for such a theoretical basis, in the same way as Keynesian theory paved the way for the present System of National Accounts. The disadvantages of these theoretical approaches are first that they do not offer a complete theoretical framework and, second, that they are difficult to apply in practice.

Despite these disadvantages, evolutionary theories appear to offer the means of better identifying and classifying intangible investment; the main task is to make this new theoretical approach usable in practice.

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