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The Limits of the Knowledge-Based Capital Framework

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Knowledge-based capital (KBC) investment refers to business spending on knowledge-related assets such as R&D, managerial competence and advertising that incurs future returns for firms. However, many forms of KBC, or intangible capital as it is also known, have to-date been absent from national economic accounting, and many advocate their inclusion as an important step toward a better understanding of our changing economy. Unfortunately, the KBC framework as currently conceived suffers from a number of fundamental problems: in particular, it wrongly assumes that that firms are rational investors, glossing over differences in returns to different types of capital, and it oversimplifies the aggregation of capital from the firm level to the national level. These issues, as well as some less critical problems, need to be overcome before the KBC framework is applied to economic theory and policy.

The KBC framework, as currently promoted by its advocates, suffers from two key challenges. First, by incorporating the neoclassical assumption that firms invest rationally in all capital with a positive net return, the framework effectively assumes that all classes of capital spending have the same return for firms and thus the same effect on economy-wide productivity. This assumption obscures more than it reveals. The inclusion of all forms of knowledge capital risks leading policymakers to give short shrift to certain kinds of physical capital, particularly ICT capital that research has shown plays an outsized role in driving productivity and innovation.[1] At the same time, the KBC framework overvalues whole classes of intangible investments that have little or no impact on growth, such as advertising

and architectural designs, or that can actually destroy economic value, as we have seen in the case of investments in new financial products.

Second, the KBC framework assumes generally that the sum of benefits to firms from investments can be aggregated to national levels. There are a number of reasons why this may not be the case, particularly for intangible capital, which typically exists in far from ideal market conditions: using only firm-level capital investments ignores "clusters" and other regional or national benefits. More seriously, the framework assumes that investments like the development of brand capital through advertising are not "zero sum" in the sense that one firm's spending simply cancels out another's.

In addition to these two fundamental problems, there are a number of more technical issues with the current KBC framework, primarily due to the inherent difficulty in quantifying many types of intangible investments. At the core of all these issues is the need to move beyond simplistic notions of tangible versus intangible capital and instead focus on the kinds of capital, tangible and intangible, that have the largest impact on productivity and growth. Just because spending is capitalized does not mean that it drives growth. Any further incorporation of intangible capital into national accounts requires some serious rethinking and a fuller understanding of how different types of capital works to increase firm and national output.

WHAT IS KNOWLEDGE-BASED CAPITAL AND WHY MEASURE IT?

KBC is business investment in knowledge-related areas that does not fit into traditional categories of physical capital such as machines and buildings. At its core, KBC attempts to improve the measurement of value in our changing economy. Particularly in developed economies, changes in technology and economic organization have led to sources of value that were irrelevant or impractical in the past, or that were simply so closely aligned and embodied in physical forms of capital that there was little point in measuring them independently.

These changes in technology and economic organization, driven by improvements in the quality and cost of information technologies, have led to significant changes in business spending throughout the economy. Since 1979 U.S. businesses have reduced spending on traditional forms of capital investment (tangible capital), such as physical buildings and machines.[2] (Figure 1) Over that same period, however, business spending in less intangible areas of investment—including software, research, creation of artistic originals and new product and architecture designs, mineral exploration, advertising, management, and training—increased steadily in as a percent of GDP.

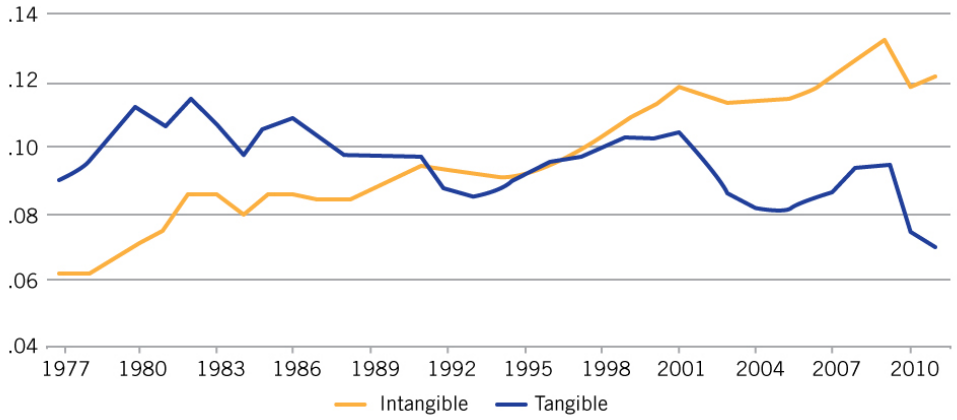

Figure 1: Investment by private industries excluding real estate/housing 1977-2011 (ratio to GDP)

Based on data like Figure 1, KBC advocates argue for the primacy of KBC capital in the knowledge-based, post-industrial economy. But caution is required before making this leap in logic. The reality is that much of this shift in spending is due to both changes in the price of tangible and intangible goods and services and to more fundamental shifts in the system of production. Tangible goods such as computers and IT-enable machines, primarily due to Moore's Law and the falling price of computing power, have gotten cheaper, while many intangible goods such as research or consulting services have not due to "Baumol's cost disease."[3] Companies spend less on machines and more on management capabilities and advertising, because the price of the latter has grown much faster than the price of the former. Moreover, as the United States has lost manufacturing output due to foreign competition, investment by manufactures in machines has stagnated.[4]

On the other hand, as the use software has become more important and knowledge-based competencies become more important, the rise in KBC spending does reveal important shifts in the way those businesses produce goods and services.

Regardless of the reason for the shift in spending, a significant share of business investments are not adequately captured in the traditional capital accounting framework. Traditional statistics miss much of this new spending in part because they are intended to describe an economy where research, design, and production are done on-site and end up embodied in physical objects. In today's economy, such a system of measurement fails for two reasons. First, production has become more fragmented and businesses frequently have a much more nebulous relationship with existing physical production processes. Second, value itself has become less tangible, as goods like books or CDs morph into digital form and services are replaced by software.

ATTEMPTS TO MEASURE KBC

The idea of KBC was formally proposed by Corrado, Hulten, and Sichel (CHS) at a conference in 2002 and then in a subsequent 2005 paper. While attempts had previously been made to quantify the hidden intangible value of firms using stock valuations, CHS were the first to apply an accounting framework to intangible investment, using spending on inputs instead of output measures.[5] CHS rightly reasoned, at least when applied to

firms as opposed to the entire economy, that "any use of resources that reduces current consumption in order to raise it in the future… qualifies as an investment."[6] Applied to businesses, this means that all business spending going toward future returns (normally defined as having payoffs beyond one year) should qualify as capital investment. They further argue that there is a distinct class of "intangible" investment that affects businesses in similar ways. This is KBC: business investment in disembodied knowledge-based goods and services.

KBC consists of investment that has at least partly gone unrecorded and not been categorized as investment, so it is hard to measure almost by definition. CHS rely on their understanding of business functioning and business investment to produce estimates of KBC investment, breaking down business spending into three major categories of assets as seen in Box 1: computerized information, innovative property and economic competencies.

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BOX 1: OECD DEFINITION OF KBC[7]

Asset Categories:

- **Computerized information**: Knowledge codified in computer programs and computerized databases recorded in the official System of National Accounts (SNA) since 1993.
- **Innovative property:** Knowledge assets that are protected through intellectual property rights (IPR), such as patents, designs, copyrights and, to some extent, trademarks. These assets result from spending on R&D and mineral exploration, but also from a range of expenditures on creative and inventive activities, artistic originals, architectural designs and new financial products. While most of these expenditures are recorded somewhere in official national accounts, few are explicitly reported as investments in KBC.
- **Economic competencies:** Knowledge embedded in a firm's human and structural resources, such as firm-specific training, organizational capital, and brand equity and measured mainly by using secondary sources of data and a set of provisional assumptions. This asset category represents the biggest challenge in terms of definition, measurement and modelling.

Data sources and measurement assumptions for investments in knowledge-based assets:

Asset type	Data sources	Measurement assumptions	Depreciation rate (%)
Computerized Information			
Software	Recorded in SNA	Includes own use, purchased and custom made software	33
Databases	Included in SNA estimates of software investment		33

Innovative Property			
Science and engineering R&D	R&D surveys, business expenditures on R&D (BERD) estimates	BERD	20
Mineral exploration	Recorded in SNA	R&D in the mining industry	20
Artistic originals, usually leading to copyrights and licenses	Recorded in SNA		20
New product development in the financial services industry	Input-output and supply-use tables	20% of intermediate purchases of the financial industry	20
New architectural and engineering designs	Services Annual Survey and supply-use tables	50% of purchases of architectural and consulting engineering services	20
R&D in social sciences and humanities	Included in BERD estimates		20
Economic Competencies			
Brand equity	Surveys of advertising expenditures; Services Annual Survey; supply-use tables	*Advertising*: purchases of advertising services *Marketing*: outlays on marketing services Doubled to take into account production costs and own account component	60
Training	Surveys of employer-provided training	Direct costs and wage costs of employee time in training for market-sector industries	40
Organizational Capital	Employment and earnings data; Services Annual Survey	*Own account*: 20% of managerial wages *Purchased*: 80% of services purchased from the management consulting industry	40

While KBC primarily involves new knowledge-based technologies, the distinction between tangible and intangible is sometimes less clear that it might seem. Software, for example, is in many cases as tangible as previous generations of physical machines were: think of a 3D printer controlled by computer software versus the process of making a die casting using precise tools and technical training. There are obvious tangible and intangible investments being made in both cases; the main difference is that in the case of the 3D printer, the software is a distinct entity that can be purchased separately from the machine.

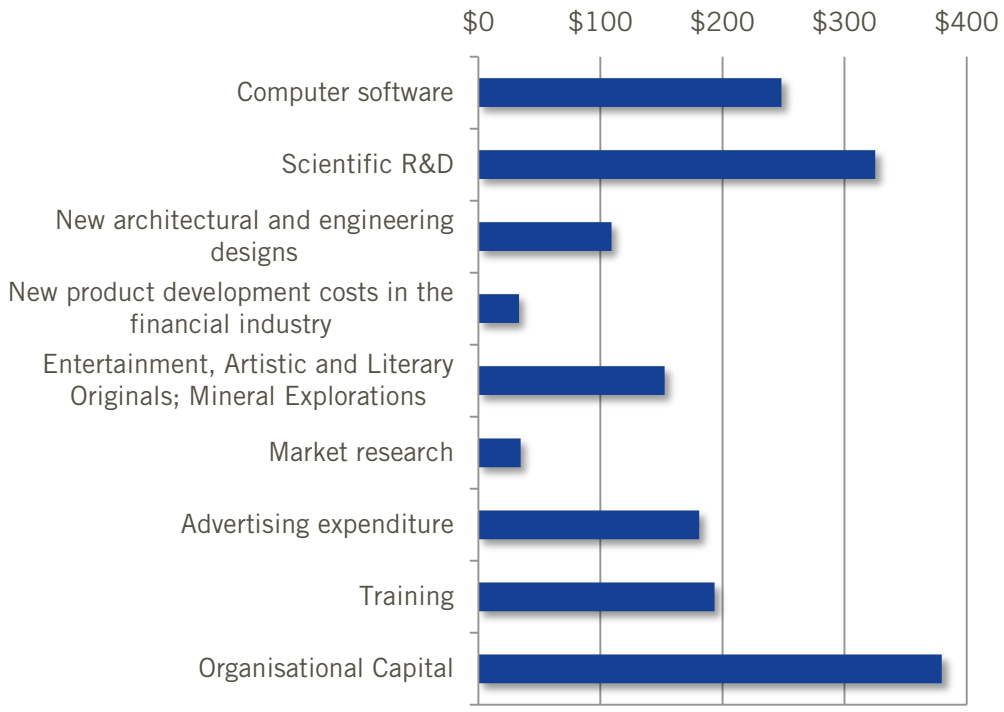

Figure 2: U.S. business investment by KBC type, 2010 (billions nominal USD)[8]

The asset categories determined by CHS are useful but nevertheless somewhat arbitrary.

Similarly, the asset categories determined by CHS are useful but nevertheless somewhat arbitrary. It is of course no easy task to catalogue all the intangible value a firm possesses, or the resources a firm expends maintaining or increasing that value. CHS categorize types of KBC investments by the investment's legal definition. This works from an accounting standpoint but it also functions to obscure the role the role that KBC plays in the economy. The subcategories under Innovative Property, for example, are delineated primarily by which types of information the state has chosen to enforce property rights for, and the overall category has little relation to any function that these types of property have in production or consumption. Another example is the distinction between economic competencies embodied in management and those embodied in non-managers: CHS chose to include the former (in the form of 20 percent of management wages) but not the latter, even though actual embodiment of knowledge which might vary extensively between firms. The OECD recently began work on a new approach to measuring spending on organizational capital, which uses occupation-level data to more precisely measure which occupations engage in management tasks.

The idea of KBC has gained wide acceptance in the international statistical community since CHS's 2005 and 2009 publications. A body of literature offering international KBC estimates quickly arose, providing estimates for at least 32 countries.[9] In 2013, the OECD authored several major reports with KBC as the focal point. One of the major goals of the reports was to promote tighter standardization of measures across countries. Since many of the initial CHS estimates for components of KBC relied on satellite or non-standard statistical accounts, international harmonization is a daunting task that may require significant ground-level changes on the part of national statistical agencies. Another goal of

the reports was to work on disaggregating the country-level estimates, since discrepancies, difficulties, and misleading numbers remain.

ISSUES WITH KBC ACCOUNTING METHODS

There are two fundamental problems with the KBC framework as currently constructed. First, the measurement of KBC is built on the assumption that firms invest rationally, with the proper incentives to optimize their internal rate of return (IRR) on the basis of reliable information about the future. While this assumption is common and may seem innocuous, it can lead to substantial errors, particularly in the context of intangible goods. Second, the concept of KBC disregards significant externalities, spillovers, and other aggregation problems when going from firm-level KBC investment to national-level investment. Taken together, these two problems show that KBC requires further refinement before it will be useful in macroeconomic analysis or as a guide for policy; as it currently stands, while the emphasis on new types of capital is welcome, KBC is a limited and often misleading tool. Additionally, there are a number of smaller changes to KBC that could enhance our understanding of intangibles and the ways that they contribute to growth and productivity.

Assuming Rational Investments

The current KBC framework relies on the neoclassical assumption of firm rationality, that firms make all possible investments with a positive net present value. This assumption is necessary for KBC to be useful because KBC measurements are based in input/output accounting and do not show causation. Instead, accounting methods simply show what went in (types of firm investment) and what came out (productivity or output growth)—and leave the rest of the firm production process as a black box. Inside this black box, firms are assumed to make optimal decisions about what to produce and how to invest in order to produce it.

For firms that produce goods and services using undifferentiated labor and capital purchased on well-functioning markets, input/output accounting may be a relatively accurate portrayal of both firm decision making and the production process itself. In such cases a firm would keep hiring workings and buying widget machines until they reached zero marginal returns. However, this textbook example does not do justice to the real world, particularly with regard to intangible capital.

For both tangible and intangible capital, the idea that firms make "rational" investment decisions means that firms invest in all possible projects that have a rate of return that exceeds current interest rates. This supposed equivalence based on assumed rates of return is part of the logic behind the claim (often attributed to Michael Boskin, chair of the Council of Economic Advisors under the first Bush presidency) that it doesn't make any difference whether we invest in potato chips or computer chips. For this to be true, however, a number of unrealistic assumptions must also be true about the way that firms, capital markets, and capital itself operate. One of these assumptions is that firms have perfect information about the future and about the return for every possible type of investment: in reality, firm investment options may be highly uncertain or widely miscalculated, or firms may be simply unaware of other investment opportunities. It also assumes that firms make investments based entirely on cost considerations, when in fact

firms invest based on a number of other factors as well, such as "following the herd" and just making the safe investments that their peer competitors are making. Firms may also face financing constraints that render them unable to invest in ways that might qualify as rational.

By adhering to the neoclassical assumption that firms make rational investments in all different types of capital, including all different types of KBC and also tangible capital, the CHS methods gives equal weight to important and less important KBC components. This is most clearly a problem with regard to the linking of KBC to productivity, because the overly-broad nature of KBC fails to accurately explain the true dynamics of how firm-based productivity grows. Specifically, software, machines, and research and development have significantly greater impacts on firm productivity than other intangible investments like architectural design and advertising that do little or nothing to increase aggregate productivity. In this sense, many of the categories CHS include, such as the production of artistic originals or architecture and engineering designs, are more akin to purchasing inventories of consumable goods to sell: they may provide lasting value to the firm as they are sold, but they have little or no effect on productivity. While all knowledge capital is useful, some types of intangible investment do much more for aggregate productivity than others.

By adhering to the neoclassical assumption that firms make rational investments in all different types of capital… the CHS methods tend to obscure important parts of KBC and overemphasize less important ones.

In singling out intangible capital but treating all capital within these broad categories the same, the CHS framework also tends to neglect important types of tangible capital. There are many types of tangible capital that are still critically important to the economy and to economic growth—as important as the most beneficial intangible capital. However, just as different types of KBC have different economic effects, some investments in tangible capital similarly contribute more to productivity and economic growth than others. A firm's purchase of a new building counts as capital investment, but research shows that it does not increase economic productivity in the same way that upgrading industrial robots does, for example.[10] In effect, having KBC as a broad umbrella term risks sending policymakers a message that policies to support investment by firms in tangible capital that will encourage long-term productivity growth are no longer important, if for no other reason that their models show tangible capital declining as a share of overall capital spending. In short, because KBC is grounded in the neoclassical economic framework where "potato chips" are the same as "computer chips"—that is, all firm spending on capital has the same effect—it risks leading policy dangerously astray. For example, some policy makers have argued against incentives, such as accelerated depreciation, for investing in machinery on the basis that KBC is now the key driver of growth.

Instead of lumping all capital together or categorizing it based on whether it has mass and occupies space, it is more useful to directly examine the productivity impacts of more specific types of capital. This is not a new idea: ITIF has previously referred to ICT as "super capital" due to its outsized productivity benefits, as shown by scholarly research since the 1990s starting with the work of Brynjolfsson and Hitt.[11] A more recent example: a 2014 OECD report found that "ICT investment represents on average 12 percent of total investment, but its contribution to GDP growth during the 2000-12 period was comparable to that of non-ICT investment."[12] But ICT is not the only type of capital with

outsized productivity benefits. High-tech manufacturing machines and R&D are some other classes of investments that have large positive effects on productivity. Indeed, any capital investment that increases firm output per unit of input instead of simply increasing top-line revenue is at least "more super" than capital that only achieves the latter.

Instead of using simple tangible/intangible categories, it is important to distinguish between productivity-increasing capital like ICT, and capital that only increases top-line revenues, because without the right policy incentives firms are likely to underinvest in productivity-enhancing capital. This underinvestment can be seen in industry-level studies. For example, banking industry investment into ATMs, check depositing via smartphone, and other consumer self-service innovations can greatly increase productivity. Unfortunately, there is some evidence that only a modest share of the technology budget in many companies goes to investment in productivity-improving capital. During the mid-1990s, for example, only one fifth of total discretionary spending on technology went to improving productivity. The McKinsey Global Institute found such a similar pattern in hotels in the 1990s, where, despite increased investment in IT since 1995, there was been little increase in hotel productivity. A large part of the reason, according to McKinsey, was that "hotels were focused on improving their top line-revenue-and made IT investments primarily to achieve this goal." While this focus on revenue may make sense from the perspective of an individual company, from the perspective of the economy as a whole what matters most is increasing productivity. And while both kinds of capital may have led to increased firm profits, capital that boosted productivity did the most to boost overall economic welfare.

Aggregating from Micro to Macro

The second fundamental problem with the prevailing KBC framework is a problem of aggregation. KBC accounting is based at the firm level and measures the inputs and outputs of individual firms. This would be fine if it were used only to assess firm performance. However, KBC is frequently used as a macroeconomic indicator and linked to national productivity growth. This jump from micro to macro reflects the doctrinaire thinking in neoclassical economics that national output is simply the aggregate sum of firm output.[13] KBC aggregation methods ignore positive and negative externalities, and also ignore the possibility of zero-sum markets.

KBC indicators undervalue or ignore economic value that exists between firms or within regions or nations. An extensive literature on the value of clusters and up- and downstream linkages has shown that much of the intangible value that exists in an economy exists on the regional or even national level: for example, the externalities created by larger labor markets, knowledge spillovers, the reduction of transportation costs, and the mixing new ideas and different industries.[14] While this value may unintentionally be reflected in indicators like wages from R&D expenditures, most of these aggregate-level factors are invisible to firm-level accounting.

Aggregation can also be difficult in markets that differ substantially from textbook perfect markets—as do many types of intangible investment almost by definition. In particular, the non-rivalrous nature of many investments in the "Innovative Property" category makes

them difficult to aggregate in a meaningful way. The non-rivalrous nature of these investment goods means that an accounting approach is susceptible to significant double- or under-counting errors. Intellectual property only needs to be developed once, so if two firms invest in parallel research or development but one firm completes the research more quickly, the winner-take-all nature of IP protection means that the investments made by the second firm are worthless. For example, if two pharmaceutical firms invest in researching a new molecule, and one firm is able to patent it first, the all of the economic returns from that patent will go to the first firm. In contrast, the large spillovers from intangible investments without IP protection are likely underestimated because multiple firms may benefit from a single firm's investment.

Other types of intangible investments may even have negative externalities. Most prominently, investments in the financial sector that went into creating new types of financial products and debt contracts contributed to the worst financial crisis in western countries since the Great Depression. While some of these financial innovations presumably provided benefits to the broader economy, it is difficult to argue that they have contributed as much value to the aggregate economy as they have to private firms.

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Another area where aggregating firm-level spending does not work is in zero-sum markets, as can be seen in the case of advertising spending and firm brand value. The question of whether advertising provides net social value, instead of cancelling out in a zero-sum battle, has been debated for at least a century as described in Corrado and Hao.[15] In defense of their assumption that all capital is equal, Corrado and Hao provide four arguments for why advertising does provide a net societal good and should thus count as capital investment. While such spending can in certain industries provide some benefits to economies, simply aggregating all advertising and marketing outlays as investment requires assumptions about advertising markets that do not seem warranted.

It is imperative when thinking about the effects of advertising to distinguish carefully between the level of individual firms, the macroeconomic level, and the international level. Corrado and Hao define three different views of advertising: the *zero-sum view*, where ads just change market share within industries, changing firm shares on the micro level but with no effect on a sector or macro level; the *persuasive view*, where ads work primarily through their strong effects on consumer preferences and demand, influencing both the micro and macro levels; and the *informative view*, where ads increase total (micro and macro level) firm revenue by facilitating market transactions. On a macro level advertising and brands can facilitate market transactions by reducing information costs and facilitating trust. This is can be "productive capital," particularly in markets where consumers might not be aware of new products or in nations where inadequate government oversight makes trust in markets scarce. In the informative view, further improved information increases competition and thus decreases consumer prices. But lower consumer prices are an economic transfer, not a macro-economic goal in itself.

Corrado and Hao are advocates of the informative view of advertising, but their arguments against the zero-sum and persuasive view are not convincing. Their first point is that any framework that views advertising or brand value as a depreciating investment inherently

accepts that advertising has a future value. But this only implies that demand is stimulated for an individual firm, not for an entire economy. Regardless of how much firms advertise the only way that firms can raise aggregate output is to convince people to dissave or trade leisure for additional work, unless information costs are so high that lowering them can significantly raise aggregate productivity. In addition, Corrado and Hao do not account for the production costs of advertising itself; that comes at a cost of forgone production and consumption. After all, consumers pay the cost of advertising in higher prices.

Their second argument is that since corporate valuations tend to exceed tangible capital stocks, this implies that the corporate brands themselves have net social value. This argument, somewhat oddly given the context, fails to take other types of intangible capital into account that may be increasing firm valuations. It may also overstate the accuracy of market valuations, implying that investors can accurately measure competition among brands and discount among them. The argument would also imply that aggregate brand value has fluctuated strongly over different periods in time.

Corrado and Hao lean heavily on recent work by Rauch to make their final two arguments.[16] Rauch finds that decreasing ad prices increase ad spending and that increased ad spending results in decreased consumer prices in many industries, while in several other industries it increases prices. He argues that for advertising spending to cause prices to fall, it must increase competition between firms. In his model, firms are not able to charge as much for their products because their competitors have an easier time informing customers about their lower pricing.

The problem with using this logic to argue that advertising has a net benefit for society, however, is that increased competition may only affect prices and not have any effect on productivity. Competition only leads to higher productivity when it increases output or decreases input (leaving the other fixed); instead of changing productivity, competition may simply be reducing profits for business owners. More competition may simply be trading producer welfare for consumer welfare—which may be useful, but it is not economic growth. Competition is a means, not an end, and even if advertising increases competition we cannot assume this is also creating growth. In order for that to be true, we must make additional assumptions. Corrado and Hao, for example, argue that when producers are able to better inform customers they may be able to reach more advantageous economies of scale. While this may be true in some instances, there is no evidence it is the case or that firms would not achieve such scale economies in the complete absence of advertising. Moreover, the firms examined in the Rauch paper were restricted to firms that advertised in one province only—meaning that they were only a small subset of total commerce, and perhaps the subset that is most likely to be constrained in terms of their ability to spend on advertising.

To be clear, we do believe there is an important role for advertising and that it does facilitate markets in important ways, both on the micro and macro levels. The primary issue we take with the CHS framework is the idea that the contribution of advertising towards productivity growth is a straightforward function of advertising expenditures.

The Internet provides an example of the danger of doing so. With the advent of the Internet and the invention of Craigslist, classified ads for housing basically became free. This is despite the fact that the value of the service to the economy was demonstrably the same or better than the previous alternatives. Likewise, the costs of advertising in real terms during the Super Bowl increased by nearly a factor of 6 from 1982 to 2002, despite the fact that viewership was roughly the same over the period.[17] The magnitude of aggregate advertising spending seems unrelated to any kind of productivity increase.

Other Issues

In addition to the two fundamental problems with the KBC methods, there are a number of smaller tweaks that could make the final estimates more accurate. Organizational capital and human capital are both very difficult to quantify, and current methods lead to a number of inaccuracies in their tallies. In addition, it could also be useful to recognize the contribution from "prosumer" investment in ICT goods, which often provide a critical complement to firm investment.

Attempts thus far to measure the value of organizational capital, using 20 percent of management wages and 80 percent of consulting fees as a proxy for this investment, have not recognized the significant imperfections in the market for executive leadership. These markets operate based on far from perfect information and often feature distorted incentives and problematic power relationships between shareholders, executives, and employees. These issues have been explored in large body of literature, most of which is critical of existing policies.[18] While some conservative neoclassical economists still maintain that executive compensation is simply evidence of high productivity and extremely valuable skills, the general consensus among economists is that the high pay observed in C-suites is more reflective of shifting bargaining power and market failures than an objective measure of value provided to the firm.

These non-market forces that determine executive pay are of particular concern when comparing management expenditures across countries, which vary widely. Because management salaries are deeply rooted in culture and political economy, cross-country comparisons reflect those differences as well as any actual differences in management quality. In other words, including management salaries makes U.S. intangible capital investments appear much higher than other countries simply because of much higher managerial compensation in the United States. The OECD has also recognized difficulties with this metric and has been working to improve it.[19]

The issue of valuing human capital is also inherently challenging. Partly due to data constraints and partly due to the focus on private business spending, current KBC estimates leave out critical areas where human capital value is created. Take for example the original CHS estimates for training expenditure in the United States. The estimates are based on mid-1990s surveys of spending by businesses on in-house and outside training of their employees, adjusted by changes in overall business spending since then. A minor problem here is that training expenditures have been relatively flat since then while overall business expenditures have risen. New work by O'Mahoney has made much more precise

estimates for the EU available, and better data will eventually be forthcoming for the United States.[20]

The much larger issue, however, is that these human capital estimates ignore both unpaid on-the-job learning and state- and employee-sponsored training. State- and employee-sponsored training exist to a large extent due to major market failures in incentives for business investment in employee skill advancement, so using employer-sponsored training as a proxy for overall employee skills seems unlikely to give an accurate picture. On-the-job learning, on the other hand, not only lacks distinct market valuation, it also eludes most attempts at quantification. Tracking simple output rates would suffice for a limited number of jobs, but the value of quality is hard to measure, and the interdependent nature of much employment means that much value cannot be understood on an individual basis.

Finally, focusing as it does on firm expenditures, the existing framework for KBC ignores value from "prosumer" capital, such as computers and smartphones, that can have significant impacts on economy-wide productivity. While we do not typically think of consumers (as opposed to workers) as being productive, the nature of many new technologies is such that when consumers use ICT products and are digitally connected and literate, they can not only save time for themselves but also save significant time and costs for producers. Online ordering is perhaps the most obvious example, but there are many other examples of consumer goods that boost economy-wide productivity: smart thermostats can reduce fossil fuel use, 3D printers in homes will eliminate shipping and even production costs, and crowd-sourced reviews can provide enormous value to both producers and consumers, eliminating waste and increasing quality. Any future capital investment accounting system will need to incorporate "prosumer" investments if it is accurately assess the role of capital in driving growth.

SUGGESTED AVENUES OF IMPROVEMENT

With the backing of the OECD and national statistical agencies, the concept of KBC and methods used to measure intangibles stand to refocus our understanding of investment in significant ways. However, the two fundamental problems with KBC discussed above may significantly detract from that understanding, or even mislead us. In order to incorporate intangibles into national accounts in a more useful and accurate manner, the following changes should be made to the framework. First, the framework should focus attention on the types of capital that do the most to drive productivity instead of making an artificial tangible/intangible distinction. Second, more careful attention must be paid to the problems inherent in aggregating firm-level expenditures into national accounts, as intangibles present a particularly tricky problem due to the peculiarities of their market structures. Finally, additional adjustments to methodology should be made, including: finding more accurate ways of valuing human capital, reconciling important differences in international economic systems that can lead to distorted and misleading international comparisons, and including the value of "prosumer" capital.

Our first suggestion, refocusing policymakers on productive capital instead of KBC, is essentially remedying an unintended side effect. Emphasizing KBC sends a misleading message to policymakers: that intangible capital is inherently good and tangible capital is in

the "buggy whip" category. The right message, instead, is that investments must be understood first and foremost by the contribution they make to productivity. This is true regardless of their tangibility. Many tangible investments—such as advanced manufacturing tools or high-tech research facilities—are essential to productivity growth, while many intangible investments—designing a new building —are not. Including intangible investments in our national accounting is an important step forward, but creating an artificial tangible/intangible distinction distracts from the importance of productivity.

What economies need is the right amount of the right types of investment, and that can only be understood at a level more granular than a simple tangible/intangible dichotomy. To that end, we have attempted a rough categorization of the current KBC subcategories according to their contribution to productivity. (Table 1)

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Low	Medium	High
Artistic originals	Organizational capital	Software
New architecture designs	New engineering designs	Databases
Brand equity	Training[21]	Training
New product development in financial services		Mineral exploration
Social sciences and humanities R&D		Science and engineering R&D
Buildings		Machines

Table 1: Suggested categorization of types of intangible capital according to productivity

The distinction between consumer goods and services and intermediate goods and services may present a more useful dichotomy for understanding productivity and investment. Investments relating primarily to the supply of consumer goods, such as creating artistic originals, are unlikely to directly increase productivity unless productivity is simply a matter of achieving larger economies of scale. Investments in intermediate goods and services, like software, R&D, or training are more likely to lead to increased productivity. Therefore, an indicator focused on intermediate goods, or other tangible and intangible investments with a stronger theoretical link to higher productivity, could prove more useful.

Second, intangible accountants need to make a more careful distinction between positive- and zero-sum investments at the national and international level, and develop more robust estimates of the actual net value created. The value of advertising spending is particularly difficult to pin down objectively. As firms compete for a fixed supply of attention using theoretically costless information, the link between individual and aggregate benefit is elusive.

As noted above, when considering whether a given investment is zero sum it is necessary to understand the differences between firm, national, and international levels. As a macroeconomic concept, KBC may be somewhat better linked to international competitiveness than to productivity. Competitiveness is related to productivity, but is primarily related to productivity and innovation in traded sector industries."[22] Certain

types of KBC, such as brand value and artistic originals, may have a large impact on competitiveness simply because they allow companies to enter new markets outside of their zero-sum national markets; also these industries are subject to substantial economies of scale. For example, the brand value of many multinational firms enables them to gain market share in nations outside their home nation.

Finally, more work is needed developing sound accounting methods for a number of other categories, particularly methods that may be subject to significant international differences in valuation. The markets for intangibles, from patents to management, are highly imperfect and it measuring them in a way that is meaningful across time and space is not easy. While some efforts have been made to improve these measures, particularly the Organizational Capital category, others categories also require refinement and robustness checks.

Another area where accounting methods could be improved is in the databases category. Only a small portion of collected data is measured in the existing accounting framework, and therefore all but a small portion of data's benefits to businesses go unaccounted for. Data has a wide range of uses, including helping businesses make better decisions that can eliminate risk and waste, increase innovation, and help open new markets.[23] Data can also help automate processes, directly boosting productivity. However, many new uses of data are difficult to track and value, and many uses for data are still unknown or not yet understood. The OECD has begun grappling with these issues but there is much work to be done by statistical agencies working together with private industry.

CONCLUSION

Knowledge-based capital is not a new factor in the economy—new ideas like patents, institutional concerns like management quality, and new ways of organizing information like software have long been important sources of value. Rather, understanding different types of KBC as an investment has become increasingly important as new technologies have reshaped the economics of information. Recent attempt to measure KBC are step in the right direction, but they also risk distracting policymakers from a simpler but more coherent view of capital focused on its impact on productivity. Adding many new types of intangible investment as economic inputs and then assuming that they all have an equal role within the "black box" of the firm almost guarantees that the types of investment that are most worthwhile will be deemphasized. Furthermore, it is necessary to rethink the way that firm-level expenditures aggregate to the macroeconomic level, as there is good reason to believe that simple addition give a misleading picture of the true national value. Keeping track of our evolving economy is a difficult but necessary task; if we are to succeed, we must ensure that our models adequately reflect reality.

ENDNOTES

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