How did Microsoft Become “Microsoft”?

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ABSTRACT

The story Microsoft told in the paper is a story of a company that has successfully used knowledge inputs to produce knowledge outputs. It is a story of innovation driven by systematic investments in knowledge capital, and, it is a tale that could be told for other successful technology companies, indeed, for the information revolution as a whole. This “Third Industrial Revolution” has been the cutting edge of economic growth in the U.S. over the last three decades and will be continue to be so for the foreseeable future. The case of Microsoft illustrates the critical importance of investment in knowledge-based intangible capital in sustaining this growth.

Several broad implications can be drawn from this study. First, successful innovation involves more than good ideas or insights. Second, investment in R&D is not, by itself, sufficient. A wider range of investments is needed to commercialize the results of the research process, including investments in marketing and customer support and in organizational capabilities and human capital. Third, the cumulative investment in this knowledge-based capital is not recorded as an asset on company financial statements, even though, in the case of Microsoft, it represents half of the company’s total assets and, since 1995, explains more than half of its product growth. Any attempt to understand the factors driving company growth and value or, more broadly, the anatomy of the information revolution, should therefore start by examining investments in the accumulation of knowledge.

How did Microsoft Become “Microsoft”?

The Microsoft Corporation was one of the fundamental contributors to the IT revolution and one of the principal winners. Microsoft began its life as a publicly-traded company in 1986 and has grown to dominate the market for computer operating systems and office application suites. Revenues grew from $198 million in 1986 to $44,282 million in 2006, and the stock price increased from its offering value of $21 per share (about $0.08 when adjusted for stock splits) to a peak of around $50 in late 1999 (again, split adjusted), and is now around $30. In the process, the company emerged as “Microsoft”, one of the very top global brand names.

This remarkable growth parallels the similarly phenomenal growth of information technology itself. Business investment expenditures for software grew from $26 billion in 1986 to $227 billion in 2007, while computer investment grew from $34 to $94 billion over the same period. Microsoft was at the center of this these developments, riding the wave of demand for software created by the structural shift toward IT. However, there is more to the Microsoft story than the surge in demand for software. Microsoft invested heavily in supply-side drivers of growth like product research and development, sales and marketing, and organizational development. By 2006, the cumulative investment in these intangible assets amounted to $66 billion.

The story of this $66 billion is told in this study, and it is a story that needs to be told because conventional accounting practice ignores this kind of capital. Current financial accounting does not recognize expenditures on product development and marketing as investments in the company’s future, and Microsoft’s conventional balance sheet for 2006 records only $70 billion in assets and puts shareholder equity at $40 billion. When the missing intangible capital is added to these figures, the company's assets are seen to be $136 billion, and shareholder equity increases to $104 billion. This new estimate of shareholder equity is a lot closer to the company's market capitalization, some 45 percent of the total compared to only 17 percent without the extra $66 billion. The rate of return to equity investors is also affected, falling from the conventional rate of 31.4 percent to an intangibles-corrected 15.7 percent.

The "missing" intangible capital is an important driver of the rapid growth of Microsoft's products. The company grew at a phenomenal average annual rate of 30 percent over the period 1988 to 2006, propelled by high rates of productivity growth and capital formation. As we will see below, investments in intangible capital were the main force behind these numbers. The overall conclusion of this study is that Microsoft became "Microsoft" through the successful use of knowledge inputs to produce knowledge outputs.

II. Macroeconomic Growth and the IT Revolution

The ability of any economy or company to grow depends in part on how successful it is in growing the inputs of capital and labor needed to produce the product, and on its ability to increase the productivity of those inputs. Economists have studied this process using a variety of techniques, but the one that has gained the greatest traction is the sources-of-growth model used by the Bureau of Labor Statistics (BLS) in its productivity program. The basic idea is to assume that there is a stable link between input and output (the "production function") and to use this link to divide the growth rate of output between (1) the growth rates of a list of inputs (capital and labor in the macro economy), each weighted by its relative contribution to output, and (2) an unexplained residual which is interpreted as the change in the joint productivity with which the inputs are used (total factor productivity (TFP)).

Table 1 shows the "BLS" estimates of the contributions to growth made by the various non-intangible inputs and TFP for the non-farm business economy of the U.S. over the years 1995 to 2003.[1] These estimates, on the left-hand side of the table, highlight the role played by information technology (ITC) equipment, which was responsible for 25 percent of sectoral growth, and changes in labor composition toward more educated workers accounted for another 14 percent. Traditional "bricks-and-mortar" capital, that is, plant and equipment, played only a minor role. The largest individual contributor to growth was TFP (51 percent). TFP is measured as a residual in this framework, so it sweeps together many factors not directly related to technology, like variations in capacity utilization, but it also captures the diffusion and capture of technical knowledge and organizational know-how developed elsewhere.

There is, however, something missing from this picture. Where are the expenditures for R&D, for product design and marketing, for human resource and management programs? In the cover story of BusinessWeek in February 2006, Michael Mandel observed:

[1] The BLS does not include intangible capital in its own productivity estimates. The numbers in this table are obtained from the paper by Corrado, Hulten, and Sichel (2009), with uses the core BLS data as the basis for adding intangibles ti its framework. That framework is modified slightly in the process (hence the quotation marks around BLS). The BLS data shown in the left-hand side of Table 1 exclude investments in software in order to sharpen the comparison with growth estimates that include intangibles. Following the BLS convention, the growth of output and capital is shown in per worker terms.

"Grab your iPod, flip it over, and read the script at the bottom. It says: 'Designed by Apple in California. Assembled in China.' Where the gizmo is made is immaterial to its popularity. It is great design, technical innovation, and savvy marketing that have helped Apple Computer sell more than 40 million iPods. Yet the [U.S. national accounts doesn't] count what Apple spends on R&D and brand development, which totaled at least $800 million in 2005."

The same observation applies to Microsoft keyboards ("Designed in Redmond, WA USA … Made in China"). The "great design" and "savvy marketing" are not in the BLS productivity numbers, nor, until recently, are they in the GDP estimates.[2] They are, however, as much a part of the knowledge revolution as computers and software, because it is not enough to grow a modern economy by making more of the same old things. The development and marketing of new "things" is of central importance.

This omission has been addressed in recent years by a growing body of research. A 2009 study by Corrado, Hulten, and Sichel ("CHS") found that U.S. businesses invested as much in intangible capital as they did in their plant and equipment (including ITC). CHS put the amount of missing intangible investment at more than $1 trillion in the early 2000s, and the corresponding amount of intangible capital at $3.4 trillion. The impact of these intangibles on the BLS sources of growth estimates is shown in the right-hand panel of Table 1. The addition of this category of capital raises the growth rate of output per hour worked slightly, but the main effect is one the input side. The inclusion of intangible capital reduces the impact of the other sources of growth and is of equal in importance to tangible fixed capital. When ITC capital and the labor composition effects are combined with intangibles, these

[2] Mandel's comment refers specifically to the U.S. national accounts produced by the Bureau of Economic Analysis (BEA), but applies with equal force to financial accounting practice. BEA has recently moved to capitalize R&D, but financial accounts still omit most of the intangible capital produced within a company.

categories of knowledge-oriented capital explain almost 60 percent of the growth in output per hour.

III. What exactly are these intangibles assets?

The intangibles in studies in this paper include R&D, both scientific and non-scientific, software, worker-training, brand equity, and organizational development. They do not affect the current volume of output produced, and differ, in this regard, from tangible plant and equipment. Instead, they typically involve the development of specific products or processes, or are investments in organizational capabilities, creating or strengthening product platforms that position a firm to compete in certain markets. Intangibles frequently involve the development and use of knowledge and ideas and are therefore "non-rival," in the sense they can often be used by more than one firm (the source of appropriability problems) or have multiple uses over time by the same firm (one source of cost allocation problems). They are predominantly developed within the firm on "own account" that is the primary user, and they form the intellectual-property of the firm.

Finally, they are called "intangibles" because that is, in fact, what they are. They lack a physical embodiment like other inputs, and are therefore not directly visible like buildings and equipment. The latter can be enumerated and their age and condition assessed, but in what units do you measure knowledge or expertise, and how do you know when intangibles are no longer in use? This lack of visibility is one of the reasons that they are excluded from financial accounts, and it is the source of skepticism about their status as capital.[3]

IV. Microsoft's Intangible Capital

The macroeconomic estimates suggest an important role for own-account intangibles in the business sector as a whole, both as a driver of economic growth and as a source of national wealth. It is therefore not surprising that they also appear as an important source of value and growth for a technology company like Microsoft. Indeed, data from the company's annual reports suggest that most of Microsoft's employees are engaged in non-production activities. In 2006, only 3 percent of Microsoft's 71,000 employees were listed under the category manufacturing and distribution (M&D), while the rest were in the following categories: 28 percent in product research and development (PR&D), 30 percent in sales and marketing (S&M), 17 percent in product support and consulting (PS&C), and 10 percent in "general and administration" (G&A). In other words, 97 percent of the work force apparently was not engaged in direct production/distribution activities, with the presumption that many were engaged in activities intended to stimulate future revenues and profits through the production of intangible capital.

This presumption is strengthened by the cost data reported on Microsoft's 2006 income statement, shown in Table 2. The first line in left-hand data column reports the

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[3] It is fairly clear that R&D is more oriented to future products and processes than to current ones, but there is less of a consensus that sales and marketing, as well as organizational competency, should be treated as capital. After all, much advertising is transitory (the Sunday adds, etc.). However, marketing is much more than advertising. According to Microsoft's 2006 Form 10k report, advertising expenses were only 12.5 percent of total sales and marketing expenses. Moreover, marketing is part of the product innovation process in many companies. A product may be technologically feasible, indeed, brilliantly novel, but it has no commercial value unless people know about it and want to buy it.

company's revenues without adjustment for own-account intangibles, and the next four lines show the direct and indirect operating expenses. The cost of revenue (direct production cost) accounted for 29 percent of the total operating expenses. This is a greater fraction than the employment numbers above, but the indirect (intangible) cost categories still dominate: 37 percent for sales and marketing, 25 percent for product research and development, and the rest for general administration. The bottom line, net income of $12.6 billion, is 28 percent of total revenue.

Large as it is, this $12.6 billion understates the true amount of shareholder value created in 2006. As previously noted, some part of the reported intangible expenses (that is, the PR&D, S&M, and G&A outlays) was designed to increase future net income, not current income. These investments built shareholder value (see below), but this value is not counted in conventional accounts reported in the first column of data. To get at the amount of this value, some fraction of the outlays for intangibles must be capitalized and added to the top line.

Following the general guidance of the CHS macro research, adjusted to reflect the high-technology nature of the company, the fractions selected were 100 percent (PR&D), 70 percent (S&M), and 20 percent (G&A). This procedure yielded an estimate of $14.3 billion in current outlays for intangible investment. This figure does not, however, include the cost of capital used in product development and marketing, so a profit component must be added to arrive at the full value of the investment. In this study, an imputed mark-up of $8.1 billion is therefore added to cost, based on a pro-rata share of Microsoft's overall income.[4] This gives a total investment in intangible capital

[4] The following thought experiment helps motivate this adjustment. Suppose that rather than producing PR&D within the company, Microsoft were to outsource this function to another company. That company

of $22.4 billion. This is the value of internally produced own-account capital produced in 2006. To get at the total value of production, this amount must be added the conventional measure of revenue of $44.3 billion to arrive at the true extent of Microsoft's 2006 operations. Similar adjustments are made to S&M and G&A and after all are made, the value of product shown in Table 2 increases from $44.3 billion to $66.7 billion.[5]

The company's net income is obtained by subtracting total operating expenses, depreciation, and taxes from the top-line value of total product. These items are shown in the rows of Table 2. Deprecation is one of the items most affected by the inclusion of intangibles: it amounts to $1.2 billion without intangibles, and this increases to $19.9 billion when intangibles are counted (reflecting the disproportionate sizes of the tangible and intangible capital stocks).[6] The $22.4 billion in intangible investment that was added to the top line of the modified income statement in Table 2 is partly offset by the additional $18.7 billion in depreciation charges, and, as a result, net income only increases by $4 billion, from $12.6 billion to $16.6 billion. This $4 billion is the value to

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spends $14 billion to produce the research that it then sells to Microsoft. The price charged to Microsoft would exceed the $14 billion by the mark-up for profit that the research firm includes in its price.

[5] The $26.7 billion in total operating expenses reported in Table 2 has been adjusted by subtracting the depreciation tangible capital, so that it can be counted explicitly as a separate item devoted to depreciation alone. This is done in order to accommodate the depreciation of intangible capital in the second data column.

[6] The rates of depreciation used in this study are 25 percent for R&D capital, 33 percent for S&M, and 25 percent for G&A. The corresponding dollar amounts in Table 3 are $9 billion for R&D, $9 billion for S&M, and $1 billion for G&A. The depreciation of tangible capital is shown as $1.2 billion, though this was revalued to reflect the Hulten-Wykoff depreciation rates for the productivity part of this research.

the shareholders of creating more intangible capital within the company than is lost to depreciation.[7]

Once the investments in intangible capital have been estimated, they are added to the stocks of existing intangibles stocks built up from past investments, with a subtraction made for depreciation. The resulting net stocks of PR&D, S&M, and G&A capital built up this way are shown in Table 3. The value of these stocks in 2006 was $66 billion, and the inclusion of these additional assets raises total assets to $136 billion and shareholder equity to $106 billion. These increases represent a near doubling of total assets and an increase in total equity of more than 250 percent. It is also interesting to note that the plant and equipment recorded on the balance sheet (at historical cost) is a puny $3 billion.

V. The Sources of Company Value

The addition of intangible capital to Microsoft's balance sheets suggests that Microsoft's shareholders actually own a lot more capital than the books show -- $66 billion more according to the estimates of Table 3. This is perhaps one factor explaining why the value of the company's shares, $238 billion in 2006, was much higher than the conventionally reported equity of $40 billion. The additional $66 billion in new intangibles narrows the market-to-book value gap significantly, from 17 percent to 45 percent. A study of 613 U.S. R&D-oriented companies by Hulten and Hao (2008) found a narrowing of the gap from 42 percent to 86 percent in 2006.

The return to equity is also affected by extra intangible capital. The

[7] When a company's research budget is neither growing nor shrinking, the amount added to the top line as investment in R&D just equals the amount of depreciation on the R&D stock, leaving a zero balance. The increase in net income in Table 2 reflects the growth in Microsoft's intangible investment.

conventionally measured return on equity -- net income as a fraction of measured equity -- is 31.4 percent, but this falls to 15.7 percent under the new view when all the company's capital is counted. By way of comparison with the 15.7 percent, a 2007 research paper by Hulten and Hao found that the average return to equity in 2006 was 12.2 percent for their 613 company sample.[8]

VI. The Sources of Microsoft's Growth

The sources-of-growth analysis shown in Table 1 for the U.S. non-farm business sector can be adapted to the case of Microsoft, with some minor changes. The financial data shown in Tables 2 and 3 for 2006 provide the starting point for this, since similar tables can be constructed for the years 1986 to 2005, using publicly available financial reports. These tables can then be aligned to form the time series required for the analysis.[9] The resulting time series are denominated either in the contemporary prices of each year, or, in the case of balance assets, in historical prices.[10] These must be

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[8] These Hulten-Hao results are not exactly comparable to those for Microsoft in this paper because different assumptions about deprecation were used, as well as a different procedure for estimating the amount of S&M and G&A capital (Microsoft's financial reports provide unusually rich data on these intangibles and this permits more precise estimation procedures). In unpublished work with Janet Hao and Kirsten Jaeger, using comparable assumptions, Microsoft's 2006 return on equity was found to be 14.5 percent, compared to 19.7 percent for Apple Computer, 12.3 percent for Cisco, 10.0 percent for Hewlett-Packard, 7.4 percent for Intel, 10.2 percent for IBM, and 15.8 percent for Oracle.

[9] The alignment process is subject to some well-known caveats. The purpose of annual financial reports is to report the company's financial results and general condition for a given year. Changes in accounting rules and mergers and acquisitions can introduce inconsistencies with previous financial reports. The change in the treatment of employee stock options is a case in point. In this research, data have been adjusted to reflect these options to the extent possible, but the results have to be seen in light of these intertemporal consistency issues. The year 1988 is used as the starting point for the growth part of the analysis rather than 1986, in order to reduce the potential bias resulting from errors in the imputed values of the initial 1986 capital stocks.

[10] Balance sheet tangibles are carried at their cost at the time of acquisition (historical cost), with possibly some subsequent revaluation. In this research, the $3 billion in plant and equipment carried on Microsoft's books for 2006 is revalued to current prices (and depreciation is adjusted to reflect economic

revalued in the prices of a common year in order to control for price inflation over time. Financial reports do not, however, provide the required price deflators, and they must therefore be approximated with deflators not specific to Microsoft.[11] The exception is the price index for Microsoft software, which is used as the price of directly produced output, which is based on 2007 research by Abel, Berndt, and White on the price of Microsoft product, supplemented by the BEA prepackaged software deflator in those years not covered that study.

Inflation-corrected total output, including intangible investments, was $457 million in 1988, total output grew at an average annual rate of 30 percent over the period to $75.4 billion (in 2000 dollars). What supply-side factors explain this extraordinary growth? The sources-of-growth estimates that underlie these figures are shown in the Table 4. Unlike the estimates in Table 1, where the growth rate of business-sector real value added *per hour* is reported, Table 4 show the allocation of total gross output (not per hour) among the growth rates of the various inputs (now including intermediate inputs like materials), each weighted by its share in the value of output. What is left over is assigned to total factor productivity.[12] Over the *whole* period of the analysis, the growth in intangible capital accounted for 44 percent of output, while the rest of the

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rather than accounting depreciation), giving a restated value of $6 billion. The imputed value of the own-account intangibles is continuously revalued to current prices.

[11] For the three types of intangible capital, the following deflators were used: a BEA R&D Price Deflator (R&D), the BEA Advertising Output Price Index (S&M), and the BLS wage index for executive, administrative, and managerial employees (G&A). BLS investment price deflators were used for the various categories of tangible assets on the balance sheet, and the BLS intermediate input price deflator was used for that input. The wage rate was calculated implicitly from the annual employment at Microsoft in relation to an imputation based on labor-share data from the BLS.

[12] The income share of each input represents the impact multiplier that the input has on output growth (the “output elasticity”). The unweighted stock of intangible capital grew at an average annual rate of 27.4 percent for the period 1988 to 2006, and its average share-weight was 51.0 percent. The impact of intangible capital over the period was the product of the two, or 13.3 percent.

inputs explained another 35 percent, leaving 21 percent "explained" by the TFP residual. Intangibles were the most important drivers of growth in each of the three subperiods shown in Table 4, and the relative importance of intangibles has increased over time, even as their absolute growth rate has declined.[13]

One way to highlight the importance of Microsoft's intangibles as a driver of growth is to carry out the analysis without them. The result is shown in the figure below, for the periods 1995-2006 and 2001-2006. It is apparent in Table 5 that ignoring intangibles not reduce the overall growth of product (the height of the vertical bars in the figure), since conventional output grew at a slightly higher – i.e., at the 32.9 versus 30 percent average annual rate with intangibles.[14] Instead, the main effect of ignoring intangibles is to reassign their effects to the remaining factors.

The bottom line of all these numbers is that any attempt to quantity Microsoft's emergence as a key player in the ITC revolution must recognize the central replayed by its investments in firm-specific intangible capital input. Paradoxically, because of financial accounting conventions, this part of the company's capital is absent from its balance sheets and only latent in its income statements.

VII. Product versus Process Innovation Components of the TFP Residual

The role intangible capital in the evolution of Microsoft involves more than its contribution as an input. Successful product innovation is an essential part of the

[13] The relative contributions of R&D and S&M are roughly of equal importance for the period as a whole, but their importance has shifted somewhat over time toward R&D. The contribution of IT capital is surprisingly small in all sub periods.

[14] Output without intangible s (that is, the direct revenue part of output) started at $210 million in 1988, and grew at a slightly higher annual rate of 32.9 percent to $56.4 billion. Thought output ex intangibles grew at a more rapid rate, by 2006 the *level* of output inclusive of intangibles was 34 percent higher than conventionally measured output because of the higher value in 1988..

“Microsoft” story, and this kind of innovation involves intangible improvements in the characteristics of the company’s products. In the case of Microsoft, product innovation is reflected in the transition from DOS to Windows to XP to Windows 7, and in the evolution of different generations of Word and Excel. Each new product generation is superior from the average user’s standpoint because its represents more capability per dollar spent. Measuring company output by how many software CD’s or licenses are purchased in any year greatly understates the true amount of product delivered to users, and leaves little scope for assessing the impact of the large expenditures made by the company on product research and development, marketing, and customer support.

Fortunately, economists have devised ways of measuring the extent of these quality differences by comparing the prices of successive product generations, based on the idea that the better the new software, the more a user should be willing to pay to get a hold of the superior characteristics. This price premium provides a quantitative metric of product quality and thus of product innovation.

How much quality change does this metric imply for Microsoft’s software? The BEA prepackaged software price deflator *declined* at an average rate of 7.3 percent per year over the period 1988-2006, while overall the price level, as measured by the consumer price index, rose at an annual average rate of three percent. The decline in software prices presumably reflects the large increases in power and functionality in successive software packages, but just how much of this decrease reflects changes in quality depends on the associated changes in uncorrected software prices measured in transaction units. The latter is not generally available, but the case of Microsoft is a nearly unique exception because of the previously noted study by Abel, Berndt, and White, which examines the price history of Microsoft software with and without an adjustment for quality change. They find that the unadjusted prices are roughly consistent with a flat price pattern over the sample period. The difference in the two series, applied to the longer BEA software price series with this the Abel et. al. is consistent, gives an implicit estimate of quality change at an average annual rate of 7.3%.[15] In other words, the rapid growth in Microsoft's real output is due to the intangible component of that output.

Where does this rate of quality change show up in the sources of growth estimates reported in Table 4? It is actually hiding in full view as an implicit component the TFP residual. Remember that the TFP estimates shown in this figure are already embody the BEA software price deflators, and thus incorporate quality change. To get at the quality component suppressed into the TFP residual, it is necessary to calculate a version of the TFP residual based on non-quality-adjusted transaction prices. When this is done, the product-quality component of TFP growth is found to average 4.8 percent over the period 1988 to 2006, with the component accounting for the rest of original 6.2 percent growth in TFP. Thus, more than three-quarters of Microsoft's TFP growth is the result of the quality change component of its software, which, in turn, was induced by large investments in product innovation.

[15] Since software output is only around two-thirds of total product (intangible investment accounts for the rest), the price of "total output" falls at the lesser rate of -4.4 percent. The counterfactual price estimate, on the other hand, actually rises by 0.4 percent per year, not zero percent, because of net price increases in the intangible third of total output.

VIII. Micro-Macro Comparison

The Microsoft experience is not typical of the business sector as a whole. Just how big the difference is can be seen in Table 6, where the sources of growth are compared.[16] A look at this figure shows that Microsoft's output grew at a much higher average annual rate than in the nonfarm business sector as a whole over the period 1995-2003, 10 percent compared to around 3 percent. Intangibles per worker (excluding software) were a much more important source of growth at Microsoft, adding 6.3 percentage points (almost two-third of total growth), but only 0.57 percentage points for the business sector (around 20 percent). On the other hand, Microsoft's "TFP" was *relatively* less important as a driver of growth, even though its TFP growth rate was actually larger in absolute terms.[17] Only tangible capital per worker (including software) was stronger in the business sector, accounting for 1.12 of growth versus Microsoft's 0.2 percent. In other words, Microsoft's growth and innovation statistics have far exceeded the average for the business sector and were more strongly oriented to intangibles.

Unfortunately, there is no counterpart to the product-quality decomposition estimate for TFP in the business sector as a whole. The output price deflators used for

[16] Table 6 is derived from Tables 1 and 4. While those tables are constructed along generally similar lines, two further steps are needed to put the estimates on a common basis. First, Microsoft's output must be put on the same output basis (i.e., "real value-added") as the business sector as a whole, and then converted to an output-per-worker basis by dividing output and capital stock by the labor variable.

[17] There is no explicit labor-composition term for Microsoft, and its effects are therefore suppressed into the TFP residual. Data constraints also cause software to be combined with computing equipment in tangible capital. The quotation marks around Microsoft's "TFP" are put there as a signal that this is not a true productivity measure, but one in which the true TFP residual (which is smaller) has been inflated by the share of intermediate inputs.

this sector embody a certain amount of quality change from the way they are constructed, but the extent of these quality adjustments is unknown.

IX. Conclusion

The story Microsoft told in the paper is a story of a company that has successfully used knowledge inputs to produce knowledge outputs. It is a story of innovation driven by systematic investments in knowledge capital, and, it is a tale that could be told for other successful technology companies, indeed, for the information revolution as a whole. This “Third Industrial Revolution” has been the cutting edge of economic growth in the U.S. over the last three decades and will be continue to be so for the foreseeable future. The case of Microsoft illustrates the critical importance of investment in knowledge-based intangible capital in sustaining this growth.

Several broad implications can be drawn from this study. First, successful innovation involves more than good ideas or insights, it also involves good organizations that are able to execute and translate ideas into products. Second, investment in R&D is not, by itself, sufficient. A wider range of investments is needed to commercialize the results of the research process, including investments in marketing and customer support and in organizational capabilities and human capital. Third, the cumulative investment in this knowledge-based capital is not recorded as an asset on company financial statements, even though, in the case of Microsoft, it represents half of the company’s total assets and, since 1995, explains more than half of its product growth. Any attempt to understand the factors driving company growth and value or, more broadly, the anatomy of the information revolution, should therefore start by examining investments in the accumulation of knowledge.

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Table 1

Sources of Growth in Output per Unit Labor
U.S. Non-Farm Business Sector, 1995-2003
Source: Corrado, Hulten, and Sichel (2009)

	without intangibles	with intangibles
Real Value Added per Hour	2.78%	3.09%
of which:		
ITC Capital per Hour*	0.70%	0.60%
Other Tangible Capital per Hour*	0.28%	0.24%
Labor Composition	0.38%	0.33%
Total Factor Productivity	1.42%	1.08%
Intangible Capital per Hour*	NA	0.84%

Source: Author's calculations and Corrado, Hulten, and Sichel (2009). Detail may not add due to rounding error. *Weighted by share in total value of product

Table 2

Modified Microsoft Income Statement
With and Without Intangibles
2006 ($ billions)

	Conventional Accounts	Conventional Accounts with Intangibles
Value of Product	$44.3	$66.7
Cost of Revenue	$7.7	$7.7
Research & Development*	$6.6	$6.6
Sales and Marketing*	$9.9	$9.9
General & Administrative*	$3.8	$3.8
Total Operating Expenses	$26.7	$26.7
Operating Surplus ex Depreciation	$17.7	$40.3
Depreciation	$1.2	$19.9
Gross Operating Income	$16.5	$20.5
Net Income	$12.6	$16.6

* The depreciation expense included in these items, but subtracted from Gross Operating Income and shown as a separate item.
Source: Microsoft financial statements and calculations in this paper.
Detail may not add due to rounding error.

Table 3

2006 Microsoft Balance Sheet Items
Revised to Include Capitalized Intangibles
2006 ($ billions)

	Conventional	Add R&D	Add S&M	Add G&A
Plant & Equipment	$3	$3	$3	$3
Intangibles Stocks	$4	$40	$66	$70
Total Equity	$40	$75	$102	$106
Total Assets	$70	$105	$131	$136
Equity Rate of Return	31.4%	18.9%	16.1%	15.7%
% Market Cap. Explained by Shareholder Equity	17%	32%	43%	45%

Memo: R&D Stock $35, S&M Stock $26, G&A Stock $5. Total Stock $66

Source: Microsoft financial statements and calculations in this paper. Detail may not add due to rounding errors.

Table 4

The Sources of Growth of the
Microsoft Corporation
(average annual growth rates)

	1988-1994	1995-2000	2001-2006	1988-2006
Total Real Output	45.3%	30.0%	12.2%	30.0%
Labor Input*	5.1%	2.1%	1.5%	3.0%
Intermediate Input*	8.8%	4.7%	2.6%	5.5%
Tangible Capital Input*	3.8%	1.6%	0.5%	2.1%
Intangible Capital Input *	16.9%	15.5%	6.9%	13.3%
Total Factor Productivity	10.9%	6.1%	0.8%	6.2%

Tangible Capital Detail	1988-1994	1995-2000	2001-2006	1988-1994
Land**	0.5%	0.0%	0.0%	0.2%
Buildings**	1.4%	0.5%	0.1%	0.7%
IT Equipment**	1.3%	0.9%	0.3%	0.8%
Non-IT Equipment**	0.6%	0.2%	0.1%	0.3%
Total Tangibles	3.8%	1.6%	0.5%	2.1%

Intangible Capital Detail	1988-1994	1995-2000	2001-2006	1988-2006
Research & Development***	6.6%	9.2%	3.9%	6.6%
Sales and Marketing***	9.9%	5.8%	2.6%	6.3%
General & Administration***	0.3%	0.4%	0.4%	0.4%
Total Intangibles	16.9%	15.5%	6.9%	13.3%

Source: Author's calculations. Detail may not add due to rounding error.
* Weighted by share in total value of product
** Weighted by relative share in total value of tangible capital income
*** Weighted by relative share in total value of intangible capital income

Table 5

THE SOURCES OF GROWTH OF THE
MICROSOFT CORPORATION
WITH AND WITHOUT INTANGIBLES
1988-2006
(average annual growth rates and percentage contributions)

	With Intangibles		Without Intangibles	
Total Real Output	30.0%		32.9%	
Labor Input*	3.0%	(10%)	4.6%	(14%)
Intermediate Input*	5.5%	(18%)	8.5%	(26%)
Tangible Capital Input*	2.1%	(7%)	6.6%	(20%)
Intangible Capital Input*	13.3%	(44%)		
Total Factor Productivity	6.2%	(21%)	13.2%	(40%)

Source: Author's calculations. Percent contributions in parentheses. Detail may not add due to rounding error. * Weighted by share in total value of product

Table 6

Sources of Growth of Real Value Added per Worker
Comparison of Microsoft and Non-farm Business Sector
Average Annual Growth Rates, 1995-2003

	Microsoft	CHS Non-farm Business
Real Value Added per Worker	10.00%	3.09%
Tangible Capital per Worker*	0.19%	0.85%
Software Capital per Worker*	NA	0.27%
Intangible Capital per Worker*	6.30%	0.57%
TFP + Labor Composition	3.51%	1.41%

Source: Author's calculations and Corrado, Hulten, and Sichel (2009). Detail may not add due to rounding error. * Weighted by share in total value of product