

**Who Captures Value in a Global Innovation System?
The case of Apple's iPod**

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Introduction

Innovation is held to be the key to U.S. competitiveness, but there is little understanding of who captures the value from a successful innovation. This paper is a preliminary report on a study that will answer the question for specific examples of innovation. Here, we present a framework for analysis and use that framework to look at one member of Apple's iPod family, part of a thriving ecosystem that has upended business models across the consumer electronics, computer, and entertainment industries. The iPod is a perfect example of a globally innovated product, combining technologies from the U.S., Japan and a number of Asian countries.

In the past, large electronics companies designed and developed their own products, often using internally-produced components. Such highly integrated companies created and captured a large share of the value of innovation, mostly in their home countries. Since then, supply chains in the global electronics industry have steadily disaggregated across corporate and national boundaries (Sturgeon, 2002; Dedrick and Kraemer, 1998). Companies that formerly manufactured most products in-house, such as IBM and HP, as well as start-ups that never had manufacturing capabilities, have outsourced production and even product development to global networks of contract manufacturers (CMs) and original design manufacturers (ODMs). Even vertically integrated Japanese and Korean companies rely on outside suppliers for key parts, equipment and some final assembly.

Today the creation of a successful product in the global electronics industry spreads wealth far beyond the lead firm, i.e. the company whose brand appears on the product, and who bears primary responsibility for conceiving, coordinating, and marketing new products. While the lead firm and its shareholders are the main intended beneficiaries of the firm's strategic planning, other beneficiaries include partners in the firm's supply chain and firms that offer complementary products or services may also benefit.

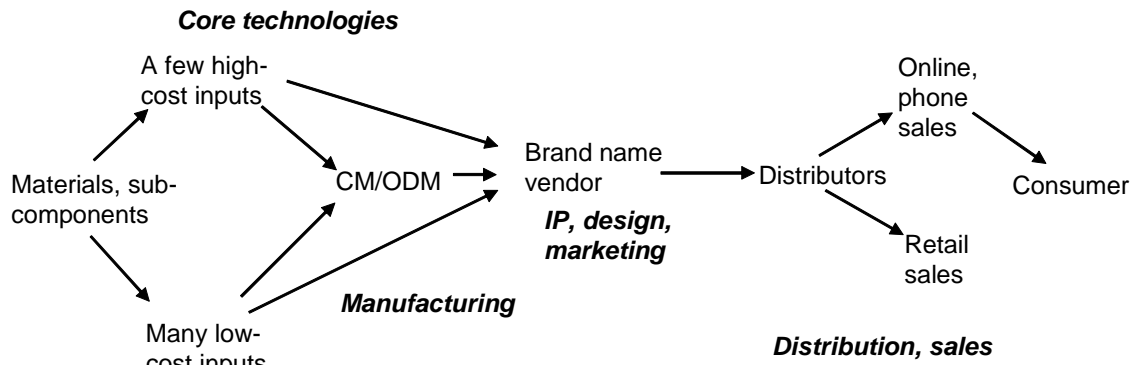
The lead firms recognize how their products create potential value and they negotiate over its division with their partners. A successful firm understands that the creation of value through innovation is not a zero-sum game, and profits are needed all along the supply chain to sustain innovation by all participants.

In this paper, we build a framework for measuring and mapping the value created along a supply chain and show preliminary results from an analysis of one model of the Apple iPod line.

Conceptual framework

Within a supply chain, each producer purchases inputs and then adds value, which then becomes part of the cost of the next stage of production. The sum of the value added by everyone in the chain equals the final product price. The natural starting point for estimating these values is a map of a supply chain showing the activities involved in passing from raw material to the consumer. A stylized supply chain for a generic electronic product is shown in Figure 1.

Figure 1. Generic electronics supply chain



Each product has a large number of low-value components, such as capacitors and resistors that cost only pennies each. Although the manufacturers of these components earn profits, they account for a small share of the total value added along the supply chain, and contribute relatively little innovation. We expect suppliers of these generic inputs to earn thin profit margins because they compete with close substitutes.

Most electronics products also contain a few high-value components, such as a visual display, hard drive or key integrated circuits. These components, which are themselves complicated systems, are the most likely to embody proprietary knowledge that helps to differentiate the final product and to command a commensurately high margin. By virtue of their high cost, these inputs will usually account for a relatively large share of total value added. Innovation is rapid in these components, and accounts for much of the rapid innovation in final products such as the iPod.

These complex components may have their own multinational supply chains. For example, an integrated circuit might be sold by a U.S. company but fabricated by a contractor in Taiwan and encased in its final package in Korea before being shipped to a product assembly plant.

For the assembly of these components into the final product, a number of large multinationals, such as Flextronics, Solectron, Foxconn, Quanta, and Compal provide assembly services. These assemblers compete fiercely for high-volume opportunities, limiting their margins. Even large vertically integrated manufacturers such as Sony and Toshiba now outsource part of their production to these CMs and ODMs.

Finally, at the apex of the supply chain, the lead firm contributes its market knowledge, intellectual property, system integration and cost management skills, and a brand name whose value reflects its reputation for quality, innovation, and customer service. Lead firms can create value by transforming the innovations of others into products that consumers find useful and usable.

Using this map as a guide, we calculate the value added at each stage of the supply chain by estimating the selling price of that stage's output and subtracting the cost of all purchased inputs.

A product-level study, such as we are undertaking, allows us to break out the value embedded in an innovative product and clarifies how it is distributed across the many participants in the supply chain. Aggregating this firm-level data, we are able to make an initial estimate of the distribution of value by country as well. The result will be of interest to managers, academics, and policy makers concerned about the value captured by innovators.

Data sources and analytical approach

Product-level data are extremely hard to obtain directly from electronics industry firms, who jealously protect information about the pricing deals they have negotiated, and often require the silence of their suppliers and contractors through non-disclosure agreements.

For many electronic products, lists of components and their factory prices are available from industry analysts. These “teardown” reports capture the composition of the product at a specific point in time. A teardown report can be used to estimate a product’s value added by subtracting the input prices from the wholesale price.

Firm-level information about pure value added is not readily available because publicly-listed companies do not generally reveal the amount of their wages for “direct labor” (workers who are involved in converting inputs to a salable product). Instead, the wage bill is hidden within “cost of goods sold” or “cost of sales.” Therefore, the number we will use to estimate the value captured by suppliers is “gross profit,” also called “gross margin,” the difference between “net sales” and “cost of goods sold.” Gross profit data are readily available from annual reports in the case of public companies. Figure 2 shows the difference between value added and gross profit. The red area includes the components of value added and the blue area includes the components of gross profit, or value captured by the firm.

Figure 2. Components of value added and gross profit

Sales price	- purchased inputs	Value added	Gross profit (value captured)	- cost of goods sold
	- direct labor			- SG&A
	- SG&A			- R&D
	- R&D			- Depreciation
	- Depreciation			- Net profit
	- Net profit			

Gross profit does not equal the full value added, since it excludes direct labor. Instead, it measures the value the company (excluding its direct workers) captures from its role in the value chain, which it then can use to reward shareholders (dividends), invest in future growth (R&D), cover the cost of capital depreciation, and pay its overhead expenses (marketing and administration). In cases such as the iPod, where the lead company, Apple, outsources all of its manufacturing, the value added calculated from the teardown report will be more or less identical to the gross profit.

Since gross profit excludes wages for direct labor, it avoids the geographical ambiguity about where a product was assembled versus where the company is headquartered. The offshore assembly aspect of value distribution needs to be captured in other ways, such as an analysis of the location, quantity, and salary of jobs.

The iPod Supply Chain: an initial view

In order to begin our supply chain analysis, we obtained several “teardown” reports for various iPod models from Portelligent Inc. These reports are based on the dismantling of an actual product, and they identify suppliers where known.

One of these Portelligent reports details the components in the 30-gigabyte (GB) version of Apple’s fifth-generation iPod, the Video iPod, which went on sale in October 2005. Table 1 shows the ten most costly inputs in the 30GB iPod model based on Portelligent’s estimates. The ten inputs in Table 1, including the cost of assembly and test, total \$123.12, which is more than four-fifths of the estimated \$144.40 total cost of inputs into the iPod and its accessories.

By far the most costly input is the 30GB hard drive from Toshiba, which has an estimated cost of \$73, by itself more than 50% of total input cost. In order to estimate the value captured by Toshiba, we will use its gross profit. This may be inaccurate for a company like Toshiba that makes a wide range of products, from memory chips to power-generating facilities, but it can suffice for a first approximation. According to Toshiba’s income statements, the gross margin for the fiscal year ending March 2006 was 26.5% of net sales.¹ As points of comparison, the gross margins for 2005 from the two top firms who produce only hard drives, Seagate and Western Digital, were 23.2% and 19.1%, respectively.² Using Toshiba’s overall gross margin,

¹ Gross profit rate calculated from data at <http://www.toshiba.co.jp/about/ir/en/finance/pl.htm>.

² Calculated from Edgar Online data accessed at <http://finance.yahoo.com>.

recognizing that it is on the high side for the hard drive industry, the value captured by Toshiba and assigned to Japan from a 30GB iPod is about \$20.

Table 1. The most expensive inputs in the 30GB 3rd-generation iPod, 2005

Component	Supplier	Company HQ Location	Manufacturing Location	Estimated Factory Price	Cost as % of all iPod Parts	Gross Profit Rate	Est'd Value Capture
Hard Drive	Toshiba	Japan	China	\$73.39	51%	26.5%	\$19.45
Display Module	Toshiba-Matsushita	Japan	Japan	\$20.39	14%	28.7%	\$5.85
Video/Multimedia Processor	Broadcom	US	Taiwan or Singapore	\$8.36	6%	52.5%	\$4.39
Portal Player CPU	PortalPlayer	US	US or Taiwan	\$4.94	3%	44.8%	\$2.21
Insertion, test, and assembly	Inventec	Taiwan	China	\$3.70	3%	3.0%	\$0.11
Battery Pack	Unknown			\$2.89	2%		\$0.00
Display Driver	Renesas	Japan	Japan	\$2.88	2%	24.0%	\$0.69
Mobile SDRAM Memory - 32 MB	Samsung	Korea	Korea	\$2.37	2%	28.2%	\$0.67
Back Enclosure	Unknown			\$2.30	2%	26.5%	
Mainboard PCB	Unknown			\$1.90	1%	28.7%	
Subtotal for 10 most expensive inputs				\$123.12	85%		\$33.37
All other inputs				\$21.28	15%		
Total all iPod inputs				\$144.40	100%		

Source: Portelligent, Inc., 2006 and authors' calculations

The second-most valuable input is the display, which came from Toshiba-Matsushita Display, a joint venture of two Japanese electronics firms. The estimated factory price was \$20.39, and the average gross margin for Toshiba and Matsushita was 28.7%, which would translate into an additional \$5.85 captured by Japan.

Next are two microchips from U.S. companies, Broadcom and PortalPlayer, that control video playback and manage the iPod's functions, respectively. Their gross margins in 2005 were 52.5% and 44.8%, respectively, leading to an estimate of \$6.60 in value captured assigned to the U.S. This number is likely to be more precise than the estimate for Toshiba or Matsushita since Broadcom and PortalPlayer are strictly chip companies.

A similar procedure was performed for all the other inputs in Table 1 that could be assigned to a publicly-listed company. In addition to the ten inputs shown, the Video iPod has more than 400 additional inputs with values from two dollars down to fractions of a penny, with an average value of \$0.05 each.

Of the ten inputs shown in Table 1, three, totaling \$7.09, had no supplier markings, and this identification problem becomes more prevalent for the smaller-value items. Because Apple is particularly sensitive about its supply base, field research and other inquiries will be needed even to make educated guesses.

For the higher-value components, we are also researching the next level up the supply chain to estimate value captured by the supplier's suppliers, especially where these have cross-border implications. In the case of PortalPlayer's controller chip, its manufacturing is external and could have been done either by Taiwan Semiconductor Manufacturing Corp. (TSMC), a Taiwanese company, or LSI Logic, a U.S. company. Chip fabrication typically accounts for about a third of the factory price of a chip, so approximately \$1.63 of PortalPlayer's cost of goods sold can be attributed to Taiwan or the U.S. TSMC's gross margin for 2005 was 44%, and LSI Logic's was 43%, so about \$0.70 was captured in this way. Moreover, PortalPlayer licenses one of the main elements of its chip design, the processor core, from a British company named ARM, which charges anywhere from \$0.35 to \$2.00 per chip (lower amounts for higher-volume deals) in royalties, which is almost pure gross profit and should be assigned to Great Britain.³

A similar third-level analysis needs to be conducted for other complex parts such as the hard drive, which contains a number of external inputs, including chips, disks, motor, and head assembly. However, these third-level adjustments tend to be small.

At the other end of the supply chain, the retail price for the 30GB model at the time of Portelligent's analysis was \$299. The difference of \$154.60 between the retail price and the cost of inputs can be further decomposed into retail, distributor, and Apple profit.⁴ We estimate a 25% wholesale discount for such units, with 10% for distribution and 15% for retail.⁵ Because most of the cost of goods for the distributor and retailer is the wholesale or distribution price, their combined gross margin is roughly equal to the wholesale discount.

Based on these values, Apple's gross profit on those units would be \$80, which is 36% of the \$224 estimated wholesale price.⁶ This \$80 profit is greater than the price of any single input, so it is definitely greater than the value added for any of its partners. And for sales made through Apple's own web or store outlets, it retains an even larger share of the value.

The following table summarizes the preceding analysis of the 30GB fifth-generation iPod. It assumes the unit is sold through a retail outlet in the U.S.

³ Royalty rate estimate from Jim Turley, "Embedded Processors, Part One," January 11, 2002, http://www.extremetech.com/print_article/0,3998,a=21014,00.asp

⁴ Apple, of course, retains the retail share of profit on units sold through its physical and virtual Apple Stores.

⁵ A gross profit margin of "less than 15 percent" for non-Apple sales is claimed in Damon Darlin, "The iPod Ecosystem," New York Times, February 3, 2006, so Apple's wholesale discount would need to be at least this large. The distribution estimate is from an industry interview.

⁶ 75% of \$299 is \$224.25, our estimate of the wholesale price received by Apple; subtracting the \$144.40 input cost leaves \$79.85, which is 35.6% of \$224.25.

Table 2. The geography of \$190 of the captured value in a single \$299 video iPod (very preliminary)

	U.S.	Japan	Korea	Total
Distribution and Retail	\$75			\$75
Apple	\$80			\$80
Seven Identified Inputs in Table 1	\$7	\$26	\$1	\$34
PortalPlayer suppliers	\$1*			\$1
TOTAL	\$163	\$26	\$1	\$190

Note: For this table it is assumed that the unit is sold in the U.S.

* PortalPlayer suppliers could also be located in Taiwan.

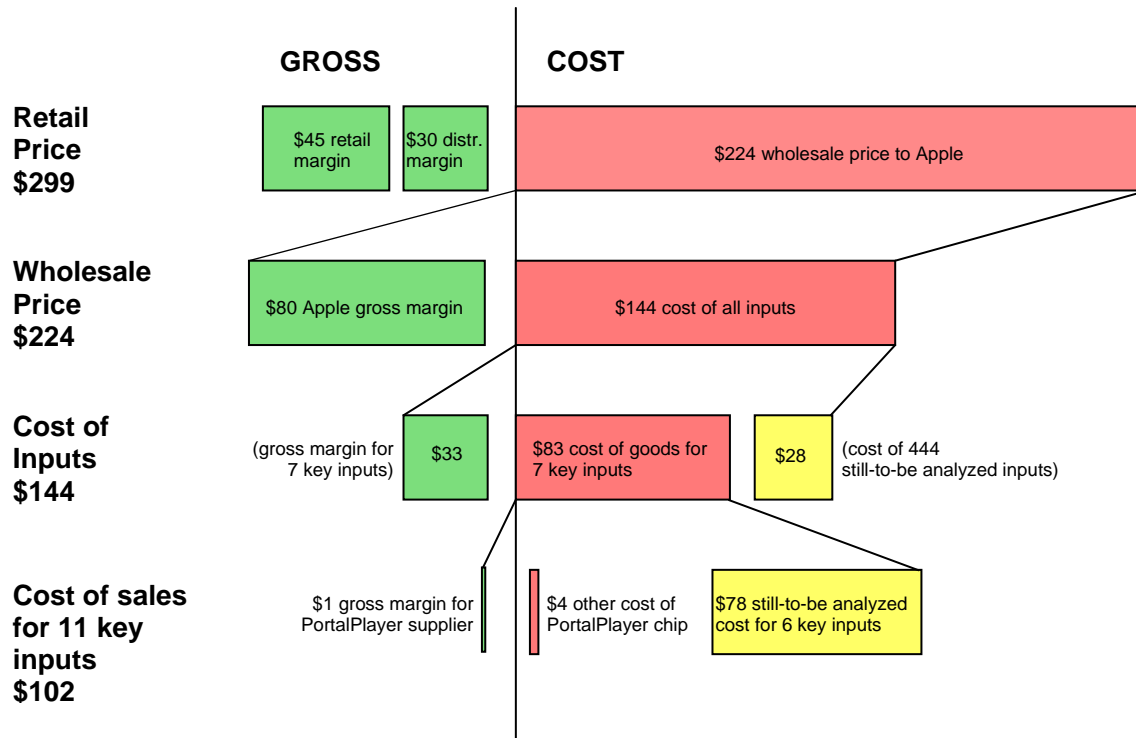
Source: Authors' calculations

Numerous inputs remain to be evaluated. They are mostly small in value, with a total cost of \$21.28 out of the total input bill of \$144.40. Even if the as-yet-unanalyzed inputs have a 50% gross margin, which is unlikely, the most all these could add to any region is \$10.64 (i.e. half of \$21.28).

Some share of the \$53.94 “cost of sales” of the Toshiba hard drive (\$73.39 less the \$19.45 captured by Toshiba) will later be added to the table, most likely in the Japan column, following an analysis of Toshiba’s suppliers and their margins.

Figure 3 provides a reconciliation of the analysis so far, back to the retail price of \$299. The green boxes correspond to the values reported in Table 2.

Figure 3. Breakdown of iPod retail price based on analysis so far



Source: Authors' estimates; see text.

The dominance of Apple's gross margin suggests that in this particular iPod model, the U.S. captures most of the value. In the case of retail units sold in other countries, a significant portion of the U.S. share would shift elsewhere. For a unit sold in Japan, the total value captured by Japanese companies might even be larger than the U.S. share, depending on the identity of the company that handles distribution.

However, it must be recalled that the gross margins for inputs in the third row of Figure 2 exclude direct labor, which is part of the \$83 cost of goods. Direct labor, most of which will be outside the U.S., would be included in an ideal value added analysis but will not be accounted for in the current phase of the study because of data availability problems.⁷

The location of direct labor differs from headquarters location for most electronics firms. Taiwanese CMs, for instance, have moved the bulk of their factories to mainland China over the last decade, retaining some high-end manufacturing in Taiwan and a few assembly factories in other low-cost regions such as Eastern Europe. In the case of the iPod's hard drive, Toshiba has shifted much of its hard drive manufacturing from Japan to the Philippines and China.

⁷ These wage and worker issues are planned as a subject of future research.

Conclusions

So what can we say about who captures the value of innovation, based on this initial analysis? First, the biggest winner is Apple, an American company, with predominantly American employees and stockholders who reap the benefits. If the iPod had been made by Sony or Samsung, the value to the U.S. would be considerably less.

Second, the producers of high value, critical components capture a large share of the value. For the 30GB Video iPod, the highest value components are the hard drive and the display, both supplied by Japanese companies. U.S. suppliers provide the two most valuable microchips.

Third, trade statistics can mislead as much as inform. For every \$300 iPod sold in the U.S., the politically volatile U.S. trade deficit with China increased by about \$150 (the factory cost). Yet, the value added to the product through assembly in China is probably a few dollars at most. While Apple's share of value capture is high for the industry, the iPod's overall pattern of value capture is fairly representative.

Today, no single country is the source of all innovation and therefore U.S. companies need to work with international partners to bring new products to market. These companies will capture profits commensurate with the extra value they bring to the table. This is simply a fact of business in the 21st century, and the good news is that many American companies are winning this game and continuing to bring significant benefits to the U.S. economy.

As long as the U.S. market remains dynamic, with innovative firms and risk-taking entrepreneurs, global innovation should continue to create value for American investors and well-paid jobs for knowledge workers. But if those companies get complacent or lose focus, there are plenty of foreign competitors ready to take their places. If this happens, the benefits from the global innovation system could quickly shift away from the U.S.

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