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The distribution of value in the mobile phone supply chain

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ABSTRACT

The supply chains of the mobile phone industry span national and firm boundaries. To analyze how value is distributed among the participants, a framework based on theories of firm strategy is applied, and a novel methodology is used to measure value capture in three phone models introduced from 2004 to 2008. The research shows that carriers capture the greatest value (in terms of gross profit) from each handset, followed closely by handset makers, with suppliers a distant third. However, the situation is reversed in terms of operating profit. Carriers shoulder the burden of network installation, maintenance, and upgrading, which absorbs much of the value from their subscription fees. Handset maker nationality, which may also influence supplier choice, is a key determinant of the geographic distribution of value capture. The results are also used to estimate the relationship of handset subsidies to carrier profits, which has been an issue of concern for antitrust authorities in several countries. The analysis shows how the framework can be used to calculate how much service charges might be inflated to cover the subsidies.

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1. Introduction

Over the past decade, firms working around the world on the convergence of computing, communications and consumer electronics have created products with a high capability to price ratio that is driving large-scale adoption, particularly in the developed economies. One of the most visible manifestations is the multi-function smartphone, a mobile phone that can perform computing functions such as accessing the Internet and storing data as well as consumer applications such as playing music and video. Nokia's N-Series, Research in Motion's (RIM) BlackBerry product line, Apple's iPhone, and a variety of products based on Google's Android operating system are the top-selling smartphones worldwide as of early 2011.

Smartphone makers have created tremendous value through product engineering, design, and system integration, as have the producers of innovative components on which they rely. Value also comes from the sophisticated telecommunications systems via which they communicate and from a distributed global network of software and service providers that may include dozens of countries and hundreds of firms (Li & Whalley, 2002).

In order to benefit from innovation within this network, firms (and, in some sense, nations) must not only create but also capture value. Within the complex global value chain (Gereffi, Humphrey, & Sturgeon, 2005) that supports the cell

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phone industry, firms vie with competitors and negotiate over the division of value with suppliers and customers. Their ability to profit from innovation is a function of firm strategies and industry structure (Dedrick, Kraemer, & Linden, 2010; Porter, 1980; Teece, 1986).

It is an empirical question who profits most when innovation, production, and distribution activities span national and firm boundaries. The answer is not readily discernable when the key prices are negotiated rather than reached in an open market environment. The answer is especially difficult to observe when prices are obscured by various subsidies or by bundling of products and services by mobile carriers, as is often the case in the US market.

From a public policy perspective, the embeddedness of the smartphone in a global value network raises the question of how countries can capture the greatest economic and social benefits from innovation. When domestic handset producers rely on foreign suppliers of components and manufacturing services, will policies to support domestic producers create value for the home country or send it elsewhere? Previous research suggests that the home country of a major brand-name firm in a global value chain receives value that is diffused in the form of high wage jobs (e.g., R&D, management, and marketing), and returns to shareholders (Linden, Dedrick, & Kraemer, 2009). However, job creation in terms of headcount may be skewed towards low-wage countries where labor-intensive assembly is located (Linden, Dedrick, & Kraemer, *in press*). The following analysis focuses on financial value, but any policy discussion needs to keep the issue of manufacturing jobs in mind as well.

Another important public policy issue concerns the competitive rules for carriers. How do the existing rules of competition affect carrier profits, subscriber fees, and the rate of technology uptake by consumers? The relatively slow adoption of mobile communication technologies in the US compared to European and Asian economies has been blamed on the institutional structure of the US mobile sector, with strong carriers effectively limiting the innovation of manufacturers and fragmentation of standards slowing diffusion (Funk, 2006; Wu, 2007). However, later adoption can bring advantages (such as a lower equipment cost, learning from the experiences of other countries, and not being saddled with obsolete technologies and standards) that may exceed the potential competitive benefits of early adoption.

The aspect of carrier competition of concern here is the use of carrier subsidies for phones in exchange for fixed-term contracts with subscribers. Roughly half the smartphones sold worldwide are subsidized by the carrier in countries including the US, Japan, and France (Ahonen, 2010, p. 116). The social welfare costs and benefits of these subsidies have been debated in the academic literature, and they have been the object of bans in various countries, including South Korea and Finland (Albon & York, 2008; Kim, Byun, & Park, 2004; Tallberg, Hammainen, Toyli, Kamppari, & Kivi, 2007). United States policymakers have also taken an interest. Congress and the Federal Communications Commission reportedly have investigated exclusive deals made between wireless carriers and handset makers as possibly stifling consumer choice and raising prices (Puzzanghera, 2009; Reardon, 2009).

One thing lacking in most discussions about these issues is solid data on who is capturing value in the current industry structure. Such data is needed to undertake an informed analysis of firms' incentives to innovate, the market power of different firms in the supply chain, and the distribution of value among the nations involved.

This article analyzes the supply chains of three high-end mobile phone models, including two smartphones, that each benefitted from carrier subsidies. These phones are representative of the high-end phones that are offered by carriers in exclusive, heavily subsidized arrangements with handset makers.

The analysis applies a framework based on financial measures of value capture, including various measures of profitability.³ This analysis answers the following questions: (1) How are the financial benefits of innovation distributed among firms in a global value chain for advanced mobile technologies? (2) How much value is created and captured in the home countries of innovative brand-name firms and component suppliers, versus countries where the products are manufactured, or where they are distributed and used? (3) How do handset subsidies affect the profitability of carriers and handset makers, and the consumer cost of services?

Looking at individual handset models, the analysis shows that the carriers capture the greatest share of gross profits from each phone, followed closely by the handset makers who in turn capture far greater value than any of their component suppliers. However, the handset makers are able to retain more of that profit than the carriers, who must invest heavily to maintain and upgrade their costly infrastructure. In terms of national outcomes, the analysis shows that handset maker nationality matters most because these firms still retain a significant share of the profits from each unit sold. This study does not analyze the distribution of jobs and wages, but a study of Apple's iPod supply chain found that the majority of jobs are in China and other low-wage countries, but the majority of wages are paid in the home country of the brand-name firm (in that case, the US) (Linden et al., *in press*).

The next section provides a brief historical and conceptual discussion of competition in the mobile phone supply chain, followed by an introduction to the analytical approach to be used. This is followed by a functional analysis of the components within the phones in the study, and a detailed estimate of the profits accruing to firms along the supply chain of each phone. The results are then used in an analysis of the relation of handset subsidies to service charges and for comparisons of a wider set of profit measures among selected firms in the industry's value network. The final section discusses the results and considers their policy implications.

³ The concept of "value" could be defined in various ways, including the number of jobs or the wages generated by an activity as well as the financial measures (gross profit and value capture used here).

2. Competition in the mobile phone supply chain

Mobile telephony technology has shifted through recent decades from a plethora of nation-based technologies commercialized by vertically integrated firms to a few global standards supported by globe-spanning supply chains. Beginning in the 1950s, bulky portable phones with limited capabilities became available for a select user base. These have given way to slim handsets at prices that have spurred mass acceptance. In 2010, telecom equipment maker Ericsson estimated that over five billion mobile phones were in use, up from just 720 million a decade before (Ericsson, 2010).

While handset hardware has been integrating more functions over the past twenty years, industry supply chains in telecommunications, as in the broader electronics industry, have been steadily disintegrating/disaggregating across corporate and national boundaries (Dedrick & Kraemer, 1998; Sturgeon, 2002). Where once large integrated companies such as AT&T built their own infrastructure, made the key components, and designed, manufactured and distributed their own products, today these activities are more often carried out by independent companies in a vast global network spanning the semiconductor, computer, communications and consumer electronics markets.

The deconstruction of the telecommunications industry and its increasing recombination with related sectors is described by Li and Whalley (2002, p. 451) as a radical transformation where “value chains are rapidly evolving into value networks, with multiple entry and exit points, creating enormous complexity for all the players involved.” They identify the distribution of value capture among the various parties that contribute to a product or service as an important issue for determining the viability and success of new enterprises, and they call for empirical research and new tools for understanding this question.

As a first step toward understanding the distribution of value in these complex networks, this study uses the supply chain, the series of organizations and processes through which a product passes from raw materials to the consumer’s hands, as the unit of analysis. A cell phone, despite its small size, contains hundreds of parts. Most are low-value parts that account for a small share of the value. A few high-value components, such as the display and the main microchips, account for most of the cost. A brand-name (lead) handset maker, who may not even assemble the product in-house, contributes its market knowledge, intellectual property, product design, system integration and cost management skills, and a brand whose value reflects its reputation for quality, innovation, and customer service.

Mobile operators are the final links in the chain to the consumer, and their role is key because they control the customer relationship. In the US and many other countries, carriers subsidize the cost of many of the best-selling high-end handsets in exchange for a period of exclusivity from the manufacturer, with some models of RIM’s BlackBerry phones being notable exceptions. The carriers make up for the cost of the subsidies by requiring customers to commit to service contracts of one to two years. As further protection for the carrier, the bundled phones are generally locked to work only on a single carrier’s network, and the contracts include an Early Termination Fee. There are a variety of wholesale and retail channels in the mobile phone market, particularly in Europe and Asia where unlocked phones are sold by retailers without service contracts. For the purposes of this study of high-end phones, the focus is primarily on the US case to illuminate the somewhat hidden economics of subsidized handsets.

To frame the analysis of the distribution of value among firms in the mobile phone supply chain, the study draws on two theories from business strategy: profiting from innovation (PFI) and industrial organization (IO). This is consistent with the approach taken to analyze value capture in other electronics markets (Dedrick et al., 2010). The PFI framework (Teece, 1986) posits that a firm’s ability to profit from innovation is based on, among other factors, industry maturity (whether a dominant design has emerged), appropriability (the ability to capture profits from innovation through means such as patents, customer lock-in, or standards control), and complementarity (the ownership or control of assets co-specialized with the focal product). This framework helps explain the relative profitability of competing smartphone makers such as Motorola, Nokia, Apple and RIM which have had varying success not only in creating products that consumers want, but also in shaping a complete ecosystem around their handset platforms.

The IO framework explains the division of value among buyers and sellers in the supply chain based on the relative bargaining power of participants (Porter, 1980). Bargaining power depends on industry concentration at a particular level in the supply chain. Buyers (or sellers) have more bargaining power when there are only a few buyers (or sellers) in the market. This framework helps explain the relative profitability of phone makers vis-à-vis component suppliers or mobile carriers.

3. Data sources and analytical approach

The supply chain analysis method used in this article has previously been applied in studies of notebook computers and the iPod (Dedrick et al., 2010; Linden et al., 2009) where it is explained in detail. Its application here to high-end cellular handsets is important for what it reveals about the relation between phone makers and carriers, who play a more active role in sales and in the creation of a customer experience than do the retailers in the PC and iPod supply chains. The article therefore analyzes the value captured by carriers as well as handset firms; however, it only analyzes the supply chain for the phones and not for the carrier networks.

The analysis here is based on product-level data, which are extremely hard to obtain directly from electronics industry firms, who jealously guard information about the pricing deals they have negotiated and often compel the silence of their suppliers and contractors through non-disclosure agreements. However, for some electronic products, lists of components and their estimated factory prices are available from industry analysts. These teardown reports are often cited in the press,

but the retail price of the product is used as a baseline instead of the wholesale price estimated here. The analysis leads to an estimate of the handset maker's product-level gross profit, or, when expressed in percentage terms, gross margin.

Gross profit is just one measure of financial value captured by a firm. It is related to the more-familiar concept of net profit as follows:

- Wholesale price
- Cost of goods (purchased inputs and direct labor)
- = Gross profit
- Overhead costs (R&D, depreciation, marketing, and administrative expenses)
- = Operating profit
- Interest expenses, taxes, and one-time adjustments
- = Net profit

Gross profit shows what share of a firm's sales price is retained after the direct costs of producing a product are deducted. Those funds can then be used to invest in future growth (R&D), cover the cost of capital depreciation, pay overhead expenses (marketing and administration), and reward shareholders (dividends). It is an appropriate concept for the product-specific level of analysis used in most of this article because it abstracts from the company's administrative efficiency (reflected in operating profit) and from non-production factors such as the firm's leverage and its investments in other firms (reflected in net profit). Operating profit also reflects R&D, which typically applies to many different product lines in a non-proportional way, and depreciation, which is an accounting number that may have little to do with the actual economic decay of (or flow of services from) plant and equipment.

At the national level of analysis, corporate gross profit comes closest to capturing the national benefit of a firm's headquarters presence because a large share of the expenditure of gross profits on research, marketing, and administration takes place at or near corporate headquarters, as does, in the case of most carriers, infrastructure investment. It is harder to generalize about the locations where operating or net profits are disbursed. The operating and net profits at the firm level are considered in Section 6.2.

While the gross profit achieved by the smartphone producers is derived from detailed analysis, it is impractical to do so for each input. As a shortcut, the gross profit for each component is estimated by multiplying the company-wide gross margin for the supplier by the reported purchase cost of the component. The gross margin data are readily available from annual reports in the case of public companies. The results are not sensitive to the unobserved differences between the estimated and actual gross profit of individual components because the results are driven primarily by the observed wholesale price differences between components. The main point of converting to a gross profit basis is to underscore how little value remains for the suppliers after their cost of inputs has been subtracted, without any reference to their overhead costs or their overall level of competitive success.

The analysis is concentrated on suppliers of high-value components because they capture the majority of value from among all inputs. In cases where the supplier is not identified in the teardown report, additional research was conducted to identify possible sources. For many components, handset makers use multiple sources, and a teardown report will identify only one of these. With the exception of memory chips, this is less likely to affect high-value components, which are often specifically engineered for a particular phone manufacturer. Since the prices of components change over time, the goal is to derive an estimate that reflects values within a few months of the phone's introduction.⁴

As the breakdown of the profit hierarchy, from gross to net, shows, the analysis requires knowing the wholesale price of handsets (what the carrier pays to the handset maker), but this is not generally published. This value is estimated by looking at various sources, such as the prices charged to cellular subscribers, estimates of phone subsidies from carriers, and statements of average value per phone in company annual reports.

4. Inside phones

Using teardown reports (iSuppli, 2007; Portelligent, Inc., 2004, 2005), the key parts in three cell phone models that trace the evolution from feature phone to smartphone were compared. All three models were initially offered through exclusive arrangements with a US carrier, marking a tighter coordination of interests between carriers and handset manufacturers than had existed previously.

Each of the three phones was innovative in some way within its manufacturer's line-up. Motorola's V3 RAZR phone was notable for its slim design which led to it being the most purchased handset model in the US until it was unseated by the iPhone 3G in late 2008.⁵ The Palm Treo 650 combined features of a PDA and mobile phone with touchscreen and keyboard

⁴ This approach is necessitated by the dates when the analyst estimates are published. Industry experts interviewed in the course of this research stated that component prices tend to fall 5–10% per quarter depending on market characteristics. Phone prices (and carrier subsidies) change less often, and the change depends on demand for the phone, the need to clear inventory before introducing a new model, and other product-specific factors. The precise evolution of value capture over time is therefore difficult to predict but is not likely to differ qualitatively from the presentation in the text (i.e., the carrier's share will generally dominate, with the handset maker close behind).

⁵ According to NPD data reported in Reardon (2008).

Table 1

Comparison of inputs as percentage of factory cost: three phones.
Source: Authors' calculations.

	Motorola V3 "RAZR"	Treo 650 CDMA	RIM Curve 8300
Year of introduction	2004	2004	2007
Display (%)	30	23	11
Processors (%)	10	16	13
Storage (%)	9	3	9
Memory (%)	2	5	
Assembly (%)	4	6	7
Camera (%)	5	3	8
Cellular and bluetooth chips (%)	6	4	4
Cellular license (%)	4	Incl. in chip cost	5
Battery (%)	3	5	4
PCBs (%)	5	5	5
Enclosure (%)	2	2	5
Keypad (%)	6	1	2
Software (%)	Not applicable	5	Not applicable
Sub-total for key components (%)	86	82	72
Hundreds of other components (%)	14	18	28
Total (%)	100	100	100
Total parts	640	1040	585

inputs. Research in Motion's Curve 8300 was part of RIM's effort to expand its reach from business users to the consumer market with a slim product that featured a full keyboard.

Although the original Motorola RAZR was not a smartphone in the sense of offering PC-like functionality, it had a Wireless Access Protocol (WAP) browser for viewing some parts of the Internet and also a personal information management software package. More importantly, however, it helped set the trend of distinctive phones being sold at subsidized prices in exclusive arrangements with one or two carriers.

Table 1 shows how the three systems compare in terms of their key inputs as a percentage of factory cost (the total of the inputs). In the Motorola and Palm phones, the most expensive single input – up to a third of the total – is the display module, which must be compact and high-resolution. Display prices have continued to fall due to both manufacturing advances and increased competition, and the display for the Curve 8300, which dates from a few years later than the others, accounts for just 11% of the total factory cost. Microchips, including processors, wireless transceivers, and memory, are another significant expense area, accounting for about a quarter of the factory cost in all three models. Most of the remaining cost is taken up by the camera module, the license fee for the phone's cellular protocol, the battery, printed circuit boards, the keypad, the casing (called an enclosure), and the assembly of components into the final product. Each of these accounts for between 2% and 8% of the factory cost, with details shown in Table 1.

The operating systems for the computing functions were managed under different business models. Motorola's RAZR and RIM's Curve used internally developed software. This software is not counted as a cost since Motorola (or RIM) would just have paid the software fee to itself. Palm's operating system was originally developed internally, but the software business was spun off to shareholders in 2003 and acquired in late 2005 by Access, a Japanese software company that produced the world's first mobile browser. Based on Palm's reported payments to its software spin-off, PalmSource, the licensing fee per unit was about \$10.

A more detailed accounting of the key inputs in each phone is given in Tables A1–A3.

As depicted by the differences between the columns in Table 1, smartphone architectures (e.g., touchscreens versus keyboards) have not yet come together around a dominant design (Abernathy & Utterback, 1978; Anderson & Tushman, 1990). This remains true, with leading models such as the iPhone, Droid phones from HTC, Samsung and Motorola, and Nokia's N-Series featuring different physical user interfaces, in addition to their different operating systems. Some leading smartphone brands, including RIM and Nokia, offer both touchscreen and keyboard models.

One consequence of this lack of uniformity is that competition continues to be based more on feature differences than on price, consistent with the aspect of PFI theory that relates to the relative maturity of an industry (Teecce, 1986). This explains in part the attractive margins (i.e., ratios of profit to sales) that will be seen later and marks a key difference between the markets for smartphones and for PCs. In the latter, the scope for lead firms to distinguish their products is extremely limited, which results in more modest margins (Dedrick et al., 2010).

5. Value capture along the supply chain

Next, the analysis turns to a consideration of profitability along the supply chain. It starts by looking at component suppliers and the handset maker, with the results for suppliers broken down into regions as follows: US-based, Japan,

Table 2

Estimated gross profit shares of suppliers for four phones.
Source: Authors' calculations.

	US-based suppliers (%)	Japan-based suppliers (%)	Other Asia suppliers (%)	Europe-based suppliers (%)	Supplier location unidentified (%)	Total (%)
Motorola RAZR	36	28	6	0	30	100
Palm Treo 650	39	19	8	3	31	100
RIM BlackBerry Curve 8300	41	2	8	12	37	100
Nokia 7710	17	35	2	11	36	100

Other Asia, Europe (including, in one case, a chip from Israel), and Location Unidentified. After that, the value capture of the carriers is introduced.

5.1. Supplier value capture

Supplier value capture is estimated by applying each supplier's 2005 gross margin (2007 in the case of the Curve 8300) to the value of the input it supplied to the phone, as detailed in Appendix tables. Where the supplier is unknown, 33% is applied. This is the average gross margin for 270 of the leading global electronics firms for 2004 as reported in *Electronic Business'* EB300 listing.⁶

Table 2 shows the results of these calculations, aggregated for suppliers by the location of their headquarters. For the purpose of this section, the table also includes the results from a comparable analysis on a Nokia 7710 (Table A4), a touchscreen-based phone that wasn't sold in the United States. Each cell of the table represents the estimate of the gross profits earned by suppliers in a particular region as a share of all supplier profits, not including the gross profit of the handset maker.

Attributing the gross profit to the headquarters country is appropriate because overhead spending (R&D, marketing, and administration) is still largely homebound. Even in the case of the highly globalized semiconductor industry, Macher, Mowery, and Di Minin (2007) found that roughly 90% of US patents issued to chip firms from 1991 to 2003 had only US-based inventors, with little change in the share over the period. The home-country bias of patents was slightly higher in Japan and slightly lower in Europe, with Korea and Taiwan about the same as the US.

More than a quarter of the aggregate supplier profits in each phone could not be tied to a firm or a region, with a high of 36% for the Nokia phone.

Of the suppliers identified, US-based suppliers dominate, primarily due to their strength in integrated circuits. Japanese suppliers played a key role, especially in the very-thin RAZR design, but Japanese suppliers of displays and batteries have faced severe competition in recent years from rivals in Korea, Taiwan, and mainland China. For example, Japanese suppliers once dominated the market for handset displays, a high-value component. But, by 2009, Sharp Corp. ranked just third among a top five dominated by Samsung and populated by firms from Taiwan and Hong Kong.⁷

The geographical data in Table 2, although incomplete because of the unidentified components, raise the question of a possible relationship between handset maker nationality and supplier choice. The role of US-based suppliers ranges from 36% to 41% for the handsets from North American firms, but is only 17% in the Nokia phone. Europe-based suppliers are most important (11% and 12% versus 0% and 3%) in the handsets from the European and Canadian companies in the sample.

If there is a causal relationship between the nationalities of the handset maker and its suppliers, the correlation is constrained by the fact that suppliers of each type of input are not distributed evenly among the world's regions. For example, flat panel displays are produced primarily in Japan, Taiwan, and Korea. Chips, however, are important components for which production is dispersed, giving handset makers a meaningful choice so that a preference might be detected. For example, a published teardown of a smartphone from Japan's Sharp Corp. showed that it used a Toshiba application processor when Toshiba was a relatively minor supplier of these parts, suggesting that transaction costs or other hard-to-observe forces may be driving supplier choice.⁸

Such a relationship, if confirmed by further research, might be explainable by any of several processes. These include cultural affinity and a corresponding increase in trust, efficiencies from the regional co-location of the relevant engineering groups, or path dependence based on historical ties. Field work will most likely be needed to differentiate among the various possibilities.

⁶ As calculated from EB300: The Rankings, Electronic Business, August 2005. Retrieved from <http://www.edn.com/article/CA630171.html?partner=eb> on February 9, 2009. The results are not sensitive to changes in this industry-average gross margin.

⁷ Data for the fourth quarter of 2009, reported in DisplaySearch (2010).

⁸ Tearing Down SoftBank's Handset w/ Touch Sensor, Tech-On, April 22, 2008; application processor market data for 2008 are from Forward Concepts, reported in Clark (2009).

5.2. Handset firm value capture

In a supply chain analysis of iPods and notebook PCs, Dedrick et al. (2010) were able to use the retail prices to drive the analysis of how much value is captured by particular firms and countries. Unfortunately that is far more difficult in the case of high-end mobile phones because their business model is very different. The estimates that follow are rough, but should be of the right orders of magnitude. As such, they are still useful for analyzing value capture along the industry supply chain.

High-end phones such as those analyzed here are generally sold through carriers, who bundle them with service contracts and subsidize the cost of the phone in anticipation of the carrier's future subscriber revenues. The actual wholesale price received by the phone manufacturer is not observed and is treated by seller and buyer as a closely guarded secret. Moreover, the low prices paid by consumers reflect not only subsidies but also finder's fees paid by carriers to third parties, frequent promotional rebates borne by some combination of the carrier and the manufacturer, and the steeply declining price of rapidly aging technology. In the case of the RAZR, which proved to be very popular, the initial price with contract in November 2004 was \$500. By May 2005 that dropped to \$400 through Cingular (now AT&T), the exclusive network partner, but promotional offers from Amazon and other retailers at the time were as low as \$50. In July 2005, the official price through Cingular and T-Mobile (which was added as a second carrier) dropped to \$200.

The price received by the handset maker is the sum of the price paid by the consumer and the subsidy paid by the carrier. Based on Motorola's quarterly unit sales figures during 2005 and the changes in price over the year, a volume-weighted average consumer price for the RAZR is estimated to be \$250. An industry analyst consulted for this study estimated that the subsidy for this phone was probably \$100, for an average price of \$350 received by Motorola.⁹ Subtracting the estimated factory cost of \$144 (Table A1) gives an estimate of \$206 for Motorola's gross profit. As a percentage of the sales price, that's a gross margin of 82%, much higher than Motorola's overall gross margin of 32% in calendar year 2005, but it is likely that the hit RAZR phone was at the high end of Motorola's relatively wide range of business lines and the broad range of handsets that it sells.

Sales information about the Treo 650 is harder to Kim et al. (2004) at \$450 with a two-year contract and lowered it to \$350 over the next 18 months before the next-generation Treo was introduced. Palm's self-reported average handset price in the fiscal year ended in May 2006 was \$316, up from \$265 the year before. Based on the limited evidence, the wholesale price received by Palm for the Treo 650 was set at \$425, including a carrier subsidy of \$100. Subtracting the \$197 estimated factory cost (Table A2) leaves Palm a gross profit of \$228, or a gross margin of 54% (compared with Palm's overall gross margin of 33% for FYE May 2006). This disparity seems reasonable because the Treo 650 would be at the high end of Palm's offerings, which included non-phone handheld computers.

The Curve 8300 was launched in the US in mid-2007 by Cingular/AT&T at a no-contract price of \$450, or a \$200 price with a 2-year contract (and a subsidy of undisclosed size paid by the carrier to RIM). In the year ended March 1, 2008, 59% of RIM's revenues came from the United States, with 8% from the United Kingdom and 7% from Canada, so the United States price is the most relevant.

Based on previous research on small, portable electronics (Dedrick et al., 2010), a reasonable wholesale discount for distribution and retail is 25%. Against the \$450 unlocked price, that equates to a wholesale price to RIM of \$337.50. RIM's self-reported average selling price for the year ending March 1, 2008 was \$346, which will be used as the wholesale price for the present analysis.

RIM's per-unit gross profit is the difference between the \$346 wholesale price and the \$108 estimated factory cost (Table A3), or \$238. That equals a gross margin of 69%, larger than RIM's overall hardware gross margin for FYE March 2008 of 44%.¹⁰

The disparity in profits among the three handsets seems to reflect firm positioning, although the margins of error on these estimates render such analysis tentative. Motorola's 82% can be attributed to the popularity of the sleek RAZR design in the period right after its introduction. As detailed above, Motorola rapidly lowered its price to expand market share, sacrificing some of its gross margin in favor of higher volume. Palm, a mobile computing firm with limited traction in the phone market, has the lowest gross margin (54%). Research in Motion also came from a mobile computing background, but enjoyed some customer lock-in, and hence greater appropriability of value, thanks to the adoption of its pioneering push e-mail system by many corporate users. RIM was able to command 69% even on a unit targeting consumers.

Table 3 shows these handset maker gross profits in dollar terms and compares them with the total gross profits of all suppliers. In all three cases, the gross profit of the handset maker is far more than the combined estimated gross profits of all the suppliers.

These results matter not just for profits, but also for high-value jobs such as administration and research that the profits support. For example, Cohen, Di Minin, Motoyama, and Palmberg (2009) found that all the inventors listed on the majority

⁹ See also Carson (2006).

¹⁰ RIM also earns money from fees for the network services that it provides to carriers and their subscribers via RIM's Network Operations Center, on the order of \$5 per user per month, as calculated from their Annual Reports. This would add \$120 in revenue over the life of a 2-year contract. Applying RIM's FYE 3/08 gross margin for software and services, 84%, yields an additional gross profit of \$101 over the 2-year life of a contract, which yields a total gross profit per phone of \$329. However this higher figure will not be used in the body of this article in order to keep all gross profit conceptually related to the wholesale price.

Table 3

Estimated profitability of suppliers for three phones.
Source: Authors' calculations.

	Handset maker gross profit	Lead firm HQ location	Total gross profits for all suppliers	Largest region of input supply
Motorola RAZR	\$206.00	US	\$46.51	US
Palm Treo 650	\$228.00	US	\$75.90	US
RIM Curve 8300	\$238.00 ^a	Canada	\$34.77	US

^a Does not include additional gross profit from Network Operations Center services.

of patents issued to Nokia, Ericsson, Motorola, and Qualcomm between 1985 and 2001 were located in the home region. The explanations they advance are a combination of organizational inertia and the slow maturation of offshore R&D centers. A study of the global iPod supply chain (Linden et al., *in press*) estimated that twice as many jobs in 2006 (including distribution, retail, and a share of Apple overhead as well as the supply chain) were located outside the US as in it, but the US-based workers earned twice as much in total wages. Based on the information available about the iPhone's supply chain, the distribution of jobs and wages is probably similar, and this relationship holds for other smartphones as well. The evidence strongly suggests that the headquarters presence of successful firms remains vital to national outcomes (e.g., jobs for high-skilled labor).

5.3. Carrier value capture

Another element of the smartphone supply chain analyzed in this article is distribution and usage. The landscape for handset distribution is very complex. The smartphone companies sell directly in some cases, ship via distribution partners in others, and ship directly to carrier warehouses in others. Smartphones in the US are typically sold through a close arrangement between phone maker and carrier, so direct shipment (i.e., no distributor apart from a logistics company) is a common route, with a third-party freight or logistics firm generally handling the physical movement of goods.

Here, attention will be restricted to this distributor-free, carrier-direct case in order to extend the supply chain discussion to include the carrier's value capture. As mentioned above, the RAZR was initially sold exclusively through Cingular, with T-Mobile added after about 6 months. The Curve 8300 was also launched in the US as a Cingular/AT&T exclusive.¹¹ The Treo 650 for CDMA was initially sold exclusively through Sprint PCS, with Verizon added after about 6 months.

The estimate of the carrier's per-phone profit presented here uses Cingular and the RAZR. On average, Cingular, like other carriers, incurs a loss on handset sales. In Cingular's financial reports for the period, its reported cost of equipment (primarily phones) exceeded equipment revenues by 25% across all the handset models that they were offering.¹²

Carrier profits come from subscriber fees, reported by the companies as average revenue per user (ARPU), from which the \$100 RAZR subsidy discussed in the previous section is subtracted. Subsidized smartphones are frequently sold with a two-year contract, so this time period was used as the basis for calculations. The second year was discounted by 5% to estimate its net present value.

For Cingular/AT&T in 2005/2006, total ARPU, adjusted to reflect the net present value of the second year, was \$1155. The company's gross margin for services (the difference between services revenue and the cost of services, excluding depreciation, divided by revenue) during that time was about 70%. Multiplying these numbers yields an estimate of \$804 gross profit per user. Subtracting the \$100 subsidy leaves an estimated gross profit per phone of \$704 for Cingular. The same calculations for Sprint and the Treo 650 produced a carrier gross profit per user of \$975. These estimates, which are more than twice the per-phone profit estimates reported for Motorola and Palm in Table 3, make clear why the carriers are willing to subsidize handsets.¹³

Fig. 1 combines all the data described so far for Motorola's original V3 RAZR phone to show the breakdown of the value capture estimates. The dominant profit position of the carrier, with three quarters of the total gross profit from the phone, is evident, followed by that of Motorola, with about one fifth. Supplier value capture is shown by region, with the US share just slightly larger than that of Japan. Of the slice of value capture labeled Location Unidentified, at least some of it would also belong to firms based in the US or Japan. The value captured by the carrier would normally be applied to its home country, although there is foreign ownership in some US carriers (e.g., Vodafone owns 45% of Verizon Wireless).

¹¹ Cingular was rebranded as AT&T in 2007, the year of the Curve 8300 introduction.

¹² Applying this average handset subsidy rate (which is distorted by the inclusion of unsubsidized handset sales) to the V3 RAZR wholesale price calculated above leads to an estimated handset subsidy of \$87 versus the \$100 used in the analysis.

¹³ The dominance of the carrier does not rest on the two-year contract length. According to one source (Ahonen, 2010, p. 94), the average replacement cycle for mobile phones worldwide is 17 months. Even if only a 12-month period before the consumer replaces her handset were modeled, the results for Cingular and Sprint, which would be \$315 and \$451, respectively, would still be greater than the profits estimated for the corresponding handset makers (\$206 and \$228).

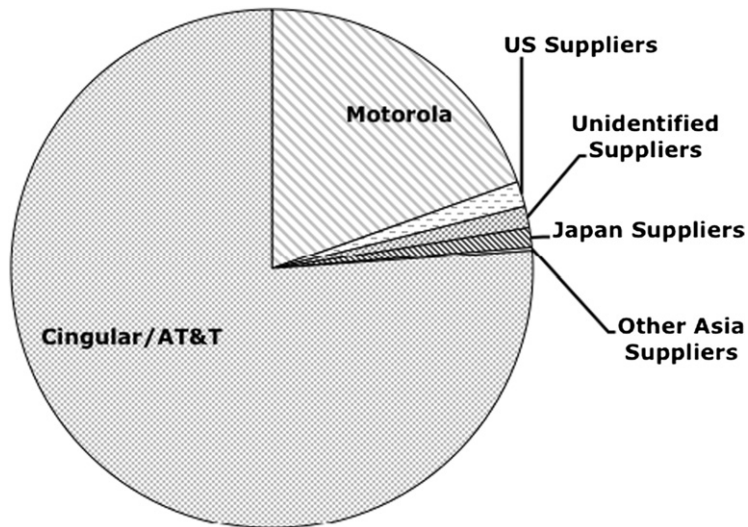


Fig. 1. Gross profit in the Motorola V3 RAZR supply chain.
 Source: Authors' calculations.

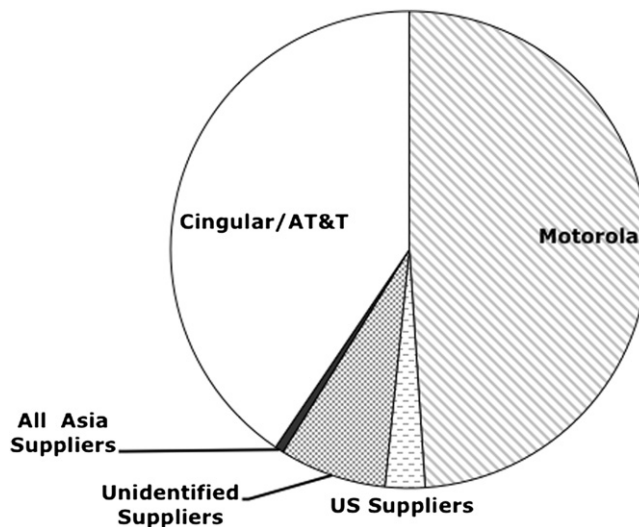


Fig. 2. Operating profit in the Motorola V3 RAZR supply chain.
 Source: Authors' calculations.

Fig. 2 shows a rough estimate of what these values look like if they were adjusted for marketing and depreciation to reflect the companies' operating profits. This was done by applying values for company-wide operating margin in each step of the estimation procedure where before gross margin was used. The most notable feature about the figure is that it reverses the ranking of Motorola and the carrier because the latter carries the financial burden of installing and maintaining a nationwide network infrastructure. The contrast of gross and operating margins would be somewhat less drastic had it been made it using Palm and Sprint because Sprint's operating margin was healthier than Cingular's at the time (see Table 4).

6. Cooperation and competition along the supply chain

The analysis so far has shown that carriers capture the most value (measured as gross profits) in the smartphone supply chain, followed by handset makers, with component suppliers a distant third. Next, the article discusses the economics of handset subsidies and market power in the supply chain in light of the value analysis. Then it returns to the supply chain to consider a broader selection of profit measures for selected firms.

6.1. The economics of handset subsidies

The subsidization of handsets within a bundle that includes handset and service contract remains a strong force in some countries, particularly the United States. According to one analyst, the average handset discount offered by carriers in the US has climbed from 60% of retail price in 2006 to 80% in 2008 (FCC, 2010, p. 169). US carriers have flirted with offering no-contract plans, but they have not pursued the strategy with any vigor. Verizon introduced a no-contract option, but offered only the same monthly pricing as for customers agreeing to a subsidized phone and a contract. In 2009, T-Mobile launched its Even More Plus plans, which offered no-contract service at a discount, but it removed the offer from its website after a year.¹⁴

Bundles make it difficult for consumers to know how much they are paying for the phone, which is often presented as free. The high monthly service fees may continue long after the carrier has recovered the full retail price of the handset.

With respect to the debate on bundling of handsets and service contracts, the value analysis can be used to think about how these numbers might differ had subsidies been forbidden at the time the phone was released. In a study of the Korean market, the elimination of subsidies in 2000 led to a drop in service charges of about 15% at the two biggest carriers (Kim et al., 2004, p. 35). In the RAZR example, the end of the \$100 handset subsidy could support a reduction in service charges by the carrier of about 10% and still leave the carrier with the same gross profit. And subsidies have gotten steeper since then as smartphones allow carriers to add data subscriptions to their voice contracts. Estimates of the subsidy on the 3G iPhone ranged as high as \$500 (Wingfield, 2008). This leaves much greater scope for carrier service charge reductions if subsidies were banned, calling into question the argument that phone subsidies are pro-consumer (Hazlett, 2010, p. 9). Removal of handset subsidies (with the hidden installment plan that they entail) and the end of bundling would allow consumers to make a more direct comparison of prices between carriers, as well as making it possible for consumers to pay for only as much phone as they need. Under the current system, all phone users are helping to repay the subsidies on high-end phones.

The picture is different for the handset maker. If the full unsubsidized price (\$350 in the case of the RAZR) had been charged on all units sold, the per-unit profit would be the same as calculated above. However it is likely that fewer units would be sold at the unsubsidized price because consumers would shift to lower-priced phones, so that Motorola's total gross profit from RAZR sales would have been lower. There is also a negative dynamic effect, because lower sales volume makes it harder for the handset maker to cover its fixed development costs and to extract price reductions from its suppliers over time. In short, the absence of subsidies would have meant lower total profits for all the firms along the supply chain: carriers, handset makers and component suppliers.

The end of subsidies could also negatively affect an innovative handset maker's ability to enter the market by slowing adoption, which lengthens the time before the device can reach critical mass in the market. Smartphones that run independently developed software applications, like those from the iPhone's App Store, benefit from network effects; the more people that are using smartphones that run on a given platform, the greater the incentive for independent software vendors to write applications for that platform. If the end of subsidies leads to the slower uptake of a new smartphone platform, then it's harder for a novel platform such as the iPhone to reach a self-sustaining critical mass of users. This type of reasoning was behind one study's endorsement of the Finnish government's permission for otherwise-forbidden subsidies to be used in the years following the introduction of 3G handsets (Tallberg et al., 2007).

The use of subsidies for enabling market entry may, however, have an anti-competitive consequence. Circumstantial evidence suggests that the adoption of one handset over another by a carrier determines market outcomes. In the US, where Nokia's N97 received no carrier subsidy, Apple's (subsidized) iPhone dominates, but in the UK, where the N97 was subsidized more heavily than the iPhone, the N97 outsold the iPhone 3GS (Ahonen, 2010, p. 116).

This state of affairs would be normal market behavior, except that the market for telecom operators is quite concentrated. The US Department of Justice merger guidelines consider a market highly concentrated if the post-merger Hirschmann-Herfindahl Index (HHI) exceeds 1800. The United States was at an overall HHI of 2220 in 2008, while continental Europe and Japan were around 3000 or more (FCC, 2010, p. 197). The practical implication is that there are far fewer carriers than handset firms, which puts dominant carriers in the role of kingmaker. So, for example, when Palm tried to revive its business in 2009 with a completely new phone platform (WebOS), it struck a subsidy deal with Sprint (as it had for the Treo phone analyzed above). However Sprint runs a distant third in the US market. Small wonder that the Palm Pre underperformed and the company had to be sold off to Hewlett-Packard the following year.

Concentration in the US market has been increasing. According to the FCC (2010, p. 42), the population-weighted HHI increased from a weighted average of 2151 in 2003 to 2848 in 2008. Although prices per minute of voice use are not especially high by international standards, these do not reflect the addition of data usage, which has been growing rapidly in the wake of smartphone adoption. As a percentage of industry revenue, data amounted to about 14% of the total in 2008 (FCC, 2010, p. 116). For Verizon and AT&T, the percentage was even higher, at about 25% each (FCC, 2010, p. 118). In terms of average revenue per user, the United States, at a national average of \$51.54 in 2008, was one of the highest in the world (FCC, 2010, p. 195). This was slightly less than Japan (at \$56.82), but considerably more than the UK (\$35.35), Germany

¹⁴ The preference by carriers for bundling has also been noted in other cases where carriers were allowed to offer either bundled or unbundled options (Tallberg et al., 2007, p. 653).

(\$20.59), or South Korea (\$30.34). Although this in part results from greater minutes of use for voice in the US, it also reflects the growing role of data services as a cash cow.

6.2. Market power in the supply chain

Handset makers and carriers each try to increase their market power so as to command a greater share of the value they create. Carrier dominance of the gross profit pie does not appear to have eroded since the early smartphones analyzed above. The most significant development in the industry in recent years is the launch of Apple's iPhone series. The authors made comparable calculations for Apple's first-generation iPhone in late 2007 and early 2008 assuming a \$200 subsidy. The estimate of Apple's gross profit per phone was \$284, and the corresponding estimate of AT&T's profit per iPhone user was \$1248.¹⁵

In the smartphone market, carriers and handset makers each try to gain advantage relative to rivals and to increase their leverage with suppliers and customers. Handset makers can accomplish this in part by building brand image with consumers. An excellent recent example of this is Apple's iPhone. Well regarded by consumers based on its hit line of iPod music players, Apple rapidly gained market share and was reportedly able to negotiate a share of monthly iPhone subscriber revenue from AT&T (Sharma, Wingfield, & Yuan, 2007). In an evolving market with no dominant design, Apple was able to benefit from its early introduction of innovations such as touchscreens and its integration of hardware and software.

Another strategy has been to create complementary assets that make smartphones more valuable. RIM introduced a push e-mail service for the Blackberry which became highly popular with business users. Apple enabled a valuable supply of applications which it offers through its App Store, a strategy soon imitated by Google, HP/Palm, and RIM. By nurturing the creation of complementary assets linked to a particular platform, phone makers may increase their ability to appropriate profits by creating switching costs for users, who would have to abandon or repurchase some applications by switching.

Appropriability for carriers is protected by a more tangible switching cost in the form of locked phones, long-term service contracts, and early termination fees. Smartphones are important complementary assets, and carriers compete with each other in part by featuring the most enticing handsets.

In terms of bargaining power within the supply chain, carriers have worked to build their own brands while diminishing the prominence of the handset makers. This movement is most pronounced in Europe, where a lesser reliance on carrier subsidies (and the associated lock-in) meant that phone buyers were used to shopping for carriers. European carriers like Vodafone and Orange turned to small phone makers or independent design houses to build custom phones using software that helped keep customers visiting carrier websites for added-value services such as ringtones (Pringle, 2001, 2002). Beyond this, carriers have been increasingly successful at negotiating customization deals that placed their names on the phones they sold, even from large, well-known companies like Nokia (Faucon, 2003; Pringle, 2004). Carrier branding occurs in the US as well, and Palm's Treo 650 was branded with Sprint's logo. On the other hand, phone makers such as Apple and RIM have built strong brands themselves and have been able to negotiate with carriers for a share of service revenues (in RIM's case, charging for its e-mail service).

But this struggle over value must be viewed in perspective by stepping back to consider a broader view of the profitability of these companies, as depicted by the major difference between Figs. 1 and 2. Here, four measures are presented: gross margin (GM), operating margin (OM), Net Margin (NM), and return on assets (ROA). The margins are the same as the profit concepts introduced in Section 3, but expressed as a ratio to sales. GM, gross profit over net sales, shows what share of a firm's sales price is retained after the direct costs of producing its goods or services are deducted. OM, operating profit over net sales, shows the success of a firm's overall productive and innovative activity. NM, the ratio of net profit (or loss) to sales, is included for reference; it is often misleading because of large one-time charges or receipts. ROA, the ratio of net profit (or loss) to Total Assets (an accounting value reported on a firm's balance sheet), shows the firm's economic efficiency in the use of capital from its shareholders and creditors.

Table 4 shows these data for four handset makers, Motorola, Nokia, Palm, and RIM; and for three carriers, Cingular, Sprint Nextel's wireless division, and Verizon's Wireless segment. The handset maker margins are company-wide values and can at best give a suggestion of how the companies compare at the level of the individual products that were analyzed in the rest of this article. Company-wide values are driven by factors such as the strength or weakness of a company's brand, whether its sales were in line with its forecast, and the general economic climate.

The company-wide carrier gross margins are significantly higher than the GMs for three of the handset makers, reinforcing the impression of Fig. 1. RIM's margins are high for a handset firm in part because the company is differentiated from others by its strong enterprise-focused business model, discussed above.

The handset firms and carriers are more similar in terms of OM, i.e., after overhead costs such as marketing, R&D, and depreciation (an accounting number that may differ greatly from the true economic deterioration of infrastructure) have been subtracted out of income. Net margin (and hence ROA) can be misleading, as demonstrated by the data for Palm, which reflect a large one-time tax benefit.

¹⁵ The AT&T estimate reflects the fact, disclosed by AT&T, that iPhone user ARPU is 1.6 that of other AT&T Wireless subscribers (Sharma & Cheng, 2008).

Table 4

Selected financial ratios for the fiscal year covering December 2005.

Source: Authors' calculations from company reports; Sprint data are for Sprint Nextel's Wireless segment only. Verizon data are for Verizon Wireless, which did not report total assets or ROA for its wireless segment in 2005.

	Gross margin (%)	Operating margin (%)	Net margin (%)	Return on assets (%)
Baseband suppliers				
Freescale	42	10	10	8
Qualcomm	71	36	33	16
Handset makers				
Motorola	32	13	12	13
Nokia	35	14	10	16
Palm	33	7	21 ^a	23 ^a
RIM	55	20	19	17
Carriers				
Cingular	58	5	1	1
Sprint	61	10	5	3
Verizon	71	23	7	N/A

^a Palm's NM and ROA reflect a large one-time tax benefit, without which ROA would have been close to its operating margin of 7%.

Even excluding the anomalous Palm data, the handset makers look far better than the carriers in terms of ROA, which reflects the difference between the huge capital investments by the carriers to build and upgrade their cellular networks and the asset-light business models of these handset makers, who outsource much of their manufacturing.

The more complete picture of profitability in Table 4 suggests that there is a limit to how much handset makers will be able to raise their margins by negotiating a transfer from their carrier partners. The carriers already have relatively low returns on assets and cannot afford to give up much more profit to the handset makers. In fact, European carriers have begun lobbying for companies that induce heavy use of the network, particularly Apple and Google, to share the cost of the network, and they appear to be getting a sympathetic hearing from governments in France and the United Kingdom (Campbell & Browning, 2011).

Although component suppliers generally have little market power in the mobile telecommunications supply chain, there are important exceptions. Table 4 also includes data for two suppliers of the baseband chip that controls the digital side of a phone's cellular functions (before and after analog chips have converted the signal for transmission and receiving). Freescale Semiconductor, the spin-off of Motorola's chip division, is one of many firms that supply baseband chips for GSM and related standards. In 2005, it ranked second behind the leader, Texas Instruments (Lammers, 2006). The fierce competition in the GSM side of the baseband market has led it to consider the once unthinkable step of selling off its wireless chip business (Ojo, 2008).

This is a sharp contrast with Qualcomm, the supplier of the Treo 650's CDMA baseband and related chips, as well as the principal licensor for the use of CDMA technology. Qualcomm pioneered the CDMA standard and has remained the near-monopoly supplier of the chips, in addition to receiving a royalty for every 3G (CDMA2000, W-CDMA, and TD-SCDMA) phone. Qualcomm's large margins demonstrate the benefits of owning a successful standard.

6.3. Policy implications

Two policy issues raised in the introduction can be informed by the preceding analysis. The first is whether policies that support domestic handset manufacturers are worthwhile if the producers rely on foreign suppliers of components and manufacturing services. This research has confirmed the results of previous studies that the greatest returns in global value chains accrue to the brand-name firms (in this case, the handset makers) that orchestrate them. Thus there is some justification for supporting domestic handset makers because the financial benefit to countries is largely a function of the success of the firms located there; home countries capture value in the form of high wage jobs (e.g., R&D, management, and marketing), and returns to shareholders. National governments can support domestic firms, consistent with WTO agreements, by creating a domestic environment where new standards can be developed and deployed, stimulating competition among domestic companies to encourage innovation, and using diplomacy to make sure that domestic standards and companies have an opportunity to compete fairly in international markets.

The second policy issue is whether the use of carrier subsidies for phones in exchange for fixed-term contracts is socially beneficial. The analysis showed that subsidized bundling is a double-edged sword. In the absence of subsidies, fewer units of smartphones would have been sold. It would therefore have been harder for handset makers to cover fixed development costs and reach a critical mass of users for their platform. This would have made it harder for an innovative handset like the iPhone to establish itself among established global competitors.

But the analysis has also pointed out the potential anti-competitive effects flowing from the fact that telecom markets in most advanced economies are concentrated among a handful of operators. Because of this, subsidy deals favor some handset makers over others, so that they may actually prevent entry by innovators. Long-term exclusive agreements involving successful handsets, such as that between Apple and AT&T (which lasted more than three years), may even have

the ability to affect competition in the carrier's market, with AT&T reporting that some 40% of its iPhone users came from other carriers (FCC, 2010, p. 81).

Possible remedies that balance the costs and benefits include a limit (perhaps one year) on the duration of the period of exclusivity between a carrier and a handset maker. An alternative is to limit bundling to the two years following the introduction of a new technology (e.g., LTE) by a carrier. This would be similar to the policy adopted in Finland in 2006 to facilitate the roll-out of 3G (Tallberg et al., 2007).

7. Summary and conclusions

This article has presented the first quantitative analysis of value capture by firms along the supply chain for high-end phones. Extension of this methodology to more pieces of the telecommunications value network is an area for future research.

This study has several limitations. In particular, the analysis is forced to rely on rough estimates for certain variables because the actual costs and prices are not public and therefore not known with any precision. Another limitation is that the analysis has not attempted to estimate the value received by handset makers from third-party "apps" (software programs that run on the phone), which are rapidly growing in importance as an element of the value network.

Within these limitations, the study analyzed the handset value chain from components to consumer. It showed that a brand-name handset maker stands to capture greater financial value from each phone than any of its suppliers. This is similar to the case of the iPod, but somewhat different from notebook PCs, where Intel and Microsoft capture a significant share of the financial value (Dedrick et al., 2010).

The smartphone supply chain also includes carriers, which have no equivalent in the supply chains of non-subscription devices such as iPods or PCs. The carriers capture a great deal of value (at least in terms of gross profit) from each handset. However the carriers must also shoulder the burden of network installation, maintenance, and upgrades, which absorbs a lot of the gross value from their subscription fees. Even so, the value of their operating profits per phone dwarfs those of any upstream suppliers of handset inputs (see Fig. 2).

The value capture methodology also allows quantification and analysis of some of the microeconomic aspects of handset subsidies. The quantitative results confirm the qualitative analysis in Tallberg et al. (2007) that argued in favor of subsidies during the introduction of new technologies in order to accelerate adoption, with proper regard for the potential anti-competitive effects of customer lock-in through long-term contract commitments. The estimates show how much higher service charges might be because of subsidies and the resulting customer commitments. Yet, it is recognized that the benefits of lower consumer prices due to subsidies benefit the entire supply chain by increasing sales volumes.

In the ongoing struggle for value capture in the smartphone supply chain, the business models and managerial attention of component and system suppliers continue to evolve. With no dominant design, firms are free to experiment with new product designs and business models. Companies at all levels of the supply chain compete with rivals for market share and profits and negotiate with their suppliers and customers to appropriate more of the profits from innovation. Brand building and management of customer relationships are critical to capturing value and growing the market as the end users of networks compare the complete bundle of features and services offered by an array of competing yet overlapping supply chains. Value-adding complementary goods and services such as downloadable third-party applications have successfully increased the value of smartphone ownership for handset makers, carriers, and consumers. They also are shifting the key level of competition toward platforms based on operating systems, including those provided by software makers such as Google and Microsoft or by the handset makers such as Apple.

In terms of national outcomes, this study shows that handset maker nationality matters most. Whereas most carriers compete and invest only in their headquarters market, the leading handset makers compete, invest, and source globally. High-value tasks such as planning and R&D still tend to cluster near the headquarters of companies, so national identity matters for jobs and income as well as for profit. The same is true for successful component suppliers, as demonstrated in the examples above by companies like Qualcomm and Texas Instruments. And, as depicted by Table 2, the choice of some key suppliers may be influenced by the nationality of the handset firm, although a broader sample needs to be studied.

Finally, the analysis also shows that, despite the very different business model followed in the phone industry compared to personal computers and the iPod, supply chain analysis, with suitable adjustments for the relevant business model, can be useful for revealing which participants capture the most value.

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Appendix A

See Tables A1–A4.

Table A1

Key inputs in the Motorola V3 RAZR phone.

Source: Portelligent, Inc. (2004) and authors' calculations.

Type	Component	Supplier	Company HQ location	Estimated factory price	Price as % of factory cost	Gross profit rate (%)	Estd. value capture	Operating margin (%)
Display module	Display module	Unknown ^a	Japan? ^b	\$42.74	29.7	28.6	\$12.22	
Processors	Baseband processor	Freescale	US	\$10.05	7.0	42.2	\$4.24	10.3
Processors	Analog ASIC	Texas Instruments	US	\$3.92	2.7	48.8	\$1.91	20.7
Storage	NOR Flash-32M bytes	Intel	US	\$12.21	8.5	33.0	\$7.25	
Memory	p-SRAM-8M bytes	Micron	US	\$3.28	2.3	23.5	\$0.77	4.4
Camera	Camera module	Altus (Micron)	Taiwan(US)	\$6.84	4.8	23.5	\$1.61	4.4
PCB	Main board	Unknown		\$2.67	1.9	33.0	\$0.88	
Cellular	GSM transceiver	Freescale	US	\$2.14	1.5	42.2	\$0.90	10.3
Cellular	Power amplifier/Tx& Rx switch	Skyworks	US	\$3.58	2.5	38.8	\$1.39	6.3
Bluetooth	Bluetooth transceiver	Broadcom	US	\$3.18	2.2	52.5	\$1.67	10.9
Battery	Li-Ion cell	Sanyo	Japan	\$4.18	2.9	17.6	\$0.74	< 0
Keypad	Substrate	Unknown	Taiwan?	\$2.56	1.8	33.0	\$0.84	
Keypad	Keypad surface	Unknown	Korea?	\$4.15	2.9	33.0	\$1.37	
Keypad	Keypad enclosure	Unknown	Taiwan?	\$2.36	1.6	33.0	\$0.78	
License	GSM	Various	Various	\$5.00	3.5	33.0	\$1.65	
		Sub-total		\$108.86	75.7			
		Other parts		\$29.06	20.2	33	\$9.59	
		Estimated assembly and test		\$5.81	4.0	33	\$1.92	
		Estimated factory cost		\$143.73	100.0		\$46.51	

Notes: Blank Operating Margin means the actual company was not known (gross margin is industry average), except in the case of Intel's flash memory chips, which are not likely to have been as profitable as its processors; industry-average gross margin was used there as well.

Question marks after a Company HQ Location indicates an educated guess based on the structure of the supply market and other sources of information.

^a The module supplier's cost of goods includes \$14 for a chip from ATI, which was then a Canadian company (now part of AMD).

^b Portelligent considered Japan the likely source for the display module and provided the 28.6% gross margin estimate.

Table A2

Key inputs in the PalmOne Treo 650 phone.

Source: Portelligent, Inc. (2005) and authors' calculations.

Type	Component	Supplier	Company HQ location	Estimated factory price	Price as % of factory cost	Gross profit rate (%)	Estd. value capture	Operating margin (%)
Display module	Display	Sony	Japan	\$46.05	23.4	31.1	\$14.32	2.6
Processors	Mobile station modem	Qualcomm*	US	\$14.30	7.3	60.0	\$8.58	30.0
Processors	Analog baseband	Qualcomm*	US	\$2.62	1.3	60.0	\$1.57	30.0
Processors	312MHz Application processor	Intel	US	\$14.22	7.2	59.4	\$8.45	31.1
Storage	NAND Flash-32M bytes	M-Systems	Israel	\$4.93	2.5	24.8	\$1.22	10.3
Memory	SRAM-1M byte	Cypress	US	\$2.81	1.4	40.4	\$1.14	-10.4
Memory	SDRAM -32M bytes	Infineon	Germany	\$3.89	2.0	30.2	\$1.17	-8.1
Memory	NOR Flash-4M bytes	Intel	US	\$2.78	1.4	33.0	\$0.92	
Camera	Image sensor	Micron	US	\$6.05	3.1	23.5	\$1.42	4.4
PCB	Main board	Unknown	Taiwan	\$6.84	3.5	33.0	\$2.26	
Cellular	RF-to-Baseband receiver	Qualcomm ^a	US	\$2.77	1.4	60.0	\$1.66	30.0
Cellular	Baseband to RF transmitter	Qualcomm ^a	US	\$2.27	1.2	60.0	\$1.36	30.0
Bluetooth	Bluetooth transceiver	Broadcom	US	\$3.53	1.8	52.5	\$1.85	10.9
Battery	Battery	Unknown		\$9.28	4.7	33.0	\$3.06	
Keypad	LED (14)	Unknown		\$2.80	1.4	33.0	\$0.92	
License	CDMA	Qualcomm*	US	Included in chip cost	-	-	-	

Table A2 (continued)

Type	Component	Supplier	Company HQ location	Estimated factory price	Price as % of factory cost	Gross profit rate (%)	Est'd. value capture	Operating margin (%)
		Sub-total		\$125.14	63.7			
				Other parts	\$59.85	30.4	33	\$19.75
				Estimated assembly and test	\$11.58	5.9	33	\$3.82
				Estimated factory cost	\$196.57	100.0		\$75.90

Note: Blank Operating Margin means the actual company was not known (gross margin is industry average).

Industry-average gross margin was also used for Intel's flash memory chips, which are not likely to have been as profitable as its processors.

^a Qualcomm margins are estimates based on Qualcomm's segment reporting of earnings before tax.

Table A3

Key inputs in the RIM Curve 8300.

Source: iSuppli (2007) and authors' calculations.

	Component	Most likely supplier	Company HQ location	Estimated factory price	Price as % of total factory cost	Gross margin (%)	Est'd value capture	Operating margin (%)
Display	Display module	Unknown	Asia	\$11.68	11	16	\$1.87	0
Processors	Baseband chip	Marvell	US	\$14.60	13	48	\$7.01	-4
Processors	Audio processor	Texas Instruments	US	\$1.88	2	53	\$1.00	25
Storage and memory	Flash and SDRAM multi-chip package	Intel	US	\$9.25	9	52	\$4.81	24
Camera	Camera module	STMicro	Europe	\$8.50	8	35	\$2.98	-5
PCB	Main PCB	AT&S	Europe	\$5.17	5	18	\$0.93	9
Cellular	RF transceiver	Freescale	US	\$2.35	2	33	\$0.78	< 0
Cellular	Power amplifier	Freescale	US	\$1.75	2	33	\$0.58	< 0
Bluetooth	Bluetooth chip	CSR	Europe	\$1.90	2	47	\$0.89	18
Battery	Battery pack	Unknown	Japan (cell)	\$4.24	4	16	\$0.68	1
Keypad	Keypad assembly	Unknown		\$1.71	2	33	\$0.56	
Trackball	Trackball mechanism	Unknown		\$0.42	0	33	\$0.14	
License	EDGE royalties	Various	Various	\$5.00	5	33	\$1.65	
		Sub-total		\$68.45	63			
				Other parts	\$31.85	29	33	\$10.51
				Estimated assembly and test	\$7.95	7	5.0	\$0.40
				Estimated factory cost	\$108.25	100		\$34.77

Note: Blank Operating Margin means the actual company was not known (gross margin is industry average).

Table A4

Key inputs in the Nokia 7710 phone.

Source: Portelligent, Inc. (2005) and authors' calculations.

Type	Component	Supplier	Company HQ location	Estimated factory price	Price as % of factory cost	Gross profit rate (%)	Est'd. value capture	Operating margin (%)
Display	Display module	Sanyo?	Japan	\$56.67	29.8	17.6	\$9.97	< 0
Processors	Baseband	Nokia/TI	US	\$7.71	4.1	48.8	\$3.76	20.7
Processors	Application processor	Texas Instruments	US	\$9.64	5.1	48.8	\$4.70	20.7
Processors	Analog ASIC	Nokia/ST Micro	Europe	\$3.38	1.8	34.2	\$1.16	27.5
Storage	SD card	Unknown ^a	Unknown	\$12.00	6.3	42.2	\$5.06	25.0
Memory	512M NAND Flash	Toshiba	Japan	\$7.82	4.1	26.5	\$2.07	3.8
Memory	64MB SDRAM	Samsung	Korea	\$3.21	1.7	30.1	\$0.97	14.0
Memory	4 MB NOR flash	Spansion	US	\$1.22	0.6	9.6	\$0.12	< 0
Camera	Camera module	Toshiba	Japan	\$11.08	5.8	26.5	\$2.94	3.8
PCB	Main substrate	Ibiden	Japan	\$7.84	4.1	26.1	\$2.05	13.7
Cellular	GSM transceiver	Nokia/ST Micro	Europe	\$2.92	1.5	34.2	\$1.00	27.5
Cellular	Power amplifier	RFMD	US	\$1.65	0.9	34.2	\$0.56	7.8

Table A4 (continued)

Type	Component	Supplier	Company HQ location	Estimated factory price	Price as % of factory cost	Gross profit rate (%)	Estd. value capture	Operating margin (%)
Cellular	Tx/Rx switch	Murata	Japan	\$0.63	0.3	39.7	\$0.25	18.3
Bluetooth	Bluetooth transceiver	CSR	Europe	\$2.79	1.5	46.9	\$1.31	23.0
Battery	Li-ion cell	Sony	Japan	\$5.77	3.0	31.1	\$1.79	2.6
Battery	Battery electronics	Mitsumi*	Japan	\$0.42	0.2	7.9	\$0.03	1.9
License	GSM/EDGE	Various	Various	\$5.00	2.6	33	\$1.65	
		Sub-total		\$139.75	73.57			
		Other parts		\$42.59	22.42	33	\$14.05	
		Estimated assembly and test		\$7.61	4.01	33	\$2.51	
		Estimated factory cost		\$189.95	100.0		\$55.96	

Note: Blank Operating Margin means the actual company was not known (gross margin is industry average).

^a Used 2005 data for SanDisk, the SD card market leader at the time, but the SD card included with the 7110 could also have been made by Toshiba or another non-US firm.

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