United States International Trade Commission
Journal of International Commerce and Economics

Comment on "Innovation and Job Creation in a Global Economy: The Case of Apple's iPod," by Greg Linden, Jason Dedrick, and Kenneth L. Kraemer (*JICE* Vol. 3, No. 1, May 2011).

Web Version:
January 2012

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Making Sure ALL Jobs are Counted

INTRODUCTION

In a nice paper recently published in this review, Greg Linden, Jason Dedrick, and Kenneth L. Kraemer look at the global value chain "that designs, builds, and brings iPods to consumers" and they estimate the jobs and wages sustained by this innovative product line.[2] As the authors state, their ulterior purpose is to shed light on the issue of innovation and job creation: how many jobs are created by industries that innovate? How many of those jobs are in the United States and how many abroad? Are some or all of those jobs well paid? Their conclusions are "that, in 2006, the iPod supported nearly twice as many jobs offshore as in the United States. Yet the total wages paid in the United States amounted to more than twice as much as those paid overseas."

Although the Linden, Dedrick, and Kraemer results are interesting, they incorporate neither the impact of interindustry relations nor the flows of economic transactions that result from those relations. Once those matters are taken into account, the total number of jobs in the United States increases significantly, materially deviating from the three authors' conclusions. In fact, the iPod supports two and one-half times as many jobs in the United States as the three authors have estimated.

INDUSTRIAL INTERDEPENDENCE AND JOB CREATION

The interdependence of industrial sectors has long been recognized as a feature of advanced economies, and Input-Output (I-O) Tables and Social Accounting Matrices (SAMs) are recognized as the proper methodology to estimate the impact of exogenous shocks. The use of I-O tables to address public policy issues related to job creation goes back to the 1940s and 1950s when the Bureau of Labor Statistics used the 1939 I-O table to analyze the degree to which different policies could contribute to full

[2] Linden, Dedrick, and Kraemer, "Innovation and Job Creation in a Global Economy," May 2011. The authors have declined to respond to this comment.

employment in the postwar years.[3] The association to the existence of unemployed resources is essential because in a full-employment economy the resources—including jobs—shift from nonperforming sectors to expanding ones with—by definition—no change in employment. The use of I-O tables and SAMs makes sense if and only if there are unemployed resources, which is precisely the context in which the innovation-employment tradeoff becomes relevant. If innovation did not cause unemployment, it would be unambiguously heralded for its positive effects on efficiency, growth, and welfare.

Linden, Dedrick, and Kraemer estimate that the iPod value chain creates 41,170 jobs—13,920 of them in the United States and 27,250 in the Asia-Pacific region. Table 1 offers the details. Notice that the inputs required to manufacture hard disk drives (HDD) are explicitly taken into account, but this is not the case for the inputs needed to produce the flash memory, the other chips, the PCB assembly, the display panels or the modules required to assemble an iPod. Input production can create more jobs than the final assembly of the product. Indeed, according to the authors, the former accounts for 6,585 jobs while HDD manufacturing *per se* requires 4,400 direct jobs. Although none of these jobs is in the United States, it is likely that part of the inputs required to manufacture the HDD inputs or the inputs of the flash memory, display panels, etc. does come from the United States. As the authors calculate, 60% of the production jobs are in China and, as the World Trade Organization points out, in 2005, 71% of U.S. exports to China were intermediate goods.[4]

What is more important for the discussion of the relationship between innovation and job creation is the fact that the 6,101 professional jobs (primarily at Apple's headquarters) and the 7,789 nonprofessional jobs (primarily in retail and distribution) are in the United States and that the jobs needed to produce the inputs necessary for those activities are NOT taken into account by Linden, Dedrick, and Kraemer.

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[3] Horowitz and Planting, *Concepts and Methods of the U.S. Input-Output Accounts*, 2009.

[4] World Trade Organization (WTO) and Institute of Developing Economies – Japan External Trade Organization (IDE-JETRO), *Trade Patterns and Global Value Chains in East Asia*, 2011.

Table 1 iPod-related jobs in the value chain, 2006

	United States	Non-United States	Locations
Hard-drive (HDD) manufacturing		2,200	China
		2,200	Philippines
HDD inputs		2,550	China
		2,550	Philippines
		840	Japan
		800	Thailand
		800	Singapore
Flash memory		1,200	Korea
		20	China
Other chips	10	140	Taiwan
		25	Various
PCB assembly and test		600	China
Display panels and modules		900	Japan
Other inputs		3,500	China
		100	Japan
		100	Taiwan
Final iPod assembly		3,400	China
		100	Taiwan
Apple engineers	700		
Apple managers/professionals	5,046	75	Singapore
		75	Various
APPLE NONPROFESIONAL	1,554	75	Singapore
		75	Various
Distribution	150	150	Various
Freight	250	250	Various
Apple store	1,785	200	Various
Other retailers	3,675	3,675	Various
Third-party online sales	650	650	Various
Total	13,920	27,250	

Source: Linden, Dedrick, and Kraemer, "Innovation and Job Creation in a Global Economy," May 2011.

COUNTING ALL THE JOBS CREATED IN THE UNITED STATES

The appropriate means to measure the total number of iPod-related jobs in the United States should recognize that the true number is higher than the number of jobs directly involved. For example, the manufacture of flash memory may require, among other things, etching equipment, microlithography equipment, thin layer deposition equipment, nonferrous metals, basic inorganic chemicals, and so on. Only the goods and services manufactured or sold in the United States should be included in this estimation because those acquired in another country create jobs in those locations but not in the United States. Input-Output models quantify interindustry linkages in a way that allows the ripple effects of the initial job creation to be determined. Those effects (on employment, output, tax revenues, or income) are classified as "direct," "indirect," or "induced"—

- Direct effects are generated by the initial exogenous shock.

- Indirect effects result from the expansion of supplier industries whose products are used by those producing the goods and services directly acquired (for example, hard disks; flash memories but also distribution, transportation or retail services).

- Induced effects reflect the expansion of overall economic activity that results from the increased purchases of consumer goods and services by the workers considered in the previous two paragraphs.

It is reasonable to assume that the indirect and induced effects associated with the 27,250 jobs located in the Asia-Pacific region will stay there. It is equally reasonable to assume that the 13,920 iPod-related jobs in the United States will have significant indirect and induced effects in the United States.[5] To estimate these effects, I use a model developed by IMPLAN, which considers 440 industrial sectors, 9 types of households differentiated by income levels, 4 types of government spending, 22 types of taxes and transfers, and 4 types of investment flows.[6]

[5] All leakages caused by imports of inputs or other goods are taken into account in these estimations.

[6] IMPLAN Web site, *http://implan.com/V3/Index.php* (accessed November 15, 2011).

The 13,920 direct jobs in the United States lead to 4,100 indirect jobs in diverse sectors like advertising, warehousing, insurance, telecommunications, or refined petroleum products. In addition, there will be 18,100 jobs to produce the goods and services consumed by the 18,020 (13,920+4,100) previous jobs. Linden, Dedrick, and Kraemer estimate that the wages paid in the United States amount to $745 million ($525 million paid to professional workers and $220 million to nonprofessional ones) but do not take into account the disposition of those earnings. The 18,020 020 jobs are needed to generate the goods and services consumed with those $745 million of income. In one sentence, the iPod value chain does NOT need 13,920 jobs in the United States but 36,120 (13,920+4,100+18,100), which is 2.6 times more—a material difference.

CONCLUSION

Assumptions about the "vanishing middle class" and the destruction of blue-collar jobs underlie many current public policy discussions. Automation, supply chain fragmentation, and delocalization have been made responsible for the loss of many jobs in the United States. U.S. companies continue to design and bring to market innovative products creating well-paid jobs for American workers even if the actual product is manufactured overseas. Research and development and corporate support functions do create indirect jobs, and so do the retail, transportation, and warehousing functions contemplated by the authors.

More structural analysis of the productive sector is needed to determine whether well-paid jobs are evaporating or whether they are not, as a result of innovation. The recent iPod case study is a nice but an incomplete parable of the profound changes that are dislocating the U.S. manufacturing structure. To properly ascertain the magnitude of the effect on employment, it is crucial—particularly in a time of high unemployment—to count all the jobs.

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