Commentary:
Why Is Forecasting for Remanufacturing Hard?

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In a recent survey, the World Economic Forum recognized environmental factors (such as extreme weather events, the failure to adapt to climate change, etc.) as some of the greatest risks of doing business—both in the likelihood of their happening and their impact if they do occur. There is widespread agreement that reducing the carbon footprint of products would greatly help mitigate the impacts of climate change. "Closing the loop," i.e., using recycled materials as much as possible and designing products that can be recycled, has become a key source of competitive advantage. The article by Goltsos and Syntetos in this issue of *Foresight* is therefore timely and important.

The authors lay down a basic framework on how forecasters can act on issues related to forecasting the "net demand" (demand minus returns) rather than just independent demand. They rightfully argue that incorporating the returns of "cores" complicates the forecasting process—in addition to the demand uncertainty, the planner now has to deal with the complexity of forecasting uncertain returns. The benefit, of course, is less virgin product sold and the creation of more sustainable operations. The authors argue that time-stamping the sales so returns can be better tracked (and hence forecasted) is in general a good idea, if the benefits outweigh the complexities.

My intent with this comment is 1) to echo the authors that returns management is important and critical, and 2) to add to the discussion on what makes this "circular" economy difficult to manage.

Product Perceptions

The first issue is the perception of the product under consideration. For certain products, such as automobiles, a remanufactured part (i.e., such as a starter or alternator manufactured from recycled cores) may not be perceived as equal to a "new" part—so the demand for remanufactured and new parts and products may not be interchangeable. Meanwhile, other products, such as aluminum cans used for beverages, lend themselves well to remanufacturing—most customers do not care, or in fact react positively, if the aluminum is recycled.

Product Life Cycle

The second issue is the length of the product life cycle. In many industries, products move to newer models faster than customers do. At a product's end of life, therefore, a core or a commodity that is collected may not be compatible with the newer models.

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Lack of Infrastructure

The third issue that plagues remanufacturing is the lack of infrastructure required to collect the product and its components at end of life. Different countries have different take-back policies and

different levels of what is now termed "extended product responsibility" (where a manufacturer assumes some responsibility at the item's end). This adds to the uncertainty of the quantity, quality, and timing of the returns, making the logistics of remanufacturing quite difficult.

Integrating Cores into Optimization Software

Due to the uncertainties involved in the acquisition process, a fourth issue is the difficulty of integration of the raw material or core-returns process into the planning and optimization software applications—such as their Material Requirement Planning (MRP) systems—that the firms are using. In my experience, many OEMs manage this either manually or independent of the MRP system. A typical returns process starts with the "disassembly" of the returned core—a process that is often uncertain. Some cores may not be usable or may be partially destroyed in disassembly operations—so even serializing product sales is not sufficient to get an accurate handle on returns.

Cost of Remanufacturing

A fifth issue, and this is particularly true in developing economies, is the cost of remanufacturing. A significant amount of capital is needed to set up take-back infrastructure, transport the cores to the factories, and disassemble, repair, or recondition them. Since there are uncertainties associated with this process and the payback is over an extended horizon, many are unwilling to undertake it.

Regulation

Lastly, regulation plays an important role in remanufacturing. In many countries, environmental protection laws indirectly act as a driver for the remanufacturing process. For example, waste from electrical and electronics equipment (WEEE), take-back programs, end-of-life vehicles (ELVs) directives, extended producer responsibility (EPR) law, and restriction of hazardous waste substances (RoHS) directives have a direct impact on the operations of firms under the jurisdiction of these laws. The European Union ELV directive, for example, has set a target for member countries to recycle and reuse 85% by average weight of a vehicle; this has a significant impact on both the design and the disposal of the vehicle.

In summary, forecasting for remanufacturing is an important issue that the forecasting community needs to be engaged in, and one certain to gain in importance. Thanos Goltsos and Aris Syntetos have hinted on how it can be done—however, the issue is complex and multifaceted, and requires a much broader worldview to successfully provide solutions.

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