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<td>Employee Health Plans Powered by Analytics</td>
<td>Wallace Hopp, Jun Li, Soroush Saghaian, and Guihua Wang</td>
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<td>A promising new model for the employee health plans of large firms bypasses insurers, instead using direct contracts with hospitals which have been designated as centers of excellence. The authors describe how combining this model with cutting edge analytics could revolutionize the delivery of high quality, cost-efficient health care.</td>
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<td>Mandatory Corporate Carbon Disclosures and the Path to Net Zero</td>
<td>Patrick Bolton, Stefan J. Reichelstein, Marcin T. Kacperczyk, Christian Leuz, Gaizka Ormazabal, and Dirk Schoenmaker</td>
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<td>To advance the world’s progress toward a net zero carbon economy, the authors recommend that governments impose a mandate on corporations requiring them to report their annual direct carbon emissions.</td>
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<td>Designing Omni-Channel Retailing to Align Financial Performance with Strategy</td>
<td>Sunil Chopra</td>
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<td>The author describes how viewing combinations of product and channel through the lens of return on invested capital (ROIC) allows retailers to design omni-channel portfolios that align their products, service offerings, and pricing. By making each channel improve invested capital turns or broaden profit margin, these portfolios increase their company’s value.</td>
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<td>Service Industrialization, Convergence, and Digital Transformation – II</td>
<td>Uday Karmarkar</td>
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<td>Through industrialization, digital technologies are changing the structure of information intensive services. The effects of this evolution are specific to each service category including transactional, functional, content-based, and knowledge-based. Consumer consumption behavior and physical services are also affected. The author argues that managers must therefore analyze the changes to their particular industry and revamp their strategies, core processes, and supporting systems accordingly.</td>
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Using Business Analytics to Upgrade Sales Promotions
Lennart Baardman, Maxime C. Cohen, Kiran Panchamgam, and Georgia Perakis

The authors present a detailed case study of how business analytics, prediction models, and optimization methods can be used to improve promotion planning. In it, they describe the entire process, from collecting data to computing promotion recommendations for retailers.

How to Choose the Right Strategy for Digital Transformation
Sunil Mithas and Roland T. Rust

Many executives believe that, in digital transformation, they must pursue either revenue growth or cost reduction, but not both. The authors explain how companies can pursue both goals by investing in information technology.

The Complete Turnaround of a Boutique Bank: A Practical Guide to Leading a Complex Transformation
Karen Ayas

In a remarkable five-year journey, Bank Leumi USA completed a major transformation with a range of dramatic effects. Through a close examination of the Leumi case, the author illustrates an approach designed to increase the odds of success in transformation and offers practical guidance to those embarking on similar journeys.

Can Blockchain Manage Trust in Organizations?
David De Cremer and James Pang

The authors illuminate the potential and the limitations of blockchain technology as the new currency of trust in organizational life. They have found that building trust within organizations requires leaving room for vulnerability, which makes blockchain unsuitable. However, it shows more promise for building trust between organizations because it acts as a regulatory middleman.

Nobel Laureate Herbert A. Simon: Pioneer of Artificial Intelligence and Trailblazer in Decision-Making
Suresh P. Sethi

Artificial intelligence is rapidly transforming our world. The author describes the fascinating career of Herbert A. Simon, a father of artificial intelligence, renaissance man, and true polymath who made pioneering contributions to fields ranging from economics to psychology and from management to the philosophy of science.
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Employee Health Plans Powered by Analytics. Wallace Hopp, Ross School of Business, University of Michigan; Jun Li, Ross School of Business, University of Michigan; Soroush Saghafian, Harvard Kennedy School, Harvard University; Guihua Wang, Jindal School of Management, University of Texas at Dallas

Large firms in the US have begun to embrace a new health care practice in which they bypass insurers for major care such as surgeries and cancer treatment, and instead contract directly with hospitals designated as centers of excellence (COEs). Although companies have already reported encouraging improvements in both quality of care and cost-efficiency, our research suggests that machine learning and data analytics can make these programs even more effective and efficient. Our idea is to mine currently available data to determine which patients would benefit from diagnosis and/or treatment at a COE and which would be better served by a local hospital. By collaboratively collecting and analyzing the data needed to guide patients to the most cost-effective care, firms can reap additional savings, whether by partnering with an independent organization or by forming their own collaborative. As well as transforming employee health plans, data analytics can be used to personalize treatment and so elevate the quality and efficiency of our entire health care system.

Mandatory Corporate Carbon Disclosures and the Path to Net Zero. Patrick Bolton, Columbia University, NBER & CEPR; Stefan J. Reichelstein, University of Mannheim & Stanford Graduate School of Business; Marcin T. Kacperczyk, Imperial College London & CEPR; Christian Leuz, University of Chicago, Booth School of Business & NBER; Gaizka Ormazabal, IESE Business School & CEPR;

Dirk Schoenmaker, Rotterdam School of Management, Erasmus University & CEPR

Despite widespread concern about global climate change, the overwhelming majority of publicly listed companies around the world still do not disclose their carbon emissions. Even fewer privately held companies do. Making carbon disclosures mandatory for both public and private companies is an elementary but essential step in the drive towards a net zero carbon economy. Firms should be required to report their annual direct greenhouse gas emissions, called scope 1 emissions, as measured in CO2 equivalents, with possible deductions for high quality offsets. Going forward, firms should also be required to report the history of their annual carbon emissions. Such a disclosure mandate is simple, transparent, and readily implemented. It will aid policy makers and asset managers alike in managing the risks of carbon transition and accelerate the reduction of carbon emissions in future.

Designing Omni-Channel Retailing to Align Financial Performance with Strategy. Sunil Chopra - Kellogg School of Management, Northwestern University

The strengths of traditional decentralized retail channels and centralized online channels are complementary. The decentralized retail channel keeps transportation costs low and brings informationally complex products directly to customers. The more centralized online channel produces higher inventory turnover and can offer a wide variety of products with a lower investment in property, plants, and equipment. Showrooms allow customers to absorb complex information about products, while centralized production and fulfilment improve turnover. Offering pickup locations, meanwhile, gives custom-
ers online shopping with a lower-cost delivery option. By focusing on the two components of ROIC (return on invested capital) a firm can identify which combinations of product and channel will create value by increasing turnover, so that it can forgo a large margin, and which combinations require a higher price because they have higher fulfilment costs or lower turnover. With this information, the firm can create a successful omni-channel portfolio, trusting some channels to compete on price alone while offering attractive services with others so that customers are willing to pay a premium.

Service Industrialization, Convergence, and Digital Transformation – II. Uday Karmarkar, UCLA Anderson School of Management, UCLA

Information and communication technologies are driving a new wave of industrialization which is changing industry structure across all sectors. The greatest impact has been on information intensive services, many of which have already experienced severe disruptions, while others soon will. The effects are also reaching into physical service sectors. As a result, companies need to reexamine their strategies and find ways to reposition themselves. Often, they must restructure internally, sometimes radically, through process industrialization and digital transformation. These changes and disruptions are occurring in major information intensive service sectors such as transactional, functional, content-based, and knowledge-based services. The changes follow patterns which are predictable to a certain extent because they arise from the nature of the new technologies, the characteristic economics of information processes, and the phenomenon of convergence. These factors influence consumer behavior, customer experience, service delivery, and even physical services. While consumers generally benefit from the changes, the effects on firms and jobs can be less positive. And companies that are late to adapt or slow in pursuing appropriate industrialization and digital transformation strategies may find themselves in irreversible difficulties.

Using Business Analytics to Upgrade Sales Promotions. Lennart Baardman, Ross School of Business, University of Michigan; Maxime C. Cohen, Desautels Faculty of Management, McGill University; Kiran Panchamgam, Oracle Retail Global Business Unit; and Georgia Perakis, Sloan School of Management, MIT

Sales promotions are an important lever with which to create a competitive advantage and increase retail profits. Most retailers therefore dedicate significant effort to more efficiently planning these promotions. We worked with the Oracle Retail Global Business Unit to develop a data-driven tool that helps to automate promotion planning. The tool uses models from optimization, statistics, and machine learning to address store and product selection, demand forecasting and validation, promotion optimization, and more. To assess the effectiveness of this tool, we applied it to data from a large retailer that sells outdoor supplies and equipment to farms, ranches, and households through more than 100 stores in the United States. We found that using our tool to optimize promotions increased our retail partner’s profits up to 10 percent without sacrificing sales and revenue. Our approach is also sufficiently generic to help a wide range of retailers to use business analytics to improve their promotions.

How to Choose the Right Strategy for Digital Transformation. Sunil Mithas, Muma College of Business, University of South Florida and Roland T. Rust, Robert H. Smith School of Business, University of Maryland

Conventional strategy advises firms to choose between revenue growth and cost reduction. Yet the ever-increasing importance of information technology (IT) and digitalization have made the choice difficult. We have found
that, with sufficient investment in IT, firms can profitably focus on both revenue expansion and cost reduction so as to meet the rising expectations of their customers. Indeed, our research suggests that ambidextrous digital strategies, which focus on both revenue growth and cost reduction, have a higher market value and become more profitable with a greater investment in IT. Firms should therefore use ambidextrous governance and agile IT management to pursue digital transformations which enable both revenue growth and cost reduction.


The metamorphosis of Leumi into a boutique relationship bank illustrates the key theoretical and practical principles necessary for complex business transformation. When enacting such deep transformative change, the devil is in the details. A close examination of this remarkable five-year journey and its dramatic results offers many insights and practical guidance, revealing what it takes to bring a small, sleepy organization to life, turn a bold vision into a collective ambition, and create a roadmap to guide the transformation. Leumi’s cohesive changes in strategy, structure, systems, and culture had a lasting effect. The bank’s Change Leadership Forum, officially charged with leading the transformation, successfully sustained the necessary momentum for change. Its periodic off-site meetings to review progress, coupled with a relentless focus on accountability for change, were highly effective in keeping the business growing. By dividing the transformation into change cycles (with a clear beginning and end) and celebrating accomplishments, Leumi kept everyone energized and engaged and built longevity into its growth platform.

Nobel Laureate Herbert A. Simon: Pioneer of Artificial Intelligence and Trailblazer in Decision-Making. Suresh P. Sethi, The University of Texas at Dallas

Herbert A. Simon, a father of artificial intelligence, renaissance man, and true polymath, made pioneering contributions to many fields including economics, management, psychology, and philosophy of science. As artificial intelligence rapidly transforms our world, Simon’s work gains ever greater importance. He argued that human rationality was limited by the availability of information and by the human mind’s processing capacity. Specifically, he noted that we tend to choose a merely satisfactory solution, rather than insisting upon the optimal one. He coined the term satisfice, a combination of satisfy and suffice, to describe how both individuals and organizations make decisions. This concept revolutionized the world of management long before the impact of AI was broadly felt. A concise and lucid writer and a supportive teacher, Simon was known for his affable character. Nonetheless he held his ground tenaciously in professional discussions.

Can Blockchain Manage Trust in Organizations? David De Cremer, NUS Business School, National University of Singapore and James Pang, NUS Business School, National University of Singapore

Organizations need innovation if they are to compete. In the 21st Century, innovation is driven primarily by new technologies. One of those is blockchain. Can blockchain technology be used to manage relationships and trust within organizations? If so, how? Building a culture of trust promotes the creativity that encourages innovation. And blockchain has been hailed as the new currency of trust. We have therefore explored the potential uses of blockchain technology in managing organizational trust. We found that building trust within organizations requires that people be vulnerable. Only by accepting risk can they discover whether they are trusted. Blockchain’s power, on the other hand, lies in building risk-free circumstances. We therefore conclude that blockchain technology cannot be used to build trust within organizations, however it is useful in building trust between organizations.
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INDIVIDUALS | ORGANIZATIONS | IN-PERSON | ONLINE
A promising new business model for the employee health plans of large firms bypasses insurers and instead uses direct contracts with hospitals which have been designated as centers of excellence. Wallace Hopp, Jun Li, Soroush Saghafian, and Guihua Wang describe how combining this model with cutting edge analytics could revolutionize the delivery of high quality, cost-efficient health care.
Whether they realize it or not, most large firms in America are in the health care business. Approximately 153 million people in the US, nearly half the population, rely on employer-sponsored plans for health coverage. Sixty-one percent of those plans are either partially or completely employer funded. Employers therefore insure 93 million people, which is more than either Medicaid (70 million) or Medicare (40 million). And with average premiums of $7,188 for single coverage and $20,576 for family coverage in 2019, health care is the second largest expense in the operating budget of most companies, after wages.¹

Center of Excellence Programs

Rising health care costs have driven up the premiums for employer-sponsored health insurance by 22 percent over the past five years and 54 percent over the past decade. Understandably, firms have responded by devising an array of measures to contain costs.¹ These measures include increased employee premiums and deductibles, consumer-directed health plans, telehealth systems, and many more. Large firms, including Walmart, Lowes, GE, Boeing, PepsiCo, and many others, have also reduced costs by eliminating the intermediary insurance company and contracting directly with centers of excellence (COEs) to provide their employees with major care such as surgeries, transplants, cancer treatment, and other procedures.² High quality medical providers also promote cost efficiency over the long term because they help patients to avoid costly future complications and readmissions.³,⁴ Finally, by using their size to negotiate favorable rates with COEs, firms can further increase their cost efficiency. As a result, even when firms must pay for their employees’ travel to a COE, these plans can produce better health outcomes at lower costs than traditional plans that rely exclusively on local health systems.

Still, these COE programs are almost certainly more expensive and less effective than they could be because they overlook the fact that different people respond differently to the same treatment. For example, if the Cleveland Clinic is designated as a COE for cardiac patients, the program might encourage (e.g., by travel and lodging subsidies) or require all patients who need cardiac procedures to be treated at the Cleveland Clinic. But for some patients, that solution is not optimal. A patient with mitral valve disease and hypertension who lives in another part of the country might be treated equally well, or even better, at a local hospital. If so, the COE program is at risk of overpaying and underperforming.

To avoid guiding patients to the wrong hospital, firms need to determine which patients benefit from a COE and which don’t. The most straightforward way to control for selection bias in observational data is to statistically account for differences in the groups being compared.
The most straightforward way to control for selection bias in observational data is to statistically account for differences in the groups being compared. Including variables in the statistical model for each factor that could bias the outcome is called risk adjustment. In a comparison of the complication rates of mitral valve surgery patients at Hospital A and Hospital B, we might include in our statistical model patient demographic and clinical variables such as the ratio of male patients to female, the proportion of patients in each age group, their average body mass index, their rates of comorbidities like diabetes and hypertension, and a variety of other factors. We could then use the model to compute an O/E ratio that compares the actual complication rate (labeled O for “outcome”) with the expected complication rate (E), for each hospital. A hospital with an O/E ratio above 1 has a higher complication rate than would be expected of an average hospital, while a hospital with an O/E ratio below 1 has a lower-than-average complication rate. If Hospital A has a lower O/E ratio than Hospital B, we deem it to have better risk-adjusted performance (because lower complication rates are better).

Yet while risk adjustment is intuitively appealing, it is not always effective. If there are influential variables which we haven’t observed, such as a healthy lifestyle, we cannot correct for them in a statistical model and the selection bias will remain. Fortunately, there are statistical tools that compensate for the selection bias of unobserved variables. One such tool is the instrumental variable (IV) approach. An IV is a variable that influences treatment assignment, such as the patient’s choice of hospital, but does not directly affect the outcome of that treatment. One such variable might be the distance between the patient’s home and the hospital. The IV approach corrects for selection biases by viewing the treatment variations as similar to those in an experiment (e.g., one that assigns patients to hospitals based on geographic proximity rather than hospital performance).

While risk adjustment is intuitively appealing, it is not always effective.

Accounting for Differences in Individual Patients

Methods for correcting selection bias, such as the IV approach, can help firms to use observational data to identify COEs. Even with their help, however, the firm may still find that its O/E ratios do not make a decision obvious. To understand why, suppose that a firm is considering hospitals for designation as cardiac COEs and wants to consider the risk of methicillin-resistant Staphylococcus aureus (MRSA) infection. The firm consults the Leapfrog Group hospital rating website (leapfroggroup.org), which gets its data from hospital surveys. Leapfrog reports that, in 2019, the Michigan Medicine hospital in Ann Arbor had an O/E ratio for MRSA infections of 0.31. Can the firm interpret that O/E ratio to mean that a given patient’s infection risk at Michigan Medicine is just 31 percent of their risk at an average hospital? Can it at least conclude that the patient’s risk is lower at Michigan Medicine than at a hospital with an O/E ratio of 0.5?

Sadly, the answer to both questions is no. The O/E ratio represents only population-average information, such that the mean risk of all patients treated at Michigan Medicine is 31 percent of the mean risk to those same patients if they were treated at an average hospital. It does not describe the relative risk for a particular patient (or indeed for any patient). Michigan Medicine could have an O/E ratio much lower than 0.31 for men over 80 who have undergone minor orthopedic surgery and a much higher O/E ratio for women under 50 who have undergone a major cardiac surgery. Michigan Medicine could therefore be a legitimate COE for some patients, but an average or substandard choice for others.

So why not simply compute the O/E ratio for each patient type in order to determine who should consider Michigan Medicine a COE? Suppose that sex, race, age, lifestyle, education and secondary medical conditions (comorbidities) might each affect the relative effectiveness of having a cardiac procedure at Michigan Medicine instead of the Cleveland Clinic. Then suppose that we group people into two sexes, six races, six age groups, four lifestyle categories, and four education levels and that we define twenty-four comorbidities. If these traits can occur in any combination, the total number of distinct categories is $2 \times 6 \times 6 \times 4 \times 4 \times 2^{24}$, or about 19 billion.

Since this number is larger than the number of people on the planet, even the observational data of every cardiac procedure that has ever been performed at Michigan Medicine and the Cleveland Clinic will not allow us to populate every possible subgroup, much less with large enough samples to allow statistical comparison. To fit a standard statistical model to data with so many dimensions, we would need more variables to represent the dimensions and their interactions than there are data points. As a result, the model may fit the data perfectly but not reveal any relationships with statistical significance or have any predictive value. Statisticians call this effect overfitting.
ting. For firms trying to locate COEs for different patient groups, we can just call it unhelpful.

Very recently, researchers have combined tree-based machine learning with instrumental variables, producing tools that can correct for selection bias.

Analytics and Machine Learning to the Rescue

By applying machine learning to data analytics, we can better address this problem of high dimensionality. Unlike statistical models that are created in advance and then fitted to data, machine learning relies on algorithms that use previous data to extract patterns from raw data. Machine learning methods have proliferated in recent years, rapidly increasing the usefulness of observational data in medical decision making. Tree-based methods are particularly useful for finding the best hospitals for various groups of patients. Very recently, researchers have combined tree-based machine learning with instrumental variables, producing tools that can correct for selection biases and use observational data to accurately estimate how choosing one hospital over another will affect the outcomes of different patient groups.

Suppose a firm is using average complication score, which weights different surgical complications by severity, as the outcome metric to choose between Hospitals A and B as a COE for aortic valve repair (AVR). Further suppose that O/E ratios indicate that Hospital A has a lower average complication score than Hospital B, such that it would be designated the COE under a population-average data comparison. By using data on past procedures at both hospitals, which includes outcomes, patient characteristics, and patient zip code (to estimate their travel distance to each hospital), the firm can use a tree-based algorithm to determine which patient characteristics are more frequently associated with successful treatment at each hospital. Figure 1 shows a possible result from such an algorithm.

Note that, in this illustration, the only variables that affect the difference between the two hospitals are gender, age, and diabetes (in males only). Many other variables, including obesity, other medical conditions, and other age categories, might affect the outcomes for individual patients, but if they do not affect the difference between the two hospitals’ overall outcomes they are not part of the tree. The conclusion we can draw from Figure 1 is that Hospital A is superior for older women, while Hospital B is preferable for younger men with diabetes. For all other categories of patients, there is no significant difference between the two hospitals. Because the tree differentiates between patient types, we call its information patient-specific information. Our hypothetical firm could use this information to designate each hospital as a COE for the patients for whom it performs better, while allowing other patients to choose whichever hospital is closer (and cheaper). By using patient-specific information to designate COEs, the firm will achieve better clinical outcomes and lower travel costs than it would by sending all patients to a single COE determined by population-average information.

A Case Study of Cardiac Procedures

Of course the above example is just an illustration. But actual data really do indicate this kind of patient-specific response to treatment at different hospitals. We used public data from the State of
New York on the outcomes of the thirty-five New York hospitals that performed open heart surgery between 2008 and 2012 to analyze their results with six cardiac procedures. These procedures, and the comorbidities we considered, are listed in Table 1. To carry out our analysis, we first generated trees for each of the 535 pairwise comparisons between these hospitals and then (for display purposes) translated these trees into assessments of the average complication score of each hospital as statistically better, worse, or the same as the state average.

Figure 2 is a graphic summary of our results, showing that the top hospital achieves superior results for all patient types, the bottom hospital is worse than average for almost all patients, and the intermediate hospitals perform variably for different types of patients. Interestingly, the performance of some hospitals is very uneven. Hospital 11, for example, has average performance for most patients but significantly above average performance for all patients with hypertension. This achievement implies that a nearby community hospital can treat some patients as well as, or perhaps better than, a distant elite hospital.

A nearby community hospital can treat some patients as well as, or perhaps better than, a distant elite hospital.

### The Power of Patient-Specific Information

To illustrate how a firm can use the patient-specific information summarized in Figure 2 to improve a COE program, we ran a simulation using the 2008-2012 data of New York cardiovascular patients. We assumed that patients select a hospital based on the quality of the hospital, as measured by quality adjusted life years (QALYs), which consider both the length and the quality of patients’ lives after their procedures, as well as the distance to the hospital (which correlates with travel cost), and any financial incentives (e.g., travel subsidy, reduced co-pay, etc.) offered by their firm to offset the cost and inconvenience of traveling to a COE.

In the first run of our simulation we assumed that the firm uses population-average information to identify COEs and patients use the same data to evaluate the risk of complication at each hospital. That is, the firm computes each hospital’s O/E ratio for outcome measured in QALYs and designates the hospital with the highest average QALY as the

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Cardiovascular Procedure</th>
<th>Abbreviation</th>
<th>Comorbidity</th>
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</thead>
<tbody>
<tr>
<td>AAA</td>
<td>Abdominal Aortic Aneurysm</td>
<td>HTN</td>
<td>Hypertension</td>
</tr>
<tr>
<td>CE</td>
<td>Carotid Endarterectomy</td>
<td>DM</td>
<td>Diabetes Mellitus</td>
</tr>
<tr>
<td>LEG</td>
<td>Lower Extremity Bypass Graft</td>
<td>CHF</td>
<td>Congestive Heart Failure</td>
</tr>
<tr>
<td>MVR</td>
<td>Mitral Valve Repair/Replacement</td>
<td>NA</td>
<td>No Comorbidities</td>
</tr>
<tr>
<td>AVR</td>
<td>Aortic Valve Repair/Replacement</td>
<td></td>
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<tr>
<td>CABG</td>
<td>Coronary Artery Bypass Graft</td>
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**TABLE 1**: Cardiovascular surgeries performed in New York hospitals
COEs will, on average, gain more clinical benefit from doing so.

The bottom line is that, by using machine learning to transform observational data into patient-specific information about hospital performance, firms can both save money and improve the health of employees in their COE programs.

Figure 3 illustrates the tradeoff between health outcome and travel incentive under population-average and patient-specific information. In both cases, by spending more money on incentives to encourage patients to be treated at a COE, a firm can improve their health outcomes by reducing the risk of complication, mortality, and readmission. However, because patient-specific information allows the firm to more accurately define COEs and guide the right patients to them, its use will lead to better health outcomes at any level of incentive investment. A firm can therefore improve health outcomes while holding incentive spending constant (option A), reduce incentive spending such that health outcomes using patient-specific information end up the same as when population-average information is used (option B), or reduce incentive spending by a smaller amount while still improving health outcomes (option C). The bottom line is that, by using machine learning to transform observational data into patient-specific information about hospital performance, firms can both save money and improve the health of employees in their COE programs.

The Bottom Line of COE Programs

It is not surprising that more precise patient-specific information helps patients to make better health decisions and consequently allows firms to spend more efficiently on incentives. But will using this information also reduce the firm’s health care costs? Because it depends on factors ranging from a given procedure’s detailed clinical outcomes to the nature of the contracts between the firm and its health care providers, this is a complex question. What is clear is the ways in which such information can be used to increase cost efficiency.
First, there are situations in which, even with a special negotiated price, the cost of a given procedure at a COE is higher than at a non-COE. From 2015 to 2018, for example, Walmart paid 8 percent more per patient for spinal surgery at a COE than at a non-COE hospital. If the outcome data for spine surgery exhibit a pattern similar to that shown for cardiovascular surgery in Figure 2, Walmart is probably paying this additional cost, in addition to travel incentives, for some patients whose health does not benefit. Using patient-specific data would enable Walmart to reduce costs without hurting patient outcomes.

Second, although Figure 2 shows that Hospital 1 is better than average for all patients, it is still not necessarily the best choice for all patients. Indeed, a finer analysis than we can display in a simple heat map reveals that Hospital 1 is the preferred choice for only some patients. If the same is true for spinal surgery patients then even though patients are, on average, better off at the COE, some are worse off. And even when the cost of the initial procedure remains the same when the firm does not send such patients to the COE, it may save on future health care costs by avoiding complications or recurrences.

By using the patient-specific analysis we have described here, firms could determine which patients will benefit from being diagnosed at the COE, as well as which will benefit from treatment at the COE.

Finally, superior diagnostics are a key factor that can offset the higher cost of surgery at the COE. They ensure that fewer patients undergo surgery at all, allowing some to instead receive effective but less invasive (and costly) treatment such as oral drugs, injections, or physical therapies. It is not necessary, however, to bundle diagnosis and treatment. By using the patient-specific analysis we have described here, firms could determine which patients will benefit from being diagnosed at the COE, as well as which will benefit from treatment at the COE. There may be groups for whom diagnosis at the COE is helpful but treatment at the COE is not. In such cases, the firm is spared the cost of unnecessary or inappropriate surgeries by having patients diagnosed at the COE and spared the extra costs associated with remote treatment by having patients treated at local hospitals.

**Toward More Effective and Efficient Health Care**

Leveraging observational data and using machine learning algorithms to generate patient-specific information is straightforward in theory. In practice, Mies van der Rohe’s belief that, “God is in the details” applies. Observational data are messy and fragmented. Machine learning algorithms are sensitive to tuning parameters. Given these complexities, does it make sense for Walmart, Lowes, GE, Boeing, PepsiCo, and every other firm with a COE program to independently analyze hospital performance? They are already in the health care business; do they need to take on the big data analytics business as well?

We suspect not. Since firms with COE programs are not in competition over health care, they stand only to gain from sharing data and analytic results. One means of doing so would be for a third party to compile and analyze the data needed to generate patient-specific hospital performance statistics. A public facing organization such as the federal Department of Health and Human Services’ Centers for Medicare & Medicaid Services (CMS) or the private non-profit Leapfrog Group are already compiling the hospital and patient data needed for these analyses. Both use the data to populate websites that compare hospital performance. Their lists of procedures and sets of outcome metrics are ever expanding. Unfortunately, to date, both sites offer only population-average information.

Since firms with COE programs are not in competition over health care, they stand only to gain from sharing data and analytic results.

However, by applying machine learning and data analytics to the same data, these organizations could readily generate patient-specific statistics. If they did, their hospital performance summaries would no longer be simple lists that look the same to everyone. Instead, their websites would generate customized hospital statistics informed by patient profiles composed of information about sex, age, existing medical conditions, prior procedures, and other characteristics that might influence a patient’s choice of hospital. By doing so, they would better serve their patients.

Meanwhile, firms could use those sites to guide their COE programs by processing the same patient-specific data against a list of candidate hospitals and using the results to generate a report that identified COEs and which patients would be best treated in them. Another option, if public facing orga-
nizations do not transform their sites to offer patient-specific data, is for firms with COE programs to form a consortium or to collectively engage a third-party administrator to generate and share the necessary data. Any collaborative approach will reduce the cost of collecting, organizing, and analyzing the data which will make COE programs more efficient and effective.

COE programs are a promising innovation which allow large firms to both improve the quality and moderate the cost of employee health care. They can achieve both of these goals more effectively by using machine learning and analytics tools to mine the vast store of observational health care data. And in so doing, they will catalyze the big data revolution which will reduce the cost and improve the quality of health care for all of us.

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Endnotes

2. In a survey of large, self-insured employers, the Society for Human Resources Management (2018) found that the percentage of firms contracting directly with COEs increased from 12 percent to 18 percent from 2018 to 2019. SHRM. 2018. For 2019, Employers Adjust Health Benefits as Costs Near $15,000 per Employee. Society for Human Resources Management. https://www.shrm.org/resourcesandtools/hr-topics/benefits/pages/employers-adjust-health-benefits-for-2019.aspx [accessed 5-15-20].
10. See: https://www.medicare.gov/care-compare/?providerType=Hospital&redirect=true and https://ratings.leapfroggroup.org/
When the only constant is change, your strongest advantage is Wharton. Be ready for greater success with the proven strategies and in-depth business acumen you can only get from our world-class faculty. Choose from a wide portfolio of results-focused programs now delivered in a live online format and on campus.
To advance the world’s progress toward a net zero carbon economy, Patrick Bolton, Stefan Reichelstein, Marcin Kacperczyk, Christian Leuz, Gaizka Ormazabal, and Dirk Schoenmaker recommend that governments impose a mandate on corporations requiring them to report their annual direct carbon emissions.¹

According to the latest IPCC report, for the world to have at least an 83 percent chance of limiting global warming to no more than 1.5°C, it must limit its total additional carbon emissions to no more than 300 gigatons (Gt) of CO₂ equivalents starting in 2020.² If the economies of the world continue to match last year’s global energy-related emissions, which amounted to 31.5 Gt of CO₂, the entire carbon budget will be exhausted in the next eight and a half years.³ The path to reach carbon net zero in time is narrowing day by day. Success depends on a universal and ambitious drive by all governments, corporations,
financial institutions, and consumers to eliminate or capture carbon emissions.

In order to reduce and ultimately eliminate net carbon emissions, we must begin with the mundane tasks of measuring and reporting them. In 2005, Trucost estimated the yearly carbon emissions of 2,993 listed companies. Only 217 of those, or 7.25 percent of companies, disclosed their emissions voluntarily. By 2018, Trucost reported on 8,446 companies and the voluntary disclosure rate had risen to 15.94 percent, representing 1,346 companies. So despite significant progress by some corporations in reporting their carbon emissions, the overwhelming majority of listed companies still do not disclose this information. Among privately held companies, disclosure rates are even lower.

Many global corporations from a wide range of industries have recently issued carbon reduction pledges, often promising to reach net zero by 2050. Yet as a recent article in the Economist pointed out, these voluntary disclosures and pledges lack a coherent framework for measurement and reporting: “Firms disclose reams of irrelevant puffery, while often failing to reveal the few things that matter. Ideally an asset manager would be able to work out the carbon footprint of their portfolio and how it may change over time. But many firms failed to disclose their emissions rigorously and often the measures made public by individual firms overlap, leading to double-counting when you add them all up.”

With COP26, the 26th United Nations climate change conference, ongoing, we suggest that making carbon disclosures mandatory is a critical component of reaching net zero. It would reveal much of the data that policy makers and asset managers need to manage the risks of carbon transition and, perhaps more importantly, to accelerate the reduction of carbon emissions. These mandatory carbon disclosures must be simple and straightforward to interpret, and the mandate must be enforceable.

The International Greenhouse Gas Protocol provides a commonly referenced methodology for measuring and reporting greenhouse gas (GHG) emissions. According to its guidelines, firms should measure their carbon footprints by including all direct (scope 1) and indirect (scope 2 and 3) emissions. Indirect emissions include all upstream emissions associated with the firm’s entire supply chain, as well as the downstream emissions associated with the use of the firm’s products. Our immediate concern is with mandating firms to report their direct (scope 1) emissions.

Over the past few years, several important initiatives to promote the reporting of carbon emissions have been underway. The Financial Stability Board, under the leadership of Mark Carney and Michael Bloomberg, has established the Taskforce on Climate-related Financial Disclosures (TCFD) to advise institutional investors and companies on how firms can effectively report their climate risks. The Sustainability Accounting Standards Board (SASB) aims, more broadly, to define industry-specific standards for how environmental, social, and governance (ESG) metrics are disclosed. Meanwhile, the International Financial Reporting Standards Foundation (IFRS) is in the midst of creating the International Sustainability Standards Board (ISSB), whose purpose is to define globally consistent and comparable sustainability reporting standards. Its efforts are backed by the International Organization of Securities Commissions (IOSCO).

Setting standards is a time-consuming process, especially to measure something as complex as environmental impact. Nevertheless, time is running out and some metrics, including direct carbon emissions, are relatively straightforward to measure. It should therefore be possible for corporations to begin systematically reporting their scope 1 emissions without waiting for a comprehensive global consensus on sustainability reporting standards. Organizations like the Carbon Disclosure Project (CDP) and Trucost have already developed considerable expertise in collecting and estimating information about GHG emissions. And according to a recent poll, there appears to be a broad consensus among economists as to the utility and effectiveness of requiring companies to report their direct carbon emissions.

Publicly listed firms will report their global greenhouse gas emissions for the past calendar year in their annual reports.

Recommendation

With an eye to COP26, we recommend that governments adopt the following corporate carbon disclosure mandate:

• Publicly listed firms will report their GHG emissions for the past calendar year in their annual reports. Private firms beyond a certain minimum size will report their global GHG emissions for the past calendar year to a na-
tional registry in the country in which they are headquartered.

- Corporations will express their GHG emissions in tons of CO₂ equivalents, determining the aggregation weights for GHGs other than CO₂ according to current IPCC guidelines.

- The measure of corporate GHG emissions comprises direct (scope 1) emissions from all installations and operating assets in which the company or its subsidiaries have a majority interest.

- In addition to the above measure of gross direct carbon emissions (GDE), we support the reporting of corporate net direct carbon emissions (NDE), provided that GDE and NDE are separately reported. The NDE metric should only allow the subtraction from GDE of those carbon offsets that the firm or its subsidiaries have removed from the atmosphere in the past year and sequestered durably. Durability requires a reasonably high degree of confidence that the captured CO₂ will not be released back into the atmosphere for at least 100 years.

- In future years, firms will be required to report not only their GDE and NDE figures for the most recent calendar year, but also the trajectory of past GHG emissions, beginning with the year in which the reporting mandate went into effect.

**Implementation and Regulatory Burden**

Governments which adopt our recommended mandate for corporate carbon reporting will presumably do so within their own institutional frameworks. Some jurisdictions have already enacted significant parts of our recommendation. Publicly listed firms headquartered in the UK, for example, have been obligated to include their scope 1 (and scope 2) emissions in their annual reports since 2013. Within the EU, all installations in carbon-intensive sectors covered by the European Trading System (ETS) must report their annual GHG emissions to the European Union Transaction Log (EUTL). However, these installation-level reports are not readily aggregated to reveal a firm’s entire emissions.\(^9\)

The European Union does have a monitoring, reporting, and verification framework in place to prevent the underreporting of carbon emissions.

Carbon-intensive production facilities in the US are likewise obligated to report their emissions to the US Environmental Protection Agency. California’s cap-and-trade system requires carbon-intensive production facilities in California to submit similar reports. Again, however, these are facility-level emission reports from which it is difficult to infer a firm’s total emissions. SEC chair Gensler recently indicated that the commission is considering carbon reporting requirements for publicly listed firms in the US.\(^10\)

More information on the implications and challenges of putting such reporting mandates into effect may be found in the Appendix.

**Direct Versus Indirect Emissions**

Companies that already disclose their carbon emissions voluntarily often report both direct and indirect emissions. The reporting of indirect emissions, however, especially scope 3 emissions, varies greatly from company to company. Google’s scope 3 figures, for instance, include only employee commuting and travel.\(^11\) By contrast, Toyota’s scope 3 figures account for more than 98 percent of all emissions associated with vehicle production.\(^12\) To reach this estimate, the company includes the upstream emissions which result from manufac
turing the tens of thousands of parts that go into Toyota vehicles as well as the future expected emissions which using the vehicles will create, specifically their fuel combustion.

So the estimation of scope 3 emissions is inherently complex and also subjective. There are no comprehensive and widely accepted guidelines for how emissions should be allocated over time and between products and producers. Some recent studies therefore view the boundaries of scope 3 emissions as inherently fuzzy.\(^13\)

Reporting indirect emissions also creates a double counting problem along the supply chain, with the direct emissions of suppliers being recounted as indirect emissions by downstream firms.

Reporting indirect emissions also creates a double counting problem along the supply chain, with the direct emissions of suppliers being recounted as indirect emissions by downstream firms.

We therefore recommend that, for the sake of simplicity and transparency, mandated corporate reporting be limited to direct emissions (and direct removals). Third-party carbon data sources will be much better able to assess indirect emissions along a supply chain when they have corporations’ global, comprehensive direct emissions reports. Meanwhile, efforts are underway to create a standardized format for the accounting of scope 3 emissions.\(^14\) Once this work has come to fruition, policymakers may wish to consider extending the re-
porting mandate to indirect emissions, perhaps emphasizing scope 2 emissions which are easier to determine and verify.

**Absolute Values Versus Carbon Intensity Measures**

The UK’s 2013 mandate requires that firms provide a carbon intensity metric, but allows them to choose their denominator variable, whether it be sales, cost of goods sold, or a physical measure of output. These measures of carbon intensity relative to production can help outside observers to gauge changes in carbon footprint, particularly for growing firms. Yet through the same ratio measure, firms may also mask their lack of progress in reducing absolute emissions, the variable that reflects progress toward net zero.

We recommend that regulators focus on requiring firms to disclose absolute values both because the empirical literature on the risks of carbon transition emphasizes the importance of absolute measures and because recent studies have found that equity prices respond to absolute emissions levels, but not to measures of emission intensity.15 Meanwhile, the readers of annual reports can easily calculate the emissions intensity of public firms so long as the denominator is based on reported financial variables. Admittedly, intensity metrics may be more informative in evaluating private firms. But nothing prevents a company from voluntarily disclosing suitable carbon intensity metrics if it wishes to provide more information on the reduction of its carbon footprint.

**Carbon Offsets**

Many companies currently calculate net emissions for their voluntary carbon reports by subtracting offsets from their gross emissions. Companies can claim these offsets by, for example, building a renewable power plant which sells clean electricity to the local grid. They can, and increasingly do, also purchase offsets in voluntary carbon offset markets. While these markets have grown rapidly, the average price of offsets has fallen to a mere $3 per ton of CO₂ as of 2020.16

Voluntary carbon offsets have reached this extremely low market price (compared with the price of €60 per ton recently established by the European Union’s emissions trading system, or ETS) probably because of the predominance of avoidance offsets. In such cases, one party claims a carbon credit for x tons of CO₂ because another party agreed to avoid emitting x tons of CO₂. As such, avoidance offsets are essentially based on counterfactual claims: because of A’s intervention, B did not emit the CO₂ it otherwise would have. We advise that mandated NDE reports include only durable removal offsets and not avoidance offsets. Firms should be permitted to claim offsets only when they, or their contractors, directly removed x tons of CO₂ from the atmosphere, for example by direct air capture and geological sequestration, or by any of a range of natural removal mechanisms such as reforestation or carbon mineralization.17

**Anticipated Effects of the Carbon Reporting Mandate**

We intend this reporting mandate not only to provide additional information to policy makers, asset managers, and the general public, but also to spur companies to reduce their future GHG emissions. With firms subject to a reporting mandate, stakeholders will be in a better position to evaluate and benchmark the firm’s GHG emissions. Moreover, firms will come to expect pressure from investors, customers, employees, and other stakeholders to improve their disclosed annual emissions.

Several recent studies have found that the 2013 UK mandate caused firms to significantly reduce their absolute GHG emissions, in comparison to a control group of firms in other European countries.18 A range of studies using different firms found these reductions to be between 8 and 16 percent. In addition, some contemporaneous studies found that the increase in the revenues and costs of sales of these UK firms was insignificant relative to the control group suggesting that, at the end of the day, reducing emissions had no tangible effect on firm profitability.19 Similar effects were observed in 2010, when the US Environmental Protection Agency (EPA) mandated carbon-intensive production facilities to report their direct emissions to a publicly accessible registry. One study found that, following the EPA mandate, US facilities reduced their carbon emissions by roughly 8 percent. These reductions were attributed to pressure from stakeholders and capital markets as well as inter-firm learning.20

Indeed, a requirement that firms report their GHG emissions is likely to provide capital markets with additional useful information that will reduce uncertainty for investors.21 After the UK introduced mandatory carbon disclosures, on average both stock return volatility and the carbon premium (the higher returns required to compensate investors for exposure to carbon transition risk) went down among companies that began disclosing their emissions to comply with the new regulation, though the companies with the highest emissions saw their carbon premium increase.22

We advise that the mandate to report annual GHG emissions should pertain to all corporations, not just publicly listed ones. If it does not, we anticipate that certain emissions-intensive activities might migrate to private firms,23 or that the heaviest emitters would simply
become private to avoid scrutiny. There is evidence of firms exiting the public market in order to avoid the regulation of publicly listed firms in financial markets.24

Concluding Remarks

The obligation to disclose essential information is the bedrock upon which capital markets are founded. As the climate crisis worsens, information about corporate carbon emissions becomes increasingly essential. Requiring all companies to report their carbon emissions could serve as a similar bedrock for the path to net zero. Our proposal is simple and immediately feasible, recommending that for now, regulators should mandate the disclosure only of direct greenhouse gas emissions. This mandate should have beneficial effects immediately, yet can later be expanded once useable frameworks for reporting more complex emissions and environmental metrics are agreed upon.

Research suggests that disclosure mandates have many benefits, but that they can also have unintended consequences.25 Broadening the mandate to include other sustainability dimensions or environmental, social, and governance concerns will therefore require careful economic analysis. Reducing global GHG emissions in time to avoid a catastrophic rise in temperatures, however, is now so urgent that mandating the disclosure of direct GHG emissions would receive broad support around the world. We therefore call for regulators to establish an immediate mandate requiring comprehensive reporting of firms’ direct GHG emissions before they consider extensions aimed at other sustainability or social issues.

We recommend that all firms be required to report their gross and net direct emissions, both for the most recent calendar year and also as an expanding trajectory of past emissions beginning with the year the mandate is imposed. We expect that an increasing number of firms will choose to supplement these reports with targets for future emission reductions. These targets then become milestones on the path to net zero. With mandated disclosure, the interested public will be able to assess over time the extent to which a firm actually meets its emission reduction targets. Management will likewise become more accountable for its emission forecasts and subsequent results.26

We recognize that a carbon reporting mandate will not solve the climate crisis on its own. Nevertheless, having examined the existing evidence, we are confident that the reporting requirement will contribute to the drive to net zero by giving corporations an incentive to reduce carbon emissions directly, and by facilitating the adoption of other CO₂ reduction policies such as carbon pricing.

The Montreal Protocol, which was established in 1987 to regulate substances that deplete the ozone layer, illustrates the international community’s ability to quickly advance a comprehensive mandatory reporting and compliance requirement. Twenty-four governments rapidly agreed to phase out chlorofluorocarbons (CFCs) by 2000, allowing the ozone layer to recover over the long term.27 The reporting mandate we advocate could be an elementary step in addressing a similar but arguably even more pressing issue threatening the world’s climate.

Appendix: Further Relevant Findings from the Academic Literature

Academic studies in accounting, economics, and finance provide a broad perspective on the adoption and effectiveness of reporting mandates.

Enforcement

The effectiveness of any reporting mandate depends, at least in part, on its enforcement. Many firms that currently do not report GHG emissions presumably have good reason to avoid the subject. Some firms may seek ways to underreport their GHG emissions in order to evade stakeholder pressure. Without the expectation of enforcement, these firms could attempt to game the system with boilerplate language or claims that certain items of information are immaterial. The existing standards for carbon accounting do necessarily allow for some discretion. Both the Greenhouse Gas Protocol and the ISO 14064 standards entail flexibility in methodology, assumptions, and estimation with regard to emission factors, boundaries, and the use of primary or secondary data. Some firms may be tempted to use this flexibility to find ways to underreport their GHG emissions. Applying the standards unevenly could also make the information less comparable, even if firms do not intend to conceal or mislead. These issues must be addressed because accurate and comparable information is essential to the efficient allocation and pricing of carbon risks. If the goal of the GHG reporting mandate is to change firm behavior and move toward net zero, effective enforcement is critical.

Studies of the introduction of global accounting standards,28 insid-
er-trading laws, and new securities regulation in the EU offer extensive evidence on the importance of enforcement. Regulators can achieve appropriate enforcement in various ways. Private enforcement relies upon private parties, such as investors or interest groups, to induce firms to comply through market discipline, private litigation, and non-regulatory methods like public shaming. Such private enforcement relies heavily on a strong legal system, which only some countries can provide. Private enforcement should therefore be combined with public enforcement by government or quasi-governmental oversight agencies.

An effective enforcement system for GHG reporting will require as a first step the careful selection of a supervising body. The agencies that oversee compliance with securities regulation and financial reporting do not necessarily have the skills and resources to extend their oversight to carbon emissions. Enforcing emissions reporting will therefore involve a substantial investment in verification expertise.

The enforcement bodies of different countries will also have to coordinate their efforts in order to obtain globally comparable emission estimates. The enforcement bodies of different countries will also have to coordinate their efforts in order to obtain globally comparable emission estimates. The EU’s Single Supervisory Mechanism for banking and the IOSCO’s Multilateral Memorandum of Understanding, an international agreement for securities regulation, offer ample evidence that coordination can make enforcement more efficient. Indeed, IOSCO supports the establishment of the International Sustainability Standards Board. If governments cannot cooperate to establish a central enforcement mechanism for GHG reporting, we recommend that a supranational institution be entrusted with achieving at least a minimum degree of coordination between national enforcement agencies.

The literature also shows, unsurprisingly, that enforcement bodies which are understaffed or lack authority are significantly less effective at enforcing regulations. We therefore emphasize the necessity of carefully defining the powers conferred on institutions established to enforce GHG reporting. The variability of enforcement of financial reporting suggests that GHG reporting could easily end up being equally variable, which again would encourage firms to avoid clear reporting and potentially move high-carbon activities to areas with weaker enforcement.

Governments must therefore select their enforcement strategies with care. One popular approach to financial reporting and corporate governance is referred to as “comply or explain.” We advise against this approach since it would allow firms to give perfunctory explanations for their non-compliance. A second common strategy is for enforcers to disclose information about the oversight process, whether it be advance information about their priorities and criteria or subsequent information about their outcomes. It is not uncommon for regulators to publish statistics about the firms they have reviewed, including compliance issues, non-compliance rates, or corrective actions. Some even publish the names of non-compliant firms. These regulatory disclosures may contribute to successful enforcement.

Regardless of the enforcement architecture, however, it is clear that simply mandating global reporting standards for GHG emissions will achieve little until those standards are backed up by robust enforcement mechanisms and other incentives for compliance. Moreover, for carbon reporting to succeed globally, it will be vital to coordinate enforcement across jurisdictions.

While a global mandate to report corporate carbon emissions has its challenges, we note that those jurisdictions that have already implemented carbon regulation mechanisms, in particular carbon pricing, did successfully adopt verification and enforcement procedures, like, for instance, the Monitoring, Verification and Reporting framework that the EU adopted in connection with its emission trading system.

**Incentives**

A consistent finding in the accounting literature is that many of the incentives that drive firms are shaped by capital market forces. Capital markets, and in particular institutional investors, can also provide incentives for firms to disclose their carbon footprints. Financial reporting by firms has been shown to be strongly influenced by the need to raise outside capital. It has also been demonstrated that institutional investors can promote not only transparency of reporting but also a reduction in carbon emissions and, more broadly, increased corporate responsibility.

While capital market forces alone cannot ensure consistent and universal GHG reporting, carbon disclosure activism can reinforce regulatory efforts. The effectiveness of activism by other stakeholders or the general public has been demonstrated with regard to other corporate disclosures and tax avoidance. Banks can also promote the disclosure of carbon emissions. If banks were to report the emissions of their loan portfolios, they would, in turn, demand disclosure from
their borrowers, many of them relatively small private firms which are difficult for public enforcers to oversee. Regulators should also consider an audit mandate for GHG reporting, since some assurance of transparency is vital for GHG reporting, even more than for financial reporting. Research suggests that accounting firms, because of their financial experience, make better certifiers than consultants. And while accounting and consulting firms may not currently have the capacity and expertise to produce high-quality emissions audits on a large scale, they have begun the process of building that capacity.

Finally, we admit that mandated disclosures are useful not only to the general public and to investors, but potentially also to competitors, customers, and suppliers. Some firms may argue that forcing them to reveal proprietary information will reduce their incentive to innovate. Yet these concerns are more likely to arise over fairly specific or detailed disclosures, not over highly aggregated ones.42 By limiting the required disclosure to firm-level direct GHG emissions, regulators substantially reduce the risk of forcing firms to reveal sensitive information to competitors, while still creating the desired incentives and pressures to drive firms to reduce their GHG emissions.

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Endnotes

1. This article is a slightly modified version of CEPR Policy Insight No. 111, originally available at https://cepr.org/sites/default/files/policy_insights/PolicyInsight111.pdf.


8. See https://www.igmchicago.org/surveys/climate-reporting-mandate/.


Time to Lead is a book is about great men and women, their actions in leadership that have withstood the test of time, what we can learn from them—and the lessons that are relevant for us here and now.

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“The authors show us that open crowds have surprising capabilities to tackle even wicked problems, and anyone seeking to gain new innovative insights from diverse knowledge sources will find this book a stimulating and invaluable reference.” - Henry Chesbrough, Professor, UC Berkeley, USA; Author, Open Innovation
Sunil Chopra describes how looking at combinations of product and channel through the lens of return on invested capital (ROIC) allows retailers to design omni-channel portfolios that align their products, service offerings, and pricing. By using each channel to improve invested capital turns or broaden profit margin, these portfolios increase the company’s value.
The concept of omni-channel retailing has circulated for several years, yet no retailer has designed a consistently profitable omni-channel network that also satisfies customers. Macy’s initial approach to omni-channel retailing was to use its stores primarily to fulfill online orders. To quote its CEO in the 2012 Annual report “We made a big leap in 2012 when we equipped 292 Macy’s stores to fulfill orders placed online or at other stores that may have been sold out of a particular item.” Yet after a few years of using its decentralized network of stores as its primary fulfillment channel for both online and walk in orders, the company switched to using centralized fulfillment centers for most online orders. Meanwhile, although Walmart was initially hesitant, its omni-channel network now uses retail stores to encourage customers to use store pick-up rather than home delivery. Yet Amazon, despite having acquired Whole Foods, directs most of its effort in the United States toward encouraging home delivery. Clearly, different firms need different forms of omni-channel networks.

No retail channel is price competitive for all products, yet retailers can design omni-channel portfolios which produce the best combinations of product, service, channel, and pricing. In each example mentioned above, the real challenge is to differentiate, within a given channel, between products that can be delivered at low cost and those that incur a higher cost and must therefore be addressed to customers who are willing to pay a premium for services. Whereas very slow-moving items may be expensive to sell through retail stores, fast moving products may be much cheaper to sell through the same channel. No retail channel is price competitive for all products, yet retailers can design omni-channel portfolios which produce the best combinations of product, service, channel, and pricing by examining these combinations through the lens of return on invested capital (ROIC).

A retailer can increase return on invested capital by increasing either profit margin or invested capital turns.

ROIC is the ratio of earnings before interest and taxes (EBIT) and invested capital (IC), where invested capital includes the two assets directly related to supply chain performance: inventories (I) and property, plants, and equipment (PPE). Thus:

\[
\text{ROIC} = \frac{\text{EBIT}}{\text{IC}} \quad \text{IC} = I + PPE.
\]

EBIT is determined by a combination of the customer’s willingness to pay and the labor and transportation costs of the retail network. For the purposes of this discussion, I assume that all physical assets, including retail stores or warehouses, are owned by the retailer and included in PPE. I also assume a unit to be in the retailer’s inventory as soon as it is physically received, regardless of whose books it appears in. While this view of inventories and PPE differs from that of accountants (for example, I ignore depreciation), it does get to the heart of how value is created by using a particular combination of product and channel to fulfill a customer’s order. Observe that:

\[
\text{ROIC} = \frac{\text{EBIT}}{\text{Sales}} \times \frac{\text{Sales}}{\text{IC}} = \text{Profit Margin} \times \text{Invested Capital Turns}
\]

Profit margin is the earning before interest and taxes per dollar of revenue. Invested capital (IC) turns is the revenue per dollar of invested capital. A retailer can therefore increase ROIC by increasing either profit margin or invested capital turns (or both). It can increase profit margin either by increasing the customer’s willingness to pay for a given product by adding a valued service or by decreasing the operating costs (labor and transportation) of that product. Likewise, it can increase IC turns by decreasing either the required inventory (while still meeting customer demand) or the investment in PPE (while maintaining sales). For example, by moving a product from a decentralized network of retail stores to a centralized warehouse, the retailer can decrease the necessary inventory and PPE, and so reduce the necessary invested capital. However, this change also increases the outbound transportation cost and the time needed to deliver the product to the customer. Unless the customer values not having to go pick up their purchase at a store, this delay decreases the EBIT.

By focusing on the two components of ROIC, firms can identify combinations of product and channel for which they can tolerate a lower profit margin, because the value is drawn from increased turnover, and those for which they must charge a higher price, because of lower turnover or higher fulfillment costs. With this information they can identify whether a channel can compete on price alone or whether they must offer attractive services so
that customers will pay a premium. My framework builds on the ideas summarized in Figure 1.

By focusing on the two components of ROIC, firms can identify combinations of product and channel for which they can tolerate a lower profit margin, because the value is drawn from increased turnover, and those for which they must charge a higher price, because of lower turnover or higher fulfillment costs.

For example, by centralizing diapers in a fulfillment center rather than selling them in stores, a firm can only decrease inventory very slightly, while its transportation cost increases sharply. Diapers from a fulfillment center are thus in the high IC turns, high fulfillment costs quadrant. Selling diapers online may therefore be appropriate only for customers who are willing to pay for the convenience of having them delivered because the price must be raised enough to compensate for the increased fulfillment cost. By contrast, stocking a seldom-read book at a centralized warehouse, rather than in every store, decreases the necessary inventory (and the IC) by a great deal, while increasing its transportation cost by only a little. The online channel may thus be appropriate for selling such books to price sensitive customers who are willing to wait a few days for delivery. A firm with an omni-channel portfolio, rooted in the ROIC, can therefore make the best use of both localization and centralization to serve its customers profitably.²

Characterizing Products, Customers, and Channels

To create an omni-channel portfolio that aligns combinations of product and channel with the needs of customers, we must first characterize products, customers, and channels. I have selected three dimensions by which to categorize products: demand uncertainty, the ratio of value to weight or volume, and complexity of information. Demand uncertainty is measured by the coefficient of variation (cv) of demand (cv = standard deviation / mean). Demand for slow moving products is much more uncertain than for those which are purchased frequently. The demand for toothpaste, for example, is relatively predictable and thus has low uncertainty. Each diamond, on the other hand, is unique, which makes the demand for any specific stone impossible to predict. A product’s value is typically measured in relation to its weight or volume. A jug of detergent has low value relative to its weight which means that the cost of holding inventory is small compared to the cost of transportation. A diamond has a very high value relative to its weight, so that the inventory holding cost is quite large compared to the transportation cost. Information complexity describes how much information a customer needs in order to completely understand a product. A fairly limited amount of information can describe a tube of toothpaste. In contrast, a customer may need to try a dress on to entirely understand its fit. The dress, therefore, has a high information complexity that can only be resolved by personal testing.

I characterize customers by their willingness to pay for services, such as help with product selection, responsiveness, home delivery, or the luxury of shopping in a particular environment. Price sensitive customers try to select the channel that offers the lowest price, even if it means weak service offerings. Customers who are more sensitive to service or convenience are willing to pay a premium to use a channel that provides those services. A service sensitive family with young children may be willing to pay extra to have its groceries delivered, while a price sensitive family with older children may drive several miles to Costco to get the same groceries at a lower cost.

I characterize channels by the information and product flow which each offers to customers. Retail customers can exchange information either face-to-face, as in a retail store, or remotely when shopping online. They can get their products through either customer pickup (in which the customer comes to the product) or home delivery (in which the product comes to the customer). I use these different methods of information and product exchange to define the four components of omni-channel retail (see Figure 2).

Supermarkets, jewelry stores, and bookstores are all traditional retail outlets at which customers receive product information face
to face and pick up their products upon purchase. Traditional retail relies on many decentralized facilities to be close enough to customers to support this model.

The apparel retailer Bonobos exemplifies the showroom channel. Bonobos Guideshops allow customers to try on different styles, get advice from salespeople, and be personally fitted. These showrooms facilitate face-to-face information exchange, but do not house inventory which customers can carry away. All purchases are shipped from a centralized warehouse. Blue Nile, on the other hand, is an entirely online channel which allows customers to browse and order diamonds and jewelry online, to be delivered from a centralized warehouse.

Many retailers now offer the fourth option, which allows customers to place orders remotely and then pick them up at a specified location. Walmart advertises “free in-store pickup” of online orders. Similarly, grocery retailers in the United Kingdom, such as Tesco and ASDA, offer a “click & collect” service which allows customers to order online and then retrieve their products from designated pickup locations.

The Strengths and Weaknesses of Each Channel

In order to strategize successfully, a firm must understand whether each interaction targets price sensitive or service sensitive customers. It must then evaluate the costs of fulfilling the order through each channel so it can use the channel that generates the most value. Different channels have different strengths which affect the two components of ROIC, profit margin and IC turns, for any given product.

Performance of channels in meeting customer needs

If its customers are willing to pay a premium for service elements such as variety or customization, speed, or the convenience of delivery, a retailer can increase profit margins as long as fulfillment costs are contained. Each channel has its own service strengths and weaknesses.

By keeping products in stock, retail stores allow nearby customers to quickly pick up physical products. Retail stores are also ideal for products with a lot of information complexity because they allow customers to try the product in person. However, these same stores can carry only a limited variety of products. The online channel, although it cannot deliver as quickly, can offer a much wider selection of products. Blue Nile uses its website to offer customers more than a hundred thousand diamonds at any given moment, while jewelry stores generally carry, at most, only a few hundred diamonds. Blue Nile’s online channel also offers the convenience of having the product delivered to your doorstep.

The showroom channel can even offer an greater variety than the online channel for products with high complexity of information and customization because it allows customers to make more precise selections, for example by being measured. Indochino, a seller of men’s suits, uses small showrooms to help customers select fabrics and styles and to be measured. The made-to-measure suits are then produced offsite at a low-cost location and shipped to the customer. Indochino can thus provide a unique product for each customer at a reasonable price. Because of the high information complexity associated with a customized suit, it would be harder to get such good results through an online channel.

Performance of channels in terms of cost

As well as customers’ willingness to pay, profit margins and turnover are also influenced by the cost of meeting those needs through each channel. The performance of each channel must therefore also be considered in terms of the necessary investment in inventory and facilities, and the cost of labor and transportation. Each channel uses either a centralized or decentralized structure to manage inventory and fulfill orders.

Figure 3 describes how aggregation of facilities and inventories affects a retailer’s costs. Decentralization increases a firm’s investment in facilities because it entails losing the advantage of economies of scale. When a firm decentralizes it must invest more in inventory because the underlying demand becomes less predictable at the local level. Decentralization also increases labor costs because the workload becomes less predictable than at a centralized facility like a warehouse. On the other
hand, decentralization lowers transportation costs by decreasing expensive outbound shipping.

Traditional retail usually requires the highest investment in inventory because every local store must be stocked with inventory. Online and showroom channels require less inventory because that inventory is aggregated into only a few locations. Blue Nile, for example, stores its entire global inventory of diamonds at two warehouses. Tiffany, by contrast, needs a larger total inventory because it must stock about 300 retail stores. As a result, Blue Nile turns its inventory over ten times faster than Tiffany, in terms of cost of goods sold: 9.8 turns in 2012 for Blue Nile compared with about 0.73 turns for Tiffany.

The online and showroom channels can operate with even less inventory if they do not introduce variety until after the customer has ordered. Indochino, for example, carries very little inventory because it does not start production of a customized suit until after an order is placed. Amazon, likewise, reduces inventory by using print on demand technology for books that sell infrequently.

The online channel with home delivery requires the lowest investment in facilities because it allows firms to centralize their operations in a few locations. Traditional retail requires the highest facility investment because face-to-face information exchange and product pickup rely upon many locations. In 2012 Blue Nile earned about $50 in sales for each dollar invested in PPE, whereas Tiffany earned less than $5.

Centralized channels like Blue Nile also make much better use of labor and have lower operating costs because they pool their resources. Filling online orders from decentralized stores increases labor costs because employees, rather than customers, must pick each order. This increase in costs is hard to justify if customers are not willing to pay a premium for the service. The efforts of Macy’s to use its stores to fulfill home delivery orders failed largely because its in-store fulfillment costs increased but it did not reap the benefits of aggregating its inventory into centralized warehouses.

Because the showroom channel needs smaller and fewer facilities than a traditional chain of retail stores but more than the online channel, it is likely to incur facility costs that are somewhere in between.

The online channel with pickup is likely to incur low facility costs if it uses existing locations (like Walmart), but medium facility costs if it must build new pickup locations. Offering pickup can, however, significantly increase the cost of labor if it requires employees to do tasks that were previously performed by customers. Click-and-collect gro-

| Table 1: Relative Costs of Each Channel to the Retailer |
|-----------------|----------|-------------|------------|----------|
|                 | Inventory| Facilities  | Transportation| Labor    |
| Traditional Retail | High     | High        | Low        | High     |
| Showrooms + Home Delivery | Low - Medium | Medium     | High        | Medium   |
| Online Information + Home Delivery | Low | Low        | High        | Low      |
| Online Information + Pickup | Low - Medium | Low - Medium | Low - Medium | Medium - High |

FIGURE 3: The Impact of Aggregation on Retailer Costs
culty services increase labor costs because workers, rather than customers, pick the orders. This is especially true of orders picked at local retail stores instead of at fulfillment centers.

The decentralized traditional retail channel is most price competitive for products like detergent, toothpaste, or diapers, whose value to weight ratio is low and whose demand is predictable.

By aggregating their inventories, firms incur higher transportation costs because of the need for outbound shipping directly to the end customer. Whereas traditional retail incurs the lowest transportation costs, the showroom and online channels which offer home delivery incur the highest transportation costs because the product is shipped to each individual customer from centralized locations. If products are shipped in sufficient volume to a pickup location, customer pick-up can lower the cost of transportation for the showroom and online channel to nearly that of traditional retail, which explains Walmart’s enthusiasm for in-store pickup of online orders.

Designing the Omni-Channel Portfolio

Given the large variety of product characteristics, firms need a portfolio of channels to fulfill the needs of all their customers. Where-as price sensitive customers may choose to buy diapers cheaply from a local store, service sensitive customers may prefer to pay a premium for home delivery of the same diapers. Figure 1 illustrates how, by focusing on ROIC through turns achieved, labor and transportation cost, and each channel's potential price premium, firms can design a suitable omni-channel portfolio. The decentralized traditional retail channel is most price competitive for products like detergent, toothpaste, or diapers, whose value to weight ratio is low and whose demand is predictable. The high demand and low cv of such products naturally result in high IC turns, while the traditional retail channel keeps transportation costs low. A decentralized retail network can therefore get a good ROIC for such products even while keeping prices low. Costco is an excellent example of this model. By selling no more than 5,000 fast moving products for which the demand is predictable, Costco achieves excellent IC turns at its nearly 800 stores with a better inventory turnover than Amazon. With all products brought to stores in quantity, Costco also has very low transportation costs. And because its products are fast-moving, its labor costs are relatively low per dollar of sales. The company’s high stock turnover, coupled with low transportation and labor costs, allows Costco to achieve a high ROIC despite low prices.

Hyper-local retail, in which stores address the specific needs of their own communities, is another model which allows firms to exploit these advantages. Nike by Melrose and Amazon 4-star use dedicated physical locations to provide locally popular products. Because their products are locally popular, the stores’ IC turns are high enough to be worthwhile. Nike and Amazon can thus achieve a decent ROIC while providing local customers with face to face service and the opportunity to examine products firsthand before purchase.

Meanwhile products such as diamonds or fashion goods, for which there is low demand and which have a high cv and value, produce poor IC turns through the traditional retail channel because they require a relatively high investment in inventory and facilities. Their cost of labor also tends to be high in the retail channel. As a result, firms must be able to set store prices high enough to generate a high profit margin if they want to get a decent ROIC for such products through the traditional retail channel. Stores must offer their customers some valuable service, including the opportunity to try high information complexity products, so that they will be willing to pay a premium. The brand prestige and luxury experience of shopping at Tiffany carry enough cachet that its customers will pay a premium to buy an engagement ring at a Tiffany store. Tiffany’s gross profit margins are around 55 percent so, in spite of poor IC turns, Tiffany stores achieve a good ROIC.

The showroom channel is ideally suited to offer competitive pricing on products with greater information complexity, unpredictable demand, and high value.

Another way for traditional retail to compete on price is through strategic actions, such as fast fashion, that improve their IC turns. Zara achieves high IC turns by restocking its stores with very little lead time which ensures that the products most in demand are quickly available in-store. Uniqlo, by contrast, improves its IC turns by offering a limited variety of products in its stores. Because of their high IC turns, both Zara and Uniqlo can charge comparatively lower prices in their stores and still achieve a high ROIC.
Using a physical showroom also allows customers to experience products firsthand while yielding better IC turns by fulfilling orders from a centralized location. The showroom channel is ideally suited to offer competitive pricing on products with greater information complexity, unpredictable demand, and high value. As long as customers are willing to wait for the product, the retailer can also keep its inventory in the form of raw materials, producing its products to order at lower cost facilities or even in low cost locations. Fashion goods, bespoke suits, and expensive customizable cars are well suited to the showroom channel. Companies such as Indochino and Black Lapel used the showroom channel to sell men’s suits and shirts, highly customized products for which it is hard to achieve an individual fit online. The showroom channel allows them to customize fit in person, while achieving high IC turns by centralizing and postponing production, thereby attaining a high ROIC even while giving up profit margin by charging lower prices than a traditional retailer.

The online information with delivery channel is most price competitive for long tail products with relatively low information complexity.

The online information with delivery channel is most price competitive for long tail products, niche products for which there is low but ongoing demand, with relatively low information complexity. Most books are in this category because the demand for each title is low and the product information is easily conveyed through a brief synopsis augmented by reviews and customer ratings. The combination of online channel with long tail products can be highly price competitive because, by centralizing inventory, it achieves much higher IC turns and lower labor costs than traditional retail. As a result, this channel supports competitive pricing for products with unpredictable demand and high value to weight ratios such as diamonds or designer apparel. Currently, the value of this combination is limited by the high information complexity of most high value products, which customers prefer to experience in person. However, as we improve our ability to interact with complex information remotely, through such technologies as virtual reality, the online channel will become highly price competitive for expensive products with complex information.

For fast moving, low cv, low value-to-weight products such as bottled water, however, the online information with home delivery channel cannot compete on price. For such products, centralizing inventory does not significantly improve IC turns but it does incur considerably higher transportation costs. To achieve a high ROIC on such products, the online channel must either charge higher prices for home delivery or reduce transportation costs. Amazon has, in many instances, used the former strategy. For example, Amazon used to sell a six-pack of Smartwater for home delivery at $6.99. In August 2018, however, it raised both the minimum order and the price per unit by changing the default to a 24-pack for $37.20. Firms can reduce transportation costs by offering such products only as add-ons to more profitable items or as part of a minimum sized order. Another way to reduce transportation costs is to use decentralized fulfillment centers. Albertsons, Walmart, and other grocery chains have begun building small fulfillment centers near existing stores and customers so they can quickly fill online orders. For grocery items with low uncertainty and value to weight ratios, decentralized fulfillment centers improve the company’s responsiveness and lower its transportation costs without giving up much in terms of IC turns.

With its lower delivery cost and much lower chance of package theft, the online information with pickup channel ideally complements the home delivery channel. Walmart encourages store pickup because its additional cost and investment is much lower than that of home delivery. Meanwhile, Amazon has been hard pressed to adopt this option in the United States because it has far fewer facility locations. The relative advantage Walmart gains by offering pickup grows significantly in rural areas, where the cost of last mile delivery is very high and Amazon has no physical locations. This channel may also become more important in urban areas where package theft is on the rise. A recent report found that about 90,000 packages are stolen every day in New York City. Given the cost of last mile delivery and the danger of theft, this channel is likely to be increasingly important worldwide. Magazine Luiza, a large retail chain in Brazil, uses it to serve rural customers at a cost that neither traditional retail nor home delivery can match.

It is important that retailers devise a portfolio of channels which match products to customer needs. A department store should thus carry the items which are most popular locally in store inventory. These products can also
be shipped to service sensitive customers at a premium, perhaps from a more central location. Retail stores should also be used as showrooms for customized products and those that are only stocked centrally, like clothing in less popular colors. Using the store as a showroom does, however, require more skilled salespeople than selling regular inventory. To sell a wide variety of slow-moving items, firms should stock centrally and sell online at competitive prices. Only if service sensitive customers are willing to pay a premium should these products be stocked in retail stores. Such stores should also be equipped as pickup locations where price sensitive customers can save on shipping costs.

A firm’s success will depend on its ability to first describe the strengths of each channel to customers in terms of services and price and then be agile enough to

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<th>Table 2: Competing for products with different uncertainty</th>
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<td><strong>Predictable demand product</strong></td>
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<td><strong>Showrooms + Home Delivery</strong></td>
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<th>Table 3: Competing for products with different value to weight ratios</th>
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<td><strong>Low value/weight or volume product</strong></td>
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match the strengths of each channel with the characteristics of each product to fulfill the needs of every customer.

A firm’s success will depend on its ability to first describe the strengths of each channel to customers in terms of services and price and then be agile enough to match the strengths of each channel with the characteristics of each product to fulfill the needs of every customer.

**How to Adapt an Omni-Channel Portfolio**

It is vital that a firm be able to adapt its omni-channel portfolio to different countries and to changes in technology and customer preferences. Amazon is now investing in putting Amazon Easy stores across India to help people place online orders. These stores are not only pickup locations, eliminating the high last-mile delivery costs common in emerging economies, they are also virtual showrooms where customers can experience a product, a service that first-time users in such economies tend to value. Amazon has also partnered with local shopkeepers in smaller Indian cities to supply groceries. This partnership broadens Amazon’s omni-channel portfolio which improves both its own ROIC and that of the local shopkeeper. The shopkeeper’s ROIC is improved by higher sales without greater investment. One small vegetable shop in central Bhubaneswar reports earning an additional $200 a month by handling deliveries to nearby customers. Meanwhile Amazon increases its sales without having to invest in PPE or incur significant delivery costs. Given the high cost of last mile delivery in emerging economies, the omni-channel portfolio must rely heavily on local facilities, often through partnerships, to serve as showrooms, micro-warehouses, and pickup locations. The use of such facilities can also be important in the large cities of developed countries.

It is vital that a firm be able to adapt its omni-channel portfolio to different countries and to changes in technology and customer preferences.

And evolution in experiential and production technologies is likely to drive significant evolution in these portfolios. As technology which allows customers to experience a product remotely improves, the centralized online channel is becoming a better option for products like jewelry, fashion, and shoes, which have a high information complexity as well as high demand uncertainty and high value to weight ratios. Centralizing such products improves turnover considerably. Firms should therefore be prepared to respond to improved experiential technologies by increasing their use of centralized channels.

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<th><strong>Table 4: Competing for products with different information complexity</strong></th>
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As flexible production technologies, such as 3-D printing, become cheaper, firms should be ready to move them into local facilities, making retail stores into local, flexible production sites while reducing their inventory of finished goods. Customers will be able to exchange complex product information like their measurements while, by postponing production, firms will be able to improve inventory turnover despite the need to stock raw materials locally. In India, where low-cost tailoring is readily available, department stores carry pants that are separated by waist size but not by inseam length, which reduces their total investment in inventory. Onsite tailors then customize the inseam length for each customer in a few minutes. Cheaper flexible production technologies thus favor firms increasing their use of local, decentralized channels.

By building an omni-channel fulfillment portfolio, firms can best serve their customers and generate good financial results while retaining the flexibility to change the portfolio in response to evolving conditions.

**Endnotes**

1. Macy’s Inc. annual report 2012.
2. For more on my proposed framework, see:
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Uday Karmarkar,
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Digital technologies are changing the structure of information intensive services through a process of industrialization. The effects are specific to each service category including transactional, functional, content-based, and knowledge-based services. Consumer consumption behavior and physical services are also affected. Uday Karmarkar argues that managers must analyze the changes to their particular industry and revamp their strategies, core processes, and supporting systems accordingly.
The US economy, already dominated by services, is becoming ever more information intensive in terms of GNP, job, and wage shares. The move toward services is visible in all the world’s economies. Meanwhile, the shift to an information focus is driven by the information and communication technologies that have appeared since the beginning of the 20th century, a process which accelerated with the advent of digitization in the latter half of that century. This trend is most visible in highly developed economies. Less developed economies have not moved as far toward this “information economy,” but they are heading in that direction, slowed only by the expense of personal digital devices. As those devices cost less and these economies do better, the same shift will occur everywhere. The largest telecom subscriber bases and the largest numbers of internet users are already to be found in countries with large populations like China, India, Nigeria and Indonesia, despite their lower wealth levels. In fact, the information economy tends to scale with population, since it is driven in large part by consumer consumption patterns, as is exemplified by smartphones and apps.

The characteristics of each sector determine the specific changes that will occur in the sector.

Of course these trends affect the economy as a whole, and they are also transforming industries, sectors, and companies. Much of the change derives from the decisions made by local managers as they strive to improve performance and competitiveness. These decisions and actions can be viewed as technology enabled service industrialization. Analogous to the 19th century industrialization of manufacturing yet combined with the economic and functional characteristics of modern information technologies, this process has created certain patterns of structural change in service systems. One important result is the convergence of different service verticals into a common form at many process stages. Another is that processes throughout the sector become modular due to simple standard interfaces, standard formats for inputs and outputs, and the disappearance of physical media. These changes in turn bring on structural consequences such as the de-integration of traditional industry verticals. While these effects generally apply to most information intensive services, each sector differs in terms of processes, services delivered, markets addressed, consumer behavior, and the preferred systems and channels. So the characteristics of each sector determine the specific changes that occur in that sector.

Initially, the consequences of service industrialization were felt most strongly by information intensive services. Even within those, there are different trends in the evolution of processes, competition, and the success of new entrants. Some sectors have already been severely disrupted, while others seem unaltered, even though they may be on the threshold of radical change. As we might expect, the effects on a content based sector, such as music distribution, look very different from those on a transaction intensive sector like retail banking or on a functional service like email or search. Some industries may appear to be shielded from industrialization to some extent or for some time, but very few will be impervious in the long run.

It is important to understand the largest categories of information intensive services as well as the main approaches that comprise service industrialization. As I described in Part I of this paper, there are certain underlying causes of the digital convergence which is changing this sector. The consequences include structural effects such as vertical de-integration, horizontal technology dominance, and modularization. Together, they inspire new and emergent strategies, including service platforms and bundling, that can apply to all categories of information intensive services. There are also factors and structural changes specific to each service category which may be traced through the evolution of some of the major information intensive services, including content delivery, transactional, knowledge based, and functional services.

**Service Industrialization and Information Intensive Services**

Service Industrialization refers to the application of technology accompanied by reengineered processes which managers and engineers implement in order to improve profitability, quality, customer retention, and market share. These actions and decisions include:

- **Automation** of process steps and information logistics;
- **Outsourcing and offshoring** to geographically disperse processes outside the company;
- **New services creation** enabled by new technologies;
- **Redesign of services and processes**, both small and large;
- **New markets, exchanges, and networks** with many to one, one to many, or many to many interactions;
Online delivery with global reach
Personal devices for customer access, ordering, delivery, consumption, and data capture,
Self-service and relocating operations within the service chain.

As I mentioned above, industrialization has its biggest impact on information intensive services. While there is a broad diversity to these services, we can categorize them into the following major types:

- **Transaction based services**, including banking, brokerage, reservations, and ticket sales;
- **Content based services**, such as music, news, data services, publishing, and education;
- **Functional services**, like telecommunications, search, email, web, and cloud services;
- **Knowledge based services**, which include financial planning, consulting, and medical diagnostics;
- **Networking, interaction, and exchange services**, such as social networks and content sharing;
- **Everything-as-a-service (XaaS)**, that transforms information and communications equipment and assets such as storage, transport, hardware, and software, into cloud and online services; and
- **Sharing services or micro-rental platforms** dealing in physical assets

Just fifteen years ago, these categories were relatively distinct and most firms tended to fall into just one of them. But those boundaries are blurring as the big players, like Amazon, Google, Apple and Microsoft, have begun to bundle together a vast range of services. Nevertheless, each category is still subject to its own distinct patterns of industrialization, competition, and process structure and therefore requires different operational and strategic approaches.

For each of these business to consumer (B2C) categories there are business to business (B2B) equivalents. For example, commercial banking and insurance are B2B transaction services, while web and cloud services (like Amazon Web Services and enterprise software (like Salesforce.com), are B2B functional services. A firm’s internal services are naturally even more specialized and firm-specific. They include management and decision making functions such as resource planning, financial management, human resource management, and sales management in addition to all internal transactional and functional services. Most organizations, including manufacturers, can be viewed as bundles of service processes, with embedded information and knowledge. These processes are equally vulnerable to industrialization and disruption to varying degrees.

The industrialization of internal services began many decades ago with mainframe computers, and before that with typewriters, telephones, calculators, tape recorders, and other electromechanical technologies. Much of this industrialization was not particularly visible to consumers except when it directly affected their own experiences. It hardly caused a ripple in the economic data, provoking Solow’s famous 1987 quip: “You can see the computer age everywhere but in the productivity statistics.” But the implications for jobs were very apparent even then. Consider how many accountants, payroll clerks, record keepers, filing clerks, and secretaries were employed in 1950, and how many were left by 1990. Nowadays, Solow’s comment is no longer apt; the effect of information technology on aggregate productivity has been increasingly visible since the mid-1990’s. Today we also see substantial effects on employment and wealth distribu-

Convergence in Information Services

One important consequence of the digitization of information intensive sectors is convergence, which occurs across all information intensive sectors as:

- Convergence to digital form;
- Convergence of logistics, including transport and storage;
- Convergence of processing, from servers to personal devices;
- Convergence of processes, both large and small, within the organization and without;
- Convergence in use and consumption by both businesses and end users.
These types of convergence and their consequences for sectors are described at length in Part I of this article. Among the major effects on sector structure are:

- Vertical de-integration and modularization of process stages;
- Lateral technology dominance across industries, caused by the convergence of sectors and processing tools;
- Ease of entry in many sectors, because of the declining costs of equipment and web services;
- Commoditization of functions and outputs leading to challenges for differentiation;
- Changes in competition patterns and competitive regimes;
- Novel designs for services and service processes;
- The emergence of platforms that can support multiple service categories;
- Bundling strategies, enabled by such platforms;
- The appearance and rapid growth of cloud and web services including infrastructure as a service (IaaS), platform as a service (PaaS), unified communications as a service (UCaaS), and software as a service (SaaS).

Beyond these general effects, each sector faces its own issues because each sector focuses on different services, different markets, and different customers and therefore uses different strategies.

Sector concentration, along with the size of the largest firms, presents an interesting conundrum. Low fixed costs, process modularization, widely available technological capability provided by third parties, and low operating costs would seem to favor low barriers to entry, as would the relative ease with which customers can switch firms. They would also then favor a plethora of firms in each sector, price competition, and the fragmentation of sectors into niches. On the other hand, commoditization, design convergence, the lack of differentiation between companies, and sector specific barriers to entry, such as network externalities, scale economies in backroom server operations, large databases, the importance of branding in a commodity setting, platforms, and lateral bundling strategies can all combine to create a concentrated market dominated by a few large firms. It turns out that both can be true in different (vertical) sectors and across different stages of end-to-end information chains.

Transaction-based Services

Some of the first information intensive services to see industrialization, restructuring, and disruption were predictably those involving fairly simple transactions that were easily automated and required little bandwidth. Retailing and consumer product sales were clear candidates for the transition to online access, bringing unprecedented convenience to customers. E-commerce is growing rapidly worldwide, with Amazon the clear leader in the US and in the world too, though with Alibaba not far behind. No retailer can afford to ignore this trend. Walmart, for example, is expending substantial money and effort to avoid being sidelined and is now in second place in the US. Meanwhile, many new firms have entered monetary transaction sectors such as bill payment, payment processing, and cash transfer. They have succeeded in part because incumbents, like banks and credit card companies, were not fast enough to provide these services in a convenient digital form. Telecom companies that once had a distinct opportunity to provide such transaction services apparently did not see it even though they spent large sums on their own bill payment channels.

Financial services, meanwhile, have gone online rapidly. Table 1 shows the evolution of retail banking, which is in the middle of highly disruptive changes, caused in large part by automation. Most banks adopted automation in the back room some time ago; now they are bringing it to the front office, albeit somewhat late. Customer access is going online, while also shifting largely to mobile devices. Once banks were permitted to add investment services, they began to do so by outsourcing, with many building relationships with existing brokerage houses so they could rapidly expand into that service. Banks have also outsourced credit card services, acting for the most part only as sales channels.

As customers use mobile devices for more and more transactions, local accessibility becomes ever less important. Most customers already do not know where their banking transactions are actually processed, and probably do not care.

US banks (with the notable exception of Citibank) have not been quick to adopt offshoring or to globalize, perhaps because of security concerns. Now, most major banks are moving their call centers offshore and it seems likely that other processes will follow. Within the US, most back room banking resources have already been dispersed geographically. As customers use mobile devices for more and more transactions, local accessibility becomes ever less important. Most customers already do not know where their banking
transactions are actually processed, and probably do not care. Banks now face the danger of commoditization and intense competition over ever larger service areas. Historically, customer service at branch banks was rarely outstanding. The service process designs for the branch offices of most banks had converged into a standard format, driven more by history and efficiency than customer satisfaction. While banks had a strong hold on local service areas, this system was adequate. As branch locations become less important, consumers give more weight to their experience with mobile access. They will also find it easy to compare online services processes across providers and it seems that as yet, the process designs for those services have not converged to a dominant design.

Many of the issues facing retail banking also apply to other transaction-based consumer information services such as brokerage, mortgage origination, bill payment, reservations, and ticket sales. These sectors must also negotiate commoditization, mobile access, new entrants, and intense competition in which some firms consolidate while others succumb. The basic requirements for success are also changing. Internally, successful firms need automation, systems integration, data analytics, outsourcing, and cost reduction through outsourcing and off-shoring. In the front office, firms must be prepared to bundle services in innovative ways and combinations, while constantly managing and improving their customers' experience.

The biggest looming threat for banks, credit card issuers, and other payment intermediaries is the impending introduction of digital fiat currencies which several countries, most notably China, are now considering. The technology which underlies these currencies will probably be distributed duplicate ledgers rather than the full, complicated blockchain mechanism. Digital currencies could place transactions in the hands of government agencies, simplifying government activities such as taxation and funds distribution, and perhaps making them more secure. Tracing the movement of money should become easier, making illegal transactions more difficult, though cryptocurrencies could still confer anonymity. Governments may be able to more directly control the quantity of money, though it remains to be seen how exactly they will do so and whether banks will continue to play a role. In any event, the adoption of digital currencies will force banks to reconsider their service portfolios, perhaps shifting more towards loans and investments.

**Table 1: Retail (consumer) banking industrialization and process changes**

<table>
<thead>
<tr>
<th>Service Stage</th>
<th>Traditional</th>
<th>Recent</th>
<th>Online Digital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access</td>
<td>Branch</td>
<td>ATM</td>
<td>Online, phone</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Teller</td>
<td>ATM and self</td>
<td>AI, platform, self</td>
</tr>
<tr>
<td>Process Menu</td>
<td>Teller, script</td>
<td>Fixed menu</td>
<td>Flexible, adaptive</td>
</tr>
<tr>
<td>Process Selection</td>
<td>Teller and customer</td>
<td>Customer selected</td>
<td>Customer routed</td>
</tr>
<tr>
<td>Process Execution</td>
<td>Teller</td>
<td>ATM (local)</td>
<td>Multiple sites, remote</td>
</tr>
<tr>
<td>Exception Handling</td>
<td>Teller, supervisor</td>
<td>Branch based</td>
<td>Automated, hybrid, off-shore</td>
</tr>
<tr>
<td>Sales, Cross Selling</td>
<td>Minimal</td>
<td>Rigid, repetitive</td>
<td>Customized, learning, adaptive</td>
</tr>
</tbody>
</table>

Like other industrialized and commoditized services, the banking sector is experiencing consolidation through mergers and acquisitions which is likely to continue for some time. In banking, as in other commodity services, scale and brand are now vital for differentiation. Right now, there are simply too many banks in the US. Since 2002, the number of FDIC insured banks has already dropped from over 7800 to around 4700, a trend that is likely to continue for some time. Banks are now bundling some services like credit cards, brokerage (like Bank of America and Merrill Lynch), and mortgage banking by way of mergers and acquisitions (Norwest Mortgage and Wells Fargo). Some banks are trying to differentiate their branches by expanding them into stores, cafes, and lounges. At best, this is a transitional strategy that may boost market presence and new customer acquisition temporarily, but will not improve core services.

Perhaps the most important potential differentiator for banks in the short term is the provision of a superior mobile banking experience.
and the automation of many related process. Working through automated server-based platforms with an increasing reliance on data analytics, these services are available 24/7, are delivered fast, and have a growing range of advanced functionality.

Convergence of processing means that the equipment and tools used for processing information are essentially the same across service sectors, regardless of their nature or purpose. With the availability of near instantaneous low cost logistics, third parties can now provide many kinds of outsourced functional service to both B2C and B2B customers. Cloud and web services, including email, messaging, internet service, hosting, cloud storage, file transfer, and website development, have become a major market catering to both businesses and individuals. The B2B sector has recently seen explosive growth, including infrastructure as a service (IaaS), platforms as a service (PaaS), unified communications as a service (UCaaS), software as a service (SaaS) and functions as a service (FaaS), all of which permit companies to outsource a significant proportion of their IT function. Salesforce.com’s customer relationship management (CRM) application was one of the earliest online services of this kind. It was quickly recognized as an effective way to centrally manage sales personnel who might be spread over a wide geographical area. Since then web service providers have proliferated rapidly. Among the many hundreds in the US, and thousands in the world, Amazon is both a pioneer and the largest player today.

Like telecom services, web services are highly standardized, largely quantifiable, remotely provided, and easy to compare by price. That makes competition intense and there have been significant price drops recently, which will probably continue. It is likely that many providers will consolidate or exit, leaving only a few big players surviving. To withstand this intense competition, firms will be driven to bundle more and more specialized services, in addition to all their standard functions, in an effort to differentiate themselves. Of the major categories of web services, the SaaS category mentioned above currently shows the most potential for differentiation and specialization. So it can be expected that web services providers will start to provide functional capabilities in SaaS format, specialized to particular functions (such as finance, HR, resource planning) or to specific industries (such as financial services, health care, and retailing). This has already happened with ERP system providers, and one can expect a convergence between web services and enterprise systems. A fast way to achieve this will be through mergers and acquisitions, and we can expect a wave of those to appear.

Knowledge Based Services

The impact of technology and industrialization is now beginning to affect services that are either passively or actively knowledge intensive. Knowledge which can be expressed as static content in the form of books, research papers, databases, music scores, or blueprints, is already being widely converted into online forms which, unlike traditional media, remain open to continuous amendment, variation, and addition. Now, services that rely on more complex knowledge and expertise, and need to respond dynamically to specific situations, are increasingly available online. These systems were originally “rule-based” and usually addressed only a limited range of issues in a narrowly defined domain. In a sense they were analogous to an FAQ page. Now we see far more complex systems using methods generally described as artificial intelligence (AI). Note that AI is not a cohesive methodology, but an umbrella term for a collection of many tools which range from variations on traditional statistics, logical processing, and mathematical modeling, to neural nets and deep learning. In this context, the relevant point is that this use of AI is effectively the automation of knowledge-based processes, which were historically performed by human experts and provided high wage jobs in many industries. This development begins to extend automation from routine tasks to those which once appeared to be protected from technology and industrialization.

One growing example of the automation of knowledge-based services is medical diagnosis. Table 2, on diagnostic imaging, also illustrates other aspects of the industrialization of expertise. The first column shows the methods used for imaging in the recent past, when X-ray equipment, the diagnosing doctor, and the transcription clerk were generally all located in one hospital. Images were captured on film, which tied these stages together. Now imaging uses many different types of equipment, including MRI and ultrasound. The images are digital, and the diagnostic process has been de-integrated and modularized. Automation of diagnosis is already used for some categories of diagnostics like mammography and prostate screening. IBM’s Watson system is being applied in oncology, though questions have been raised about its efficacy. Nonetheless, it seems very likely that AI systems will be an increasingly common tool to provide support to human diagnosticians if not to replace them. Imaging is also increasingly outsourced to external providers since the equipment is highly automated and the output image
files are easily transported. Diagnosis can readily be outsourced, geographically dispersed, or even offshored, again due to the ease of transporting image data files. The work of medical clerks, such as transcribing diagnoses, is frequently outsourced and offshored already, and is gradually being automated. Over time, many types of patient visits and diagnostic procedures are likely to involve some degree of industrialization, whether by outsourcing, offshoring, or automation. Meanwhile self-service will work for some operations as sensors and imaging equipment become smaller, cheaper, safer, and easier to use.

The IBM Watson system provides a good leading indicator of other areas in which automation of expertise is technically possible and economically feasible. So far, uses for Watson which have reached at least the trial stage include financial services, talent management, health care, regulatory compliance, systems diagnostics and maintenance, employee training, insurance claims assessment, and individualized customer service. IBM’s AI is a large-scale, multi-method enterprise system, which is not necessarily economically viable for all firms. However, many more modest applications are already available for specific cases, and it is reasonable to expect SaaS versions to become widely available in future. We are already at the point where industrialization has negatively affected employment in transactional services (bank tellers), information services (help desks and travel agent) and backroom tasks (filming clerks and accounting). Though jobs requiring more advanced expertise and knowledge have grown recently in both job share and wage share, that pattern may not continue for long.

### Content Based Services and Information Chains

Content based services include music distribution, magazines, news, images, video, weather, books, financial information, and education. Most of these sectors involve information chains, a sequence of activities which delivers content in much the way that supply chains deliver products. These chains begin with acquiring content, whether through purchase, recording, transactions and data capture by sensors (including cameras), or through creation, as with writing, art, music composition, or speech. The production process which follows can be as complex as making a movie or as simple as assembling articles on pages for a news website. Several logistical steps, such as storage, transport and final delivery, may be involved, and all of them employ industrialized information and communication technologies. These information products can be delivered to consumers through broadcasts, podcasts, streaming, or web page access. Most of the content will be consumed through devices with screens and speakers, which are increasingly personal and portable.

Though information chains might look superficially like supply chains, there are crucial differences when they are digital, with fundamentally different economics. The biggest difference is in the driving force behind the chain. In a supply chain, flow is driven by demand. Demand occurs at the end point where products are sold and inventories are depleted. The rest of the chain is set in motion by the need to replenish stock, partly as a “pull” due to demand and partly as a “push” from planned production, so that in the long term, net flow is roughly equal to sales. Digital information chains don’t work that way. Delivering digital content like music to satisfy demand does not cause any inventory depletion, so no replenishment is required. Instead, anything that goes into end inventory can in principle stay there forever. Inventories are depleted only by obsolescence and active purging. Obsolescence is due to a loss in the content’s value in the end market or to the appearance of new information that supersedes the old. So the end inventory store, whether it be a content library or a database, could just keep growing if it isn’t periodically purged of erroneous, obsolete, or low value information.

At the other end of the chain, content inflows only occur with the appearance of new material. And unlike cars or apparel, the influx of content does not necessarily match

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**Table 2: Diagnostic Imaging: resources and operations in past, current and future processes**

<table>
<thead>
<tr>
<th>Service Stage</th>
<th>Recent Past</th>
<th>Current</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access</td>
<td>Patient to hospital</td>
<td>Patient to machine, machine to patient</td>
<td>Local sensors, remote consults, and diagnosis</td>
</tr>
<tr>
<td>Process (Imaging)</td>
<td>Co-located machine, and technician</td>
<td>Outsourced service, machine, technician</td>
<td>Outsourced, automated machine, attendant</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Co-located, doctor at hospital</td>
<td>Remote diagnosis, offshore, some AI aided</td>
<td>Remote diagnosis, AI supported</td>
</tr>
<tr>
<td>Transcription</td>
<td>Co-located clerk</td>
<td>Automated, offshore</td>
<td>Automated</td>
</tr>
<tr>
<td>Diagnosis Record</td>
<td>Text (paper), film</td>
<td>Audio, text, image files</td>
<td>AI output, image files</td>
</tr>
</tbody>
</table>
either recent sales or current purge removals. Content production is not intended to replenish depleted inventory levels, so inflows look more like random arrivals of content, sometimes from unexpected sources. New content must then be processed and stored in the end database, ready for delivery. The key to new "inventory" therefore is not that the incoming content fills a specific void, but rather that it must be new, different, and of some incremental value to consumers to be worth accepting, processing, and adding to storage. The closest supply chain analogies to such information chains might be those for fashion goods or craft objects, products whose value is driven by their own novelty and their predecessor's obsolescence. Even there, depletion and replenishment still drive production. Conversely, the information chains most analogous to supply chains are those with fixed delivery schedules like news, in which a certain amount of air time or column inches must be filled and old news cannot be reused. The content production schedule in these markets is also regular, though again firms prefer new content that their competitors don't have. If new content is not available, as on the proverbial slow news day, older stock content or low-quality items may have to be used as filler. As news moves increasingly to online distribution and mobile access, consumption patterns move closer to news arrival and fixed schedules begin to fade away, though some information categories, such as weather, stock prices, and flight tracking, will continue to require regular update schedules to match demand patterns and changing conditions.

Consider the effects of digitization and industrialization on the distribution of recorded music. The information chain (Table 3) for this sector has evolved in ways similar to that of diagnostic medicine (Table 2).

Physical media once played a major role in music distribution, from capture to consumption. A few big companies dominated almost 90 percent of the market until 2012. But digitization and industrialization have caused massive changes in a very short time. Competition is now fierce, because the relative ease of content creation and capture make it an easy sector to enter while the diversity of content allows for differentiation between firms. In addition, obsolescence rates are high for many kinds of music, and new performers and performances appear constantly even for long-lived examples like the classical music of various world regions. The rest of the chain, apart from the performance itself, has been industrialized and digitized. Until recently, the music industry operated as a clear vertical, dominated by three companies that controlled relationships with artistes, and content acquisition. Today, power is rapidly shifting towards large players at the distribution and database end which is digitized and commoditized. As a result, total industry revenues have dropped substantially from 2000 till today.

For music distribution, large new firms have appeared at the on-demand service (content) delivery stage, including Spotify, Pandora, Apple Music, Amazon Music and Google Play. So far their pricing is quite similar; but with many entrants and similar services offerings, price competition is becoming more intense, and could soon lead to a shakeout. These new distributors still acquire older content from existing publishing firms, but with new artists constantly producing new music, distributors will increasingly be able to bypass publishers and deal directly with performers and independent studios.

This trend is already present with video content. Amazon and Netflix are producing and funding new content. Symmetrically, Disney is acquiring (Hulu, ESPN) and creating distribution channels for their own content (Disney Plus). These channels are also available as a bundle. As on-demand channels proliferate online, broadcast TV is seeing the first signs of decline. Film viewing in theaters is also decreasing, with ticket sales having peaked around 2002. Apple's bundling of video streaming with other content and Disney's entry into streaming video have increased the threat to other firms and the competitive intensity in video distribution. Furthermore, a considerable proportion of video viewing has shifted to advertising supported exchange, with YouTube the dominant leader.

The decline in book publishing has recently slowed, despite Amazon's relatively early start with
e-books and online distribution. Printed books may now be holding their own due to physical experiential value and familiarity. However, this could simply be a generation-al issue, since children and young adults (CYA) are moving towards online channels faster than older generations. Books may also soon need to compete against video and other online activities as delivery and consumption converge on mobile devices. On the supply side, as entry into the market becomes easier, there are a growing number of independent publishers and vanity presses for self-publishing which occupy a certain share of the total market.

The general patterns visible in content based services and information chains are modularization, de-integration of verticals, bundling strategies across various types of content and beyond, and the emergence and growing dominance of distribution platforms. Those platforms are converging to similar designs and, with new large companies entering the sector, competition is becoming intense. This pressure is leading to price wars, extensive bundling of channels and services, and backward integration as the biggest players move into creating content, especially for films and multi-episode programming. At the same time, some content is also evolving towards more finely granular formats, especially when consumed on mobile devices, as exemplified by YouTube, Twitter, and Snapchat.

Consumption Devices, Delivery Channels, and Hardware

Sony is still a presence in consumer electronics, but it has lost its leading position to Apple and Samsung. Ironically, given its early success with transistor radios, it failed to recognize the huge consumer shift to mobile devices. Previous leaders in mobile devices like Palm, Nokia, and Blackberry have also declined or disappeared. Samsung and Apple, the current leaders in smartphone sales, have a host of competitors like Huawei, Oppo, Xiaomi, Vivo, OnePlus, Lenovo, and HTC close behind them. These and several other Chinese and Taiwanese firms, are already leading in the fastest growing markets in Asia (except for Japan and Korea, where Samsung still dominates). Although for the moment they are largely unknown elsewhere, Transsion’s Itel, Infinix, and Tecno brands are now leaders in Africa. Africa and Asia are cost-sensitive markets and the Chinese companies have distinct cost advantages. None of the Chinese firms are very active in the US yet, perhaps out of concern over the legal challenges that Samsung’s designs have already faced. Design patents issued before 2015 remain in force for 14 years, so it is interesting to consider that the first iPhone was released in 2007 with patents granted in 2010. Of course, the company has continued to file new patents for subsequent designs, so it remains to be seen when the legal issues around design will be fully resolved.

For CPU chips, Intel is still the revenue leader, but it has lost ground to ARM in terms of unit sales and design wins. ARM (now owned by SoftBank Group) supplies designs for low cost, low power chips which are especially well suited to mobile applications and personal devices, but are also now used in server farms where sheer numbers and parallel processing can deliver performance, and where heat removal is a big issue. The growth of parallel processing is also driving an increased use of graphical processors. In telecommunications, companies have been subject to commoditization and in danger of relegation to bit-pipe status as mere transporters of data. It remains to be seen whether bundling content and other services will create enough differentiation to slow exits and consolidation.

Physical Services

Because they rely upon physical operations and transformations, physical services have, until recently, been somewhat removed from information intensive services and less subject to industrialization. These operations can be anything from metal machining to bagging groceries, to chemical reactions, cooking, or even simply moving things from place to place. It appeared in the past that jobs like truck driving, janitorial work, food services, policing and security, fire fighting, machine maintenance, and home delivery could not be outsourced, or viably automated. They could certainly be outsourced, and often were, but they still provided an economic foothold for domestic firms, along with substantial employment, without requiring expensive and extensive educational preparation for workers. For example, by 1996, truck driving had replaced secretarial work as the leading source of jobs in twenty-nine US states. But now it appears that even this bastion of employment is likely to see disruptive changes with the appearance of autonomous vehicles. In work categories that require rapid responses to unpredictable conditions, like policing and fire-fighting, industrialization may take the form of enhancing capabilities rather than replacing the person.

Many jobs in transactional or information intensive physical services have already been industrialized or some substitution has arisen, often including a combination of simple mechanization, automation, and self-service. Filling service at gas stations is long gone. Grocery checkout and bagging are
The disruption brought on by the combination of IoT systems with AI software is likely to affect all economies around the globe, starting with the more developed ones.

The collection of hardware and software technologies called the Internet of Things (IoT) is enabling a major leap in automation. IoT is an umbrella term for a diverse collection of devices that combine sensors, radios, actuators, Internet connections, and increasingly complex control and decision making software. Its applications range from the simple identification of tagged objects and data collection by sensors, to sense and respond systems and autonomous devices. Some of these technologies, like self driving vehicles, will be extremely disruptive for multiple industries. While the information chains of the Internet and web reach from screen to screen, IoT tools and technologies are able to connect sensors, machines, objects, computers, and people into complex networked systems that include all of these. Some early examples include smart transportation, smart energy grids, security, health monitoring, and home service systems. The disruption brought on by the combination of IoT systems with AI software is likely to affect all economies around the globe, starting with the more developed ones. The automotive sector will see disruptions at many stages, from manufacturing, sales, and ownership to rentals, ride sharing, insurance, and repair. The automation of physical consumer services, meanwhile, may have a devastating impact on employment.

Bundling is not like the financial portfolio conglomeration of the 60’s. Rather, it is a way of taking advantage of the commonality of underlying technologies and processes to bring together services which were historically quite distinct.

We are in the midst of a new wave of industrialization of physical services, going far beyond just their information components. In all likelihood, the magnitude of the impact will be immense; a McKinsey study estimated that the value of IoT products and services will reach between four and eleven trillion dollars by 2025. We are now at the very start of that change, which is why those estimates are so uncertain.

Summary

The development of information and communication technologies over the past century has driven information intensive services to become the largest part of the US economy. This growth has brought about significant changes in many industries, underpinned by digital convergence and the special characteristics of information process economics. These common factors provide a top-down perspective from which to analyze and understand how information services are changing. Scrutinizing the impact of service industrialization, which is applied at the process level and moves upwards into service designs and industry-wide information and service chains, yields a more detailed, bottom-up perspective. The eventual consequences vary by type of service. Large and disruptive effects have come early to transaction based services, while functional services have been strongly influenced by new service designs. Web and cloud services have made it far easier to outsource back room functions and information processing to the point that they have begun to resemble utilities. Meanwhile, the same factors have allowed many back room processes to be offshore and dispersed regionally and globally. Incumbents in content based services have declined as large new players have established themselves, first in distribution and delivery, and now integrating backwards to content production in response to competition. Knowledge
based services, on the other hand, are just beginning to feel the onset of industrialization, although the potential there is extensive. Physical services are also in the early stages of a wave of IoT based automation, which will likely bring radical change to industries such as the automotive sector.

The biggest danger for companies is hesitation in understanding and addressing the approaching threats. New companies may enter any sector from unexpected quarters and seemingly unrelated industries. Convergence and industrialization are driving the largest players to use lateral service bundling as a basic growth and expansion strategy. Bundling is not like the financial portfolio conglomeration of the 60’s. Rather, it is a way of taking advantage of the commonality of underlying technologies and processes to bring together services which were historically quite distinct. The tight integration of information processes means that changes in a distant part of a service delivery chain can ripple across many stages. Firms would be wise to take an end-to-end view of their industry to avoid being caught unprepared. In these dynamic times, even large and technologically able companies have fallen from industry leading positions.

Digital technologies and service industrialization have transformed the US and other developed economies on every level. We are still in the midst of this vast change, with much more to come.

Endnotes
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—Vijay “VG” Govindarajan, Coxe Distinguished Professor of Management at the Tuck School of Business at Dartmouth
Lennart Baardman, Maxime Cohen, Kiran Panchamgam, and Georgia Perakis present a detailed case study of how business analytics, prediction models, and optimization methods can be used to improve promotion planning. They describe the entire process, from collecting data to computing promotion recommendations for retailers.
Sales promotions have become ubiquitous because customers expect them. When the American department store JCPenney changed from a pricing strategy based on promotions to one based on consistently low prices, their sales dropped substantially, largely because their customers were conditioned to look for promotions. Given these expectations, it is important that retailers understand their customers’ purchasing behavior and be able to determine the right promotion policy for any situation. Fortunately, the combination of large customer datasets and ever-increasing computational power create a unique opportunity for retailers to use advanced analytics to improve their decisions.

It is important that retailers understand their customers’ purchasing behavior so they can ultimately determine the right promotion policy for any situation.

The Oracle Retail Global Business Unit (RGBU) provides clear evidence that retailers are increasingly interested in planning promotions efficiently. Oracle RGBU initiated this work after several retail grocery clients asked for software tools to support promotion planning. Retailers advertise promotions (temporary price reductions), through a variety of vehicles, such as product displays, flyers, and commercials. Their goals include generating extra sales, increasing store traffic, introducing new products, building and maintaining brand loyalty, supporting price discrimination, and retaliating against competing promotions. Oracle Retail’s grocery clients found that making frequent use of promotions with only their experience and intuition to guide them was time-consuming and also made them worry that they would leave money on the table. The situation provided a great opportunity for us to develop efficient promotion planning software that would boost retailers’ bottom lines.

In collaboration with Oracle RGBU, we developed a promotion planning tool rooted in business analytics. Most earlier promotion planning tools, by contrast, are based on simulating “what-if” scenarios to gradually arrive at the best plan. For obvious reasons, these techniques tend to be inaccurate and time-consuming. We thus created a systematic data-driven optimization model that maximizes profits by clearly determining which promotion is right for which product and at what time, all while conforming to business rules. Because consumer demand, and with it profit, is uncertain, we needed to accurately capture consumer behavior. We therefore built the demand functions of our model to be calibrated directly from data.

We created a systematic data-driven optimization model that maximizes profits by clearly determining which promotion is right for which product and at what time, all while conforming to business rules.

Our approach to promotion planning is divided into several stages, described here through our work with the Oracle RGBU. For more information about the technical components behind this tool, please see our previous work. In it we showed that, by optimizing promotions, a grocery retailer could increase its profits by 3 to 9 percent. By here describing how we applied our approach to a hardline retailer, yielding a nearly 10 percent increase in profits, we demonstrate that our method is applicable to a broad range of retailers.

The top-tier clients of Oracle RGBU run weekly promotions for over 1,000 stores in roughly 200 categories. For each store and category, the retailer handles between fifty and 600 SKUs.

Business Problem

Promotion planning is an important challenge for retailers. Effective management of promotions can produce substantial benefits which can be absolutely vital to industries such as supermarkets, which are characterized by low profit margins. Nonetheless, planning promotions at a large scale is difficult. The top-tier clients of Oracle RGBU run weekly promotions for over 1,000 stores in roughly 200 categories. For each store and category, the retailer handles between fifty and 600 stock keeping units (SKUs). Effective promotion planning maximizes profits by scheduling price promotions (i.e., temporary price reductions) and promotion vehicles (such as commercials, flyers, and displays) for the right products during the right weeks. At the same time, any approach to promotions must satisfy various business rules set by the
We here focus on these early stages of our process because it is during this period that Oracle RGBU could closely monitor the software’s performance before putting it into full effect. We began by examining the retailer’s data and selecting the products and stores we would use for pilot testing. Next, we estimated the demand function and created an optimal promotion plan. We used the large dataset of transactions between 2012 and 2014 to estimate and validate both models. Figure 1 illustrates the stages of the promotion planning process, arranged into three categories: (1) descriptive analytics for product and store selection, (2) predictive analytics for demand forecasting, and (3) prescriptive analytics for promotion optimization. We used different software tools for each stage: Oracle SQL for data collection, R for clustering and demand estimation, Python and Gurobi for optimization, and Microsoft Excel to build the tool’s user interface.

Product and Store Selection

Our partner retailer provided us with sales data from 157 stores spanning 153 weeks from January 2012 to December 2014. We used the data from the first 104 weeks as a training set and that from the latter 49 weeks as a test set. These sets gave us data on sales, prices, and promotions for each possible combination of week, store, and product, according to month and year. It also contained data on holidays, the square footage of individual stores, and the brand and size of each product. Although several entries were incomplete, the dataset was large enough that we could discard those without significantly reducing its size.

In order to select a set of products and stores for the initial application of an optimized promotion plan, we went on to subsample this dataset. By so doing, we made it possible for both Oracle RGBU and the retailer to monitor the workings of the tool and the resulting sales performance. Selecting the most appropriate prod-

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales (Units)</th>
<th>Revenue ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>1,243,897</td>
<td>12,521,783</td>
</tr>
<tr>
<td>2013</td>
<td>1,455,319</td>
<td>12,560,407</td>
</tr>
<tr>
<td>2014</td>
<td>1,495,591</td>
<td>12,598,077</td>
</tr>
</tbody>
</table>

TABLE 1: Yearly sales and revenue for the oil category during 2012-2014.

FIGURE 2: Prices and sales for one product from the oil category during 2014.
ucts and stores allowed us to control for differences in products and stores if Oracle RGBU or the retailer wanted to assess the efficacy of our promotion planning tool.

**Product Selection**

Selecting a large group of frequently promoted products gave us many other products to compare with and allowed us to see how optimized promotion planning can increase profits. The greatest opportunity to improve promotion recommendations for this retailer was in the oil category. This category is large (in terms of both item count and sales volume) and the stores promote many of its products routinely (every few weeks). Table 1 shows the yearly sales and revenue of the oil category between 2012 and 2014. This product group contains 137 SKUs, only twenty-two of which have incomplete data. The remaining 115 SKUs form a clean, representative sales and revenue dataset composed of over 99 percent of the oil category.

Figure 2 provides more information on the frequent promotions of products in the oil category, showing the sales volume and pricing of one product over the course of 2014. The retailer used four prices during this period: a regular price of 3.59 and three promotional prices of 1.99, 2.09, and 2.29. As expected, temporary price reductions immediately increased sales, but the extent of the increase was determined not only by the promotion but also by several other factors.

We applied our promotion recommendations to several products from the largest subcategory of engine oils, referring to them as treated products. We selected these treated products as forming a good representation of the engine oil subcategory. To this end, we examined specific features in engine oils, some of which are shown in Figure 3. Ultimately, we selected three treated products of the same brand but of different grades and oil types. We used all other products as control products (those sold according to the retailer’s previous promotion policy).

**Store Clustering**

We wanted to find a cluster of similar stores whose various dimensions differed as little as possible. We needed one group of stores to serve as a treatment group, in which our optimized promotion plan would be implemented, and another as a control group, which would continue to use the retailer’s existing practice. We created clusters of stores based on traits such as revenue, promotional revenue, number of products sold, and square footage. For this clustering, we used the kernel k-means method with a Gaussian kernel to find stores with highly similar traits, for example, their revenues being close. To make it robust, we tested polynomial and sigmoid kernels, finding similar results with each, and we normalized our data to equalize the scale of our variables.

The algorithm identified nine appropriate clusters of stores. Fig-
Table 4 presents the average monthly revenue and promotional revenue of each cluster. The chart shows large differences in average monthly revenue between clusters, in part because some clusters were larger than others. To make our results more robust, we wanted to include a sizable cluster with both large average revenues and large promotional revenues. Cluster 5, with its high revenues and twenty-one stores, satisfied our requirements.

Within this cluster, we wanted to ensure that all the treated stores were in close proximity so that state regulations, on taxes or price tags for example, would not complicate our comparison of different stores or our implementation. To mitigate this concern, we selected nine stores in the state of Kansas as our subset cluster, as shown in Figure 5. We then chose six Kansas stores to receive promotion recommendations, while another three Kansas stores continued to use the retailer’s policy, providing a benchmark by which to assess the impact of our promotion planning method.

Table 2 reports the average monthly sales, revenue, promotional sales, and revenue of the treated and control stores during 2012-2014. The revenue variation between stores is minimal. Although there are some significant differences in sales between stores, the variation within each group is small. Overall, this suggests that these stores are quite similar and allow for a robust comparison.

**Demand Forecasting**

Before we could formulate a promotion optimization model, we needed to create an estimated demand forecasting model. We therefore had to determine the main factors that drive demand, so that our model would yield an accurate forecast. When we were working with grocery products, the three most important factors were timing, products, and pricing. We found that these factors were also important in outdoor products. Indeed, the extensive marketing and economics literature has found that these three factors should be included in most demand forecasting models. However, while much of that literature focuses on causal inference and endogeneity, we focus on demand forecasting and generating accurate predictions.

Sales trends are generally small but steady. Figure 6 shows the average monthly engine oil sales of

---

**TABLE 2:** Yearly average monthly sales, revenue, promotional sales, and revenue in the engine oil category in the nine stores during 2012-2014 (above: treated stores, below: control stores).

<table>
<thead>
<tr>
<th>Store</th>
<th>Sales (Units)</th>
<th>Revenue ($)</th>
<th>Promotional Sales (Units)</th>
<th>Promotional Revenue ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Store 1</td>
<td>16,936</td>
<td>250,419</td>
<td>3,058</td>
<td>78,176</td>
</tr>
<tr>
<td>Store 2</td>
<td>23,589</td>
<td>308,703</td>
<td>3,607</td>
<td>83,841</td>
</tr>
<tr>
<td>Store 3</td>
<td>26,446</td>
<td>347,434</td>
<td>3,664</td>
<td>88,965</td>
</tr>
<tr>
<td>Store 4</td>
<td>16,401</td>
<td>235,320</td>
<td>2,910</td>
<td>79,952</td>
</tr>
<tr>
<td>Store 5</td>
<td>21,989</td>
<td>237,626</td>
<td>3,040</td>
<td>66,138</td>
</tr>
<tr>
<td>Store 6</td>
<td>20,726</td>
<td>251,453</td>
<td>2,796</td>
<td>66,425</td>
</tr>
<tr>
<td>Store 7</td>
<td>41,846</td>
<td>274,781</td>
<td>4,704</td>
<td>78,036</td>
</tr>
<tr>
<td>Store 8</td>
<td>38,804</td>
<td>277,743</td>
<td>4,188</td>
<td>75,271</td>
</tr>
<tr>
<td>Store 9</td>
<td>42,443</td>
<td>338,921</td>
<td>6,173</td>
<td>108,605</td>
</tr>
</tbody>
</table>

**FIGURE 6:** Time series and trend line of sales in the engine oil category in the nine stores during 2012-2014.

**FIGURE 7:** Monthly sales in the engine oil category in the nine stores during 2012-2014.
the selected stores, revealing a slight upward trend over time. We built our model to account for this trend by including a variable which represents the focal week that corresponds to each data point.

Many products are also seasonal, meaning they tend to sell more or less during certain periods. Figure 7 shows the variation in the monthly engine oil sales of the selected stores over the three-year period. Specifically, the stores sold less oil than the average during the winter months, and considerably more during the spring and summer months. Spring sales may be partly attributed to the North American planting season, when the engine oil used in planting equipment needs to be refreshed, while summer sales may be influenced by the harvesting season, during which harvesting equipment is used. Another influence on this increase is the better weather which encourages people to travel and to use bicycles, motorcycles, watercraft, and other recreational machines more often. To control for seasonality effects, we include in our model several monthly variables for each observation.

Some product categories, of course, see increased sales during holidays. Figure 8 shows the average engine oil sales of the selected stores during the holiday weeks of the three target years. The largest demand spikes fall during the weeks of Father’s Day and Thanksgiving Day. The Father’s Day spike may be explained in part by the holiday’s falling towards the latter half of spring (June in the U.S.), when the weather is warm and people are drawn to outdoor activities like motorcycling. Thanksgiving seems to be a period in which cars are refreshed and agricultural equipment stored for the winter. By contrast, the demand at Christmas and New Year’s is relatively low, largely because of store closures, winter weather, and Thanksgiving stockpiling. Our model includes several variables which account for these holiday effects.

Demand is also clearly affected by the product’s characteristics. We therefore included many variables that indicate which product each observation indicates. Although we could include product features directly in the model, we have enough data to estimate product-specific parameters and their effects.

In order to optimize promotion planning, we must also consider the effects of pricing and promotions. Knowing that customers are more likely to buy at a reduced price, we used a current product price variable. We also needed to account for price interactions between products in which the promotion of a complementary or substitutable product may increase or decrease demand for the primary product. We have found, however, that cross-product price effects are weak among products of different brands or sizes. We therefore included cross-product price variables only within each brand. That being said, one certainly could consider cross-price effects among products, brands, categories, and stores, depending on the context and available data. It is similarly important to determine what range of cross-time price effects to include. A recent promotion, for example, may have encouraged customers to stockpile so that they purchase less in the future. In building our datasets, we limited our use of cross-time price effects to the most recent sales, including product price variables only from the most recent weeks. Finally, we had to consider promotion vehicle effects in which displays make customers more aware of a product and thus more likely to buy. We used indicator variables to note whether a promotion vehicle was used, and which one.

With this large number of demand factors, we used a stepwise selection process to build our demand model. We began by estimating several linear regressions describing demand (and its non-linear transformations) as a function of the aforementioned variables, which we included with the guidance of managerial knowledge. We then used three methods, statistical significance, the Akaike Information Criterion (AIC), and the Bayesian Information Criterion (BIC), to iteratively remove some variables. From the models drawn from these three criteria, we selected the one which displayed the highest forecasting accuracy during validation. Because we are primarily interested in prediction, rather than causal inference, this stepwise selection process allows us to quickly generate good models. In estimating our model, we did not use all of our data for training purposes. To assess the model’s accuracy, we deliberately kept a subset of our data separate for testing purposes. This allowed for an out-of-sample test which provided us a fair assessment of how our model

---

**FIGURE 8**: Average holiday weekly sales in the engine oil category in the nine stores during 2012-2014.
would perform on previously unseen data. We note that other regularization methods for model selection can also be used in this context (e.g., Lasso, Ridge, Elastic net).

Sales in the winter months of December, January, and February were 36, 38, and 41 percent lower, respectively, than those of the spring months.

We have focused on linear regressions, which fit into the optimization framework and are easily interpreted by retail managers and estimated on a large scale, because we are primarily interested in the practical application of our approach. In the end, we used a log-log demand model, which interprets the estimated coefficients as elasticities, for each store and each product. The variables we chose to include were the following: product-specific effect, current price, last week’s price, and seasonal indicators both for the month and for holidays. Because promotion plans are determined at the chain level, we chose to jointly predict the demand for all treated stores.

To create our demand model, we divided the data into two parts: a training set, composed of the first 104 weeks, and a test set of the final 49 weeks. We applied the ordinary least squares regression to the training set to estimate our parameters. Table 3 presents our parameter estimates for each of the three treated products (all estimates become statistically significant at the 0.05 level). Base sales of product 1 are lower than those of products 2 and 3, but the intercept estimates are relatively close. And while all products show a similar estimated price elasticity (between -5.6783 and -5.9812), products 2 and 3 show a stronger past price effect.

Table 4 shows the parameter estimates for the effects of trend, season, and holidays (the variables again become statistically significant at 0.05). The table also includes the demand factor (the exponentiated estimate), which shows the extent to which demand increases or decreases during a given month or holiday. The first row indicates the small positive estimate of the demand trend. The demand factor indicates a sales increase of approximately 0.17 percent every week, equivalent to a yearly increase of 9.24 percent. The second part of the table shows the parameter estimates and demand factors for sales by month. We have omitted April, May, and June because the estimation method determined their parameter estimates to be statistically insignificant (i.e., indifferent from 0). The estimated sales for the other nine months were lower than those of these three base months. Sales in the winter months of December, January, and February were 36, 38, and 41 percent lower, respectively, than those of the spring months. These numbers confirm our expectation that the winter would have lower sales, while spring would see the highest sales. The final part of the table reports the estimates for holidays. Having corrected for the demand trend and for the monthly base demand, only New Year’s, Martin Luther King Day, and Christmas have a significant impact on sales. These three holidays lead to lower sales than other holidays, such as Father’s Day and Thanksgiving. During the New Year’s week, demand drops by 32 percent; during the Christmas week it decreases by 29 percent. We attribute the large Christmas decrease to the holiday closure of most stores.

Having estimated the demand model, we could now test its accuracy in forecasting demand. We used our log-log demand model to estimate future demand and then applied the exponential function to calculate the actual predicted demand. By applying our estimated model to the test set we could compute out-of-sample forecasting metrics that assess the model’s accuracy with data it has not seen before. We focused on three metrics: $R^2$ (coefficient of determination), MAPE (mean absolute percentage error), and MdAPE (median absolute percentage error). Our aim was for the $R^2$ to be

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trend</td>
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<td>1.0017</td>
</tr>
<tr>
<td>January</td>
<td>-0.4751</td>
<td>0.6218</td>
</tr>
<tr>
<td>February</td>
<td>-0.5275</td>
<td>0.5901</td>
</tr>
<tr>
<td>March</td>
<td>-0.1753</td>
<td>0.8392</td>
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<tr>
<td>July</td>
<td>-0.1319</td>
<td>0.8764</td>
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<tr>
<td>August</td>
<td>-0.1560</td>
<td>0.8556</td>
</tr>
<tr>
<td>September</td>
<td>-0.1445</td>
<td>0.8655</td>
</tr>
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<td>October</td>
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<td>0.8406</td>
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<tr>
<td>November</td>
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<td>0.7186</td>
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</tr>
<tr>
<td>New Year’s Day</td>
<td>-0.3834</td>
<td>0.6815</td>
</tr>
<tr>
<td>MLK Day</td>
<td>-0.0973</td>
<td>0.9073</td>
</tr>
<tr>
<td>Christmas Day</td>
<td>-0.3408</td>
<td>0.7112</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
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<td>November</td>
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<td>MLK Day</td>
<td>-0.0973</td>
</tr>
<tr>
<td>Christmas Day</td>
<td>-0.3408</td>
</tr>
</tbody>
</table>

**Table 3:** Estimated product-specific parameters using the training set (2012-2013).

**Table 4:** Estimated time-specific parameters using the training set (2012-2013).
close to 1, while we preferred the MAPE and MdAPE to be close to 0.

Table 5 presents our out-of-sample forecasting metrics. Our results showed very good prediction accuracy for the retail industry, with an in-sample $R^2$ for the oil category of 0.92 and an out-of-sample $R^2$ of 0.89. The proximity of the in-sample and out-of-sample $R^2$ also indicates that the model generalizes well. We observed similar results at the brand level, at the individual product level, and using the MAPE and MdAPE.

Overall, our demand model produces highly accurate predictions.

In Figure 9, we present a comparison of the actual and predicted sales of one of the treated products during the testing period. The predictions follow the same pattern as the actual sales, and often with a similar magnitude. Only in some of the highest selling periods does our model under-predict, and this difference is relatively small with a MAPE of 22.76 percent and an MdAPE of 19.68 percent throughout all the promotion periods. Overall, our demand model produces highly accurate predictions.

### Promotion Optimization

Having built and tested the demand forecasting model, we were ready to design the mathematical optimization model that would prescribe promotions. Our goal was to maximize profits during the upcoming planning window by determining which products to promote, to what extent, and when.

We also had to include business rules set by retailers through constraints in our mathematical optimization model. For each product, many retailers only offer prices from a pre-determined price ladder. We built this constraint into our model to ensure that the prices it recommended corresponded to this price ladder. In order to preserve their image, brands and stores often limit the number of promotions for each product. We therefore included an optional constraint on the number of promotions for each product. Similarly, most stores try to avoid running two promotions back-to-back, so we added a constraint to ensure a minimum separating period between promotions for each product. Our model makes it easy to include

<table>
<thead>
<tr>
<th>Forecasting Metric</th>
<th>Oil Category</th>
<th>Treatment Brand</th>
<th>Product1</th>
<th>Product2</th>
<th>Product3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R^2$</td>
<td>0.89</td>
<td>0.90</td>
<td>0.82</td>
<td>0.86</td>
<td>0.93</td>
</tr>
<tr>
<td>MAPE</td>
<td>0.6357</td>
<td>0.3728</td>
<td>0.3838</td>
<td>0.4359</td>
<td>0.2987</td>
</tr>
<tr>
<td>MdAPE</td>
<td>0.2994</td>
<td>0.2305</td>
<td>0.2777</td>
<td>0.2018</td>
<td>0.2544</td>
</tr>
</tbody>
</table>

**TABLE 5:** Forecasting metrics of the estimated demand model on the test set (2014).

Our goal was to maximize profits during the upcoming planning window by determining which products to promote, to what extent, and when.

In Figure 9, we present a comparison of the actual and predicted sales of one treated product during 2014.

**FIGURE 9:** Actual and predicted sales of one treated product during 2014.
additional business rules, according to the requirements of the retailer.

The formulation we built around these requirements is a non-linear integer optimization problem, known to be difficult to solve\(^7\). By drawing upon the methods developed in previous studies, however, we were able to generate approximate optimized promotion plans.\(^8\) The solution relies on using a linear approximation of the original non-linear problem. Interestingly, this approximation often produces promotion plans with a profit very close to optimal. It also runs significantly faster than the optimal method, allowing us to solve the problem in seconds on an ordinary computer.

“Without altering our business processes, just with optimizing the price-point for a promotion, the team of researchers showed us that we can improve our profit margins by as high as 10 percent for some of our products. This is a very significant improvement, considering that our margins are thin.”

We went on to compare our optimized promotion plan to the actual promotion policy which our partner retailer used in 2014 to determine how much optimized promotion planning could have improved that year's profits. Table 6 reports the store’s potential improvement in sales, revenue, and profit. Column (a) shows the retailer’s actual sales, revenue, and profit. Column (b) applies our demand forecasting model to historical prices to compute the sales, revenue, and profit as if our demand forecasts were reality. The differences between these two columns thus indicate the aggregate error in our demand prediction model. Our model’s 12 percent difference between yearly actual and forecasted sales is notably smaller than the 24 percent of the MdAPE prediction, showing that our model works well for the treated products and treated stores in 2014. Column (c) reports the sales, revenue, and profit which our optimization model would produce. To ensure that our comparison is fair, we compare Columns (b) and (c), both of which use the same demand forecasting model. The final column shows that our optimized promotion policy would likely have increased our partner retailer’s profits by 10 percent and its revenue by 1 percent, all at a similar sales level. In short, by using our tool to optimize promotion planning, a retailer can significantly improve its profits, while maintaining its revenues and sales. In looking over the recommended promotion policy, we noted that our model is able to keep prices high during periods of high demand by spacing promotions farther apart than the retailer had been. Additionally, as our partner’s chief information officer put it: “Without altering our business processes, just with optimizing the price-point for a promotion, the team of researchers showed us that we can improve our profit margins by as high as 10 percent for some of our products. This is a very significant improvement, considering that our margins are thin.”

We first formulated the promotion optimization problem by combining it with our demand forecasting model and design parameters. Next, we solved the optimization problem for 2014, producing a schedule of recommended promotions. We were interested to note that these promotions all give the same substantial discount and are spaced out evenly over the year. Managers will find this insight, corroborated by the results of previous real-world studies, very useful.

**TABLE 6:** Key performance indicators (KPI) for the treated products in all stores during 2014.

<table>
<thead>
<tr>
<th>KPI for 2014</th>
<th>Actual Promotions</th>
<th>Optimized Promotions</th>
<th>Improvement (c) − (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales (Units)</td>
<td>690,414</td>
<td>612,265</td>
<td>-9.02%</td>
</tr>
<tr>
<td>Revenue ($)</td>
<td>$1,478,965.89</td>
<td>$1,319,001.47</td>
<td>+1.17%</td>
</tr>
<tr>
<td>Profit ($)</td>
<td>$160,190.53</td>
<td>$173,193.78</td>
<td>+ 9.94%</td>
</tr>
</tbody>
</table>

**FIGURE 10:** Comparison of the revenues and profits of current practice and two optimization scenarios.
As well as optimizing our partner retailer’s promotion policy for 2014, we also ran several hypothetical scenarios. Because our models run very fast (processing hundreds of products within milliseconds), we could rerun the model with various parameter settings. Our promotion policy, described by Table 6, included the business rule that yearly revenues should never decrease relative to the previous year. Figure 10 compares the profits and revenues without this business rule (Scenario 1) to those with it (Scenario 2) as well as to the revenue and profit of the actual promotion plan (Current).

In talking with managers, we were careful to convey the importance of including such a rule (Scenario 2), since a 12.54 percent loss in yearly revenues (Scenario 1) would clearly be too risky.

We see this work as one important step in improving retail operations through data analytics.

The steps described here are only the early stages of implementing our promotion planning approach at a large retailer. This collaboration between industry and academy allowed us to develop a systematic data-driven approach to optimizing promotion planning. This method can be applied in many retail settings, works for general demand models, can incorporate a wide range of business rules, and is calibrated using real transaction data. We see this work as one important step in improving retail operations through data analytics. As our partner retailer said: “We have worked with the team of researchers for a little more than a year and it is truly amazing to see the growth and value that this work has brought, starting with

Author Bios

Lennart Baardman is an Assistant Professor of Technology and Operations at the Ross School of Business at the University of Michigan. His work focuses on using analytics to solve operational challenges in revenue management, pricing, supply chain management, and logistics. This research is inspired by his by collaborations with Adobe, CMPC, Johnson & Johnson, and Oracle, among others.

Maxime Cohen is a Professor of Retail and Operations Management, codirector of the Retail Innovation Lab, and a Bensadoun Faculty Scholar at McGill University. His core expertise lies at the intersection of data science and operations. He has collaborated with Google, Waze, Oracle Retail, IBM Research, Via, Spotify, Aldo Group, Couche-Tard/Circle K, and Staples as well as several retailers and startups.

Kiran Panchamgam is a Senior Principal Data Scientist at the Oracle Retail Global Business Unit. His work spans optimization, prediction, and retail analytics. He identifies retail challenges, devises solution methods, develops enterprise software systems, and implements them for a range of retailers. He has three granted and nine pending patents with USPTO and is the product manager for Oracle Retail Assortment & Space Optimization, Oracle Retail Promotion & Markdown Optimization, and Oracle Retail Offer Optimization.

Georgia Perakis is William F. Pounds Professor of Operations Management, Operations Research, and Statistics at MIT Sloan. She codirects MIT’s Operations Research Center and is Faculty Director of its Executive MBA Program. She is editor in chief of MSOM and an INFORMS Fellow in recognition of her lifetime contributions. Perakis’ analytics work has been applied to operations, retail, supply chain and healthcare. Her collaborations include Adobe, IBM Research, Lahey Clinic, Oracle Retail, Wayfair, Zara, and many more.

Endnotes

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Congratulations to the founding editorial team of the Management and Business Review for launching this impressive journal, especially to Kalyan Singhal, professor of operations management, University of Baltimore.

1st
UB launched the world’s first fully online ACGSB accredited MBA program in 1999.

45
UB’s rank among the top 100 public institutions for return on investment, according to a Georgetown University study.

25
average class size for undergraduate and graduate courses

9
consecutive years U.S. News & World Report has ranked UB’s online MBA program as a top program—more than any other Maryland institution.

4

1,500
academics and practitioners, representing 30 countries, participated in “best practices in management education” webinars hosted by UB business faculty through the Academy of Management.

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How to Choose the Right Strategy for Digital Transformation

Sunil Mithas, Muma College of Business, University of South Florida
Roland T. Rust, Robert H. Smith School of Business, University of Maryland

Many executives believe that, in digital transformation, they must pursue either revenue growth or cost reduction, but not both. Sunil Mithas and Roland Rust explain how companies can invest in information technology to pursue both goals.

Choosing a digital strategy and deciding how much to invest in digital resources are among the most critical decisions that face today’s firms. We all know that digital entrants such as Netflix, Amazon, and Uber have challenged established businesses like Blockbuster, Barnes & Noble, and conventional taxi services. Similarly, the increasing digitization of the economy is driving firms to question some of the strategic choices and tradeoffs they have taken for granted for at least the last three decades.¹

Our research suggests that, faced with increased digitization, managers will best succeed by rethinking some of the conventional strategies which forced them to choose between two rabbits, revenue growth and cost reduction, and to be satisfied with the one they caught. That choice no longer makes sense now that digital technologies can help firms to overcome conventional tradeoffs and use more complex strategies to enrich the customer value proposition.

Indeed, a high investment in information technology (IT) that targets both revenue expansion and cost reduction can be profitable. Using data from US companies, we found that, increasingly, strategies that focus solely on either revenue or cost are giving way to dual strategies which leverage IT investments. About 45 percent of firms in our sample follow a dual strategy, while the remaining 55 percent use a strategy with a single focus, with 45 percent focusing on cutting costs and 10 percent on revenue-growth. Over the last decade, we have conducted a series of studies to
understand how digitization is driving dual strategies and performance. We tracked down rare archival data on the digital investments of hundreds of firms in developed and developing economies so that we could link their digital moves with their performance. We have learned that it is time to rethink traditional strategies.

By analyzing the data from more than 300 US firms we discovered a great deal about how dual and single strategies affect a firm’s performance depending on its investment in IT (see Sidebar). We conclude that firms whose strategy has a dual emphasis are more profitable and have a higher market value the more they invest in IT. Meanwhile, firms which invest less in IT do better to choose a strategy that emphasizes either revenue expansion or cost cutting. Because adopting a particular strategic emphasis can affect a firm’s market value without affecting its profits, managers should carefully consider how their strategic choices will affect market value even if they do not seem likely to affect profitability.

**Why Digitization Drives the Need for Dual Strategies**

There are a number of reasons to take a fresh look at conventional either/or strategies that assume the need for a tradeoff between revenue growth and cost reduction. Today’s digital technologies allow firms to devise more complex strategies which pursue many competitive advantages simultaneously. These complex strategies often rely upon a portfolio of IT systems, combinations of technologies that may not be externally apparent and are therefore difficult for competitors to replicate. Such an IT portfolio can thus sustain a firm’s competitive advantage even when the underlying hardware and software is commoditized. In other words, firms can create internal IT complexity that will prevent their competitors from replicating their systems, while retaining external simplicity to attract customers. These configurations allow them to achieve both revenue growth and cost reduction while retaining the agility necessary to reconfigure their internal IT portfolio when they need to make new competitive moves.

**Firms that carefully devise a portfolio of IT applications which emphasizes both revenue enhancement and cost reduction reap greater rewards than those which pursue a singular focus.**

In order to execute their dual digital strategies flexibly, however, firms must appropriately govern their IT systems and manage IT projects. Although IT assets tend to be generalized, customization and corresponding changes in business processes, training, and incentives will allow them to be targeted at specific strategic objectives. While any individual IT system has the potential to reduce costs or enhance revenue, or even both, a tailored IT portfolio allows firms to put their strategic emphasis into operation by configuring individual IT applications accordingly. Firms that carefully devise a portfolio of IT applications which emphasizes both revenue enhancement and cost reduction may reap greater rewards than those which pursue a singular focus. A dual focus gives firms digital ambidexterity, which can propel them to a competitive advantage.

Netflix, for example, uses its carefully crafted IT infrastructure and recommendation system to differentiate itself and to drive high revenue growth while lowering costs. Meanwhile, part of the digital strategy of Starbucks is a mobile order and pay tool that allows its customers to skip lines when picking up their coffee. Through this tool, Starbucks has achieved a significant growth in sales compared to its peers. Bank of America and other banks now use mobile apps to power a high quality banking experience at a fraction of the cost of using a physical branch. And such successes abound in digital space, with Amazon, Airbnb, and Uber as prime examples.

In assessing competitive advantage, conventional strategies often focused exclusively on profit margin, a measure of the difference between the opportunity costs of the seller and what consumers are willing to pay. Such profit metrics are of limited use to entrants or start-ups, many of which focus on growth or market valuations in the early stages. As Amazon.com demonstrated, some continue to pursue revenue growth and market valuations for years in order to justify their existence.

Moreover, as they consider their strategic choices, firms need to ground their thinking in evidence-based guidance and empirically valid frameworks such as Baldrige, instead of anecdotal case studies of just a few firms. Our data-based insights, drawn from a large sample of firms, show that dual strategies often perform far better than traditional ones. As a result, digital entrants and even established businesses are now pursuing dual strategies that focus simultaneously on revenue growth and cost reduction.

**The Performance Implications of Dual Strategies and Digital Ambidexterity**

Our research reveals at least three reasons why dual strategies are more profitable and more valued by the stock market.

First, a dual-emphasis strategy can be far more complex, allowing a firm to surpass competitors who
use a single-focus strategy. The dual strategy also requires a complexity and breadth of applications that competitors have a hard time replicating. By thus limiting competition, firms with a dual strategic emphasis are more profitable and more valuable.

Second, a dual emphasis creates more options for profitable growth by opening access to “low-hanging” investment opportunities with a positive return. Firms with a dual emphasis are likely to enjoy lower cycle times in product development and in managing supply chains and customer relationships, which will allow them to more quickly realize their revenue and cost targets and thereby accelerate their cash flows. Those cash flows may also be less variable than those of single emphasis firms because they are drawn from two sources, revenue growth and cost reduction, rather than just one.

Our research revealed that firms use “disciplined autonomy” to manage the inherent tensions of pursuing multiple objectives.

Third, a dual strategic emphasis, being more ambitious in its scope, may allow employees and partners to reach stretch targets, those which require entirely new approaches, for higher revenues and lower costs. The firm will thereby improve its chances of getting more without changing its investment levels which, in turn, will increase its cash flows, profits, and market value.

**How to Achieve Digital Ambidexterity**

We suggest several practical ways for firms to adopt a dual focus and, through it, achieve superior performance.

**Pursue multiple strategic objectives:** Dual strategy firms do not pursue just one metric to the exclusion of all others. Instead they manage the tensions that duality creates in such a way as to spark creativity. Our research revealed that firms use what we call “disciplined autonomy” to manage the inherent tensions of pursuing multiple objectives. The idea is that overarching IT systems, such as agile software development, can provide discipline, giving business units or teams the autonomy and discretion to apply selected methods within that framework.³

Firms which pursue multiple strategic objectives and ambidextrous governance should be able to create a portfolio of IT systems that simultaneously targets both revenue growth and cost reduction.

Despite the challenges of a simultaneous focus, Tata Consultancy Services (TCS) uses its IT systems to manage its dual strategies of arbitrage and aggregation. TCS’s global IT platform, Ultimatix, is a key component in its Global Network Delivery Model, which helps the firm fulfill its dual strategies. Ultimatix combines a diversity of IT systems to create a seamless interface through which its more than 300,000 employees around the world share information about projects, clients, colleagues, and customers. It also gives them access to analytical tools to aid in decision making. As the competitive environment becomes more complex and turbulent, firms must be able to immediately respond to several emerging challenges at once. To do so, they may have to shift their strategic posture on short notice or be able to assume different postures for different functions. Firms which are, in this sense, ambidextrous will be more likely to succeed. SAP provides another example of this vital flexibility. It uses a framework of agile methodologies to rapidly deliver software that is Google-fast, Apple-simple, and yet industrial grade, like GE’s jet engines.

Another example is Zara, which uses its robust but simple IT systems to sell high fashion at significantly lower costs than its competitors. Narayana Health uses IT to produce a daily profit and loss report by minutely tracking its activities. It also uses telemedicine to provide high quality service to patients over a broader area and at much lower costs.

**Ambidextrous governance:** The hidden DNA of dual emphasis firms is the ambidextrous governance systems they create in order to strike the right balance between revenue and cost focused projects.

Because a company’s governance is central to its culture, practices, and resources, competitors are hard put to replicate its influence. For example, before 2008, Starbucks used a DOS point-of-sale system which made barista training fairly lengthy. Moreover, its managers did not communicate by email because the store computers were locked down for compliance reasons. To achieve a successful digital transformation, Starbucks did far more than hire a CIO and tweak its reporting structure. It established new routines and actively involved its CEO, Howard Schultz. These new governance processes helped it to overcome the technology debt it had incurred by long neglecting...
in-store IT infrastructure. With support from Schultz, the then CIO Stephen Gillett started a new business unit called digital ventures whose purpose was to introduce new digital services to customers who were increasingly using smartphones, tablets, and laptops to interact with the company. These moves helped Starbucks to become a retail leader in mobile payments, improve its loyalty card system by developing related smartphone apps, and offer free in-store Wi-Fi and content throughout the United States.

**Agile Management of IT Systems and Projects:** Firms which pursue multiple strategic objectives and ambidextrous governance should be able to create a portfolio of IT systems that simultaneously targets both revenue growth and cost reduction. A digital portfolio of sufficient complexity can use customer relationship management (CRM) to provide a differentiated customer experience while lowering costs through end-to-end enterprise resource planning (ERP) systems or supply chain management (SCM) systems. IT portfolios differ depending on their firms’ digital strategies. In our research, we found that firms which focused on revenue used more CRM systems, while those that focused on cost had more end-to-end and supplier-facing ERP and SCM systems. Dual focus firms, on the other hand, tended to have a combination of CRM systems and ERP and SCM systems, which was consistent with our theory that diverse IT systems help dual emphasis firms to improve their performance through digital ambidexterity. The dual emphasis firms in our sample also spent the most on IT salaries, while revenue focused firms spent the least. This finding reinforced our belief that, in order to manage diverse IT resources, dual emphasis firms must hire more IT employees or more employees with managerial and technical expertise in supervising diverse projects.

What makes these firms’ project portfolios inimitable is their interdependence. Project 3 may, for example, rely upon the earlier projects 1 and 2. Progressive firms multiply their options by undertaking a variety of IT projects and arranging them carefully in terms of must-do and may-do elements so as to retain the flexibility necessary to deal with technical and market uncertainties.

Some go so far as to consider Starbucks as much a tech company as a coffee company because of its smart digital moves. It is important to remember, however, that it has traveled a long path and negotiated a maze of interdependencies in order to access previously unavailable options. In 2001, Starbucks started with a simple prepaid card to speed the checkout process. It then scaled up, offering online registration and reloading of the card, and allowing customers to view their transaction history. Next, the company chose a growth option, awarding loyalty points and conducting sales promotions based on the resulting data. It then went on to cobrand the card with Visa so that it would also function as a credit card. Finally, it built on all of these earlier initiatives by creating a smartphone app to manage the whole process.

In 2013, Starbucks worked on about one hundred IT projects, thirty-five of them customer- or employee-facing, another thirty-five to forty aimed at reducing costs, and the rest comprising a broad portfolio concerned with resilience, security, and productivity. The company’s aim was to complete more IT projects sooner, rather than executing fewer projects for a multiyear big bang delivery. It completed thirty-seven projects in 2011, fifty-nine in 2012, and its target of one hundred in 2013. Other companies can learn from the example of Starbucks. Some of the recent methodologies for software development, like agile and Scrum, will allow them to experiment with a variety of projects while incurring less risk than they would have with earlier waterfall methods.

**Some Caveats on Planning Dual Strategies**

Although a powerful tool when used correctly, dual strategies are not for all organizations. It is more difficult for firms to follow a dual strategic emphasis than a single one because the former requires the firm to manage greater complexity and risk in ensuring that all its decisions align. Focusing on two goals simultaneously can confuse efforts to set targets and assess performance across a range of business units. Dual-emphasis firms should also beware of ending up with a portfolio of IT systems that does not seamlessly integrate the flow of data and information. Focusing on two goals simultaneously can make it difficult for managers to agree to prioritize IT projects. We therefore advise that some firms which are unwilling to invest in digital resources may do best to continue using binary strategies.

Managers need not choose between two rabbits, revenue growth and cost reduction; instead they can chase and catch both rabbits.

**Conclusion**

Smart managers know that changes in time and technology call for new strategies. We have found that, in
order to succeed in the face of new challenges from startups and competitors, managers must synchronize their digital strategies with appropriate governance systems and a flexible portfolio of IT applications. In a shifting digital context, dual or ambidextrous strategies are not only more rewarding, they also gain power when synchronized with appropriate governance and digital investments. Managers need not choose between two rabbits, revenue growth and cost reduction; they can chase and catch both rabbits by adjusting their strategies, governance, and IT management.

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**ABOUT OUR RESEARCH**

Our research into how today’s firms should approach strategy has produced data and evidence based insights. Figures 1 and 2 show a summary of our key findings to help managers to make informed choices when they synchronize IT and strategy to improve their firm’s profits and market value. Figure 1 shows that with high IT investment, dual-emphasis firms can significantly outperform single-emphasis firms. Conversely, with low IT investment, single-emphasis firms (i.e., revenue or cost) are more profitable than dual-emphasis firms. Figure 2, which uses market value as a measure of firm performance reveals a different pattern. It shows that, when firms spend more on IT, the stock market values dual-emphasis firms more highly than single-emphasis ones. This finding is similar to that in Figure 1. However, the market values of dual-emphasis firms are more than those of single-emphasis firms even when they invest little in IT and therefore have lower profitability.

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**FIGURE 1:** Synchronize Digital Strategies with Digital Investments for Profitability

<table>
<thead>
<tr>
<th>Digital Investments</th>
<th>Digital Strategy</th>
<th>Low Profitability</th>
<th>High Profitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Single-focus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Dual focus</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FIGURE 2:** Synchronize Digital Strategies with Digital Investments for Market Value

<table>
<thead>
<tr>
<th>Digital Investments</th>
<th>Digital Strategy</th>
<th>Low Market Value</th>
<th>High Market Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Single-focus</td>
<td>Low Market Value</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Dual focus</td>
<td>High Market Value</td>
<td></td>
</tr>
</tbody>
</table>

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**Author Bios**

**Sunil Mithas** is a World Class Scholar and Professor at the Muma College of Business at the University of South Florida. Mithas has consulted and conducted research with a range of organizations including A. T. Kearney, Ernst & Young, Johnson & Johnson, the Social Security Administration, and the Tata Group.

**Roland T. Rust** is Distinguished University Professor and David Bruce Smith Chair in Marketing at the Robert H. Smith School of Business at the University of Maryland. He has won top career contributions awards in services, marketing research, marketing strategy, and advertising, as well as an honorary doctorate in economics.
1. We use the phrase digitization to describe the deployment of digital resources and technologies to transform a business process or an organization. Although some authors prefer the term digitalization to digitization, and distinguish between the two, we consider these terms to be roughly equivalent in practice based on our experience in corporate settings.

2. Prior research reported that revenue expansion and cost reduction could be achieved simultaneously only in certain sectors, such as manufacturing, but not in service where high-quality human labor tends to be more expensive - Anderson, E. W., Fornell, C., and Rust, R. T. 1997. “Customer satisfaction, productivity, and profitability: Differences between goods and services,” Marketing Science (16:2), pp. 129-145. These reports argued for focusing on revenue expansion or cost reduction, but not both Rust, R. T., Moorman, C., and Dickson, P. R. 2002. “Getting return on quality: Revenue expansion, cost reduction, or both?,” Journal of Marketing (66:4), pp. 7-24.


Leonard Kleinrock Annual Award

for the Best Paper Published in the Management and Business Review (MBR)

This award is named for Internet pioneer Leonard Kleinrock. By contributing to the development of technologies that now underpin most networked data transmissions, including the Internet, Kleinrock is a co-creator of one of the greatest inventions in human history.

In 1988, Kleinrock chaired the National Research Council’s Network Review Committee, whose report informed the 1991 High Performance Computing Act which dramatically improved computer network infrastructure across the U.S. and paved the way for the Internet’s current ubiquity. For more details on Dr. Kleinrock’s extraordinary career and accomplishments, see the laudation in the Winter 2021 issue of MBR.

Through his elite research and determination to translate that research into practical innovations which have enormously benefitted the world, Kleinrock exemplifies the aspirations of MBR. We hope the papers honored with this award will fulfill these aspirations by bringing management research and practice together to serve the needs of humanity.
The Complete Turnaround of a Boutique Bank: A Practical Guide to Leading a Complex Transformation

Karen Ayas
The Ripples Group, Ripples Business Academy

In a remarkable five-year journey, Bank Leumi USA completed a major transformation with a range of dramatic effects. Through a close examination of the Leumi case, Karen Ayas illustrates an approach designed to increase the odds of success in transformation and offers practical guidance to those embarking on similar journeys.
A majority of transformation efforts fail, yet a few have outstanding results.1 Bank Leumi USA (Leumi), with Avner Mendelson at the helm, provided a great illustration of how to successfully transform a business.

The Ripples Group was a partner on this remarkable journey from 2013 to 2017, working with Mendelson and his team to guide the bank through a major transformation and attract new investors to accelerate its growth. The financial results have been stellar: the return on equity (ROE) increased from 2.5 percent to over 10 percent, the net income quadrupled, and total revenue increased by 60 percent. The bank also became more internally efficient and its employees more engaged. For example, there was a year over year increase in median employee satisfaction ratings despite significant turnover (see exhibit 1).

Through the transformation of Leumi, we found answers to these conundrums and an approach that can guide leaders through complex business transformations.

Leading a Complex Business Transformation: The Challenge

There is a vast body of research and information on organizational change and transformation.2 Yet turning these insights into practice is still a challenge for CEOs looking to transform their organizations. Put another way, there may be lots of good recipes and even cookbooks, but it’s not just about picking a winning recipe, you still have to do the cooking! And so many things can go wrong: You don’t have all the ingredients, they don’t mix well, you’ve stirred for too long… or not long enough, the temperature is not quite right, or you just get distracted and skip a step.

Consider some of the common issues that arise with recipes for change. Virtually every “cookbook” starts with organization diagnostics, which should give you a sense of your current reality. But how deep should you dive? How much time can you devote to diagnostics before you have to act? Next, the recipe calls for “a vision” but how do you protect your team from “vision fatigue” when they’re facing tough operational challenges?

And there’s more! When the task at hand is a complex transformation calling for change on multiple fronts, how should you structure it? How many parallel initiatives can you run? How do you reconcile growing the business with transforming it? And knowing that this will be a multi-year undertaking, how do you keep everyone engaged and committed?

Through the transformation of Leumi, we found answers to some of these conundrums and an approach that can guide leaders through complex business transformations. While the nature of business and its leaders makes every case unique, calling for a customized recipe, there are some common mistakes you can avoid and some ingredients that will increase your odds of success.

The Case of Leumi

Avner Mendelson was appointed CEO of Leumi in September 2013, with a clear mandate to wake up the sleepy organization and rebuild it. The bank had had many CEOs over the preceding thirty years and most of them had been at the ends of their careers. Most had not tried to move the needle, and those who did had failed in their attempts.

“It was like a raft floating with no particular destination or ambition” is how Mendelson described the organization he found. He also quickly noticed the upside: this organization had survived multiple crises which had caused other banks to fail. Resilience was evidently part of its DNA.

Most CEOs are under immense pressure to deliver immediate results. Although impatient by nature, Mendelson took the opportunity to observe and fully understand the business before jumping into action. He was careful to challenge all assumptions, inquiring deeply and observing first-hand, and to invite others to help him along.

The bank’s financial performance had gone from bad to worse in the past three years. Its operational and IT infrastructure were totally inadequate. Over the years, it had evolved a warm, fuzzy family culture. “We take care of each other here and everyone always gets a 5 out of 5 on performance” explained one of the senior managers. Mendelson could see that this high tolerance for mediocrity, albeit in the guise of family culture would be a major barrier to building the high

Exhibit 1 – Overall employee satisfaction scores 2013-2017

<table>
<thead>
<tr>
<th>Year</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>3.7</td>
</tr>
<tr>
<td>2014</td>
<td>3.8</td>
</tr>
<tr>
<td>2015</td>
<td>3.9</td>
</tr>
<tr>
<td>2016</td>
<td>4.0</td>
</tr>
<tr>
<td>2017</td>
<td>4.1</td>
</tr>
</tbody>
</table>
performing culture needed to turn the business around.

Mendelson began by articulating a bold vision for transformation, developing a clearly defined roadmap and creating a leadership forum charged with its execution. He then focused on sustaining momentum and driving accountability for change (see Table 1, p80).

**Articulating a Bold Vision**

Mendelson quickly developed a clear understanding of his new business. The road ahead was clear to him, and he knew how to begin, so why waste time on formulating a vision?

A two-hour session with the management team devoted to envisioning the future, with everyone articulating their hopes, made him realize that vision can be contagious. Only after many revisions and iterations was the team able to articulate the vision in a crisp and compelling way: “Become the best boutique relationship bank.” In concrete terms, the team had to achieve a 10 percent ROE within five years by building a bank that distinguished itself through outstanding service. This was a bold aspiration for a stagnant business with only a 2.5 percent ROE.

The company’s first ever town hall was held in New York and conveyed clearly that things were going to be different under the new CEO. The bank’s employees greeted the meeting invitation with a mix of criticism and anticipation, and with many questions.

At the event Mendelson used irrefutable facts to explain the need for change and presented his bold vision with direct authenticity. He had planted the seeds; many employees went home inspired by the idea of helping to create a better future.

Next, the vision had to be transformed into the collective ambition of all the organization’s key leaders. Yet even the most persuasive communicator cannot convince everyone. Any change will have its believers, its skeptics, and its cynics. You must make use of the believers, who embrace the vision, to build the necessary momentum and help to spread enthusiasm and ambition. You must attend to the skeptics who can help you stay on a feasible course. Finally, you must ensure that other team members disregard the cynics even though they often have the loudest voices and substantial influence.

**Creating the Change Leadership Forum**

Mendelson now had to find a way to engage the bank’s key leaders and mobilize a critical mass of believers to pave the way. After much debate the top team created the Change Leadership Forum (CLF) whose members were chosen not solely by their titles or positions. Although many of the senior leaders argued that, in the existing culture, managers who weren’t chosen would be discouraged, Mendelson nonetheless instructed them to hand-pick only the best and most influential leaders for the forum. The CLF would be responsible for:

- stepping up to lead the change and build the future,
- working together to bridge functional and geographical gaps, and
- keeping everyone informed and engaged in the transformation. The CLF was empowered to act, but it still needed a clear roadmap.

---

**Exhibit 2 – High level transformation roadmap**

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Establish two growth businesses: Commercial Bank and Private Bank</td>
<td>• A simple, light structure that can decide and execute with agility</td>
</tr>
<tr>
<td>• Focus on selected niches and customer relationships, higher fees and profits through expertise in targeted niches</td>
<td>• Clear roles and responsibilities; accountability</td>
</tr>
<tr>
<td></td>
<td>• Strong, competent teams, starting with senior management</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Build an effective and efficient backbone to support the business including IT infrastructure, operations, HR and marketing functions, and business processes</td>
</tr>
<tr>
<td></td>
<td>• A high-performance culture that rewards excellence and does not tolerate mediocrity</td>
</tr>
<tr>
<td></td>
<td>• Create a strong and innovative wealth management platform that attracts high-caliber professionals</td>
</tr>
<tr>
<td></td>
<td>• A relentless focus on serving customers with excellence</td>
</tr>
<tr>
<td></td>
<td>• A willingness to take calculated risks</td>
</tr>
<tr>
<td></td>
<td>• Transparency and two-way communication</td>
</tr>
</tbody>
</table>

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A vision, no matter how bold and compelling, is only effective when everyone involved understands and shares it.

A vision, no matter how bold and compelling, is only effective when everyone involved understands and shares it. Clearly a wake-up call was needed. So how do you create a shared vision and a sense of urgency in an organization that has been floating happily along with its congenial culture for the past thirty years and is spread across New York, Florida, Illinois, and California?
The Transformation Roadmap

When Mendelson joined, the bank’s Project Management Office (PMO) had been charged with leading a change initiative called “Running for 10,” comprising over thirty improvement projects laid out by the prior CEO. While the PMO had composed meticulous plans, it had gained little traction in the past year. Although there was an immense amount of “Running for 10” branding on hand, including a logo on paper cups, notebooks, mouse pads, and more, it served largely as a constant reminder of the initiative’s failure. Many employees weren’t even sure what the 10 stood for: 10 for excellence, 10 percent ROE...? And for the few projects that had been completed, most didn’t know what the results were. The situation was a perfect illustration of a failed recipe for change. Mendelson’s team had to do better.

The roadmap for translating the bold vision into action had to include comprehensive and cohesive changes in strategy, structure, systems, and culture (see exhibit 2). The team could then expand this roadmap into a detailed master plan for transformation, including milestones for each domain.

Strategic focus: By every benchmark, internal and external, Leumi was very poorly rated. Where, then, would growth come from? The roadmap had to include clarifying the targeted value proposition for each of its businesses, the commercial bank and the private bank, and for the niches which would allow them to capture the full value of their relationships. The team had to build an effective model for boutique service while determining how best to expand the bank’s product and service offerings.

Structural changes: The bank’s existing structure did not include clear lines of accountability or alignment across its customer-facing functions. The quality of the customer experience was diminished by a blurring of roles and responsibilities. Hilla Eran-Zick, deputy CEO, launched a major initiative to enact a new coverage model that separated business development from credit and administrative functions. She restructured the teams so they would support managers who worked directly with clients, enabling them to make faster decisions and thus creating a highly responsive service model.

Support systems: When Kate Etinger joined as head of HR in early 2014, the bank essentially did not have an HR department. Etinger quickly moved to upgrade recruitment to attract talent and improve the team, modifying compensation plans to keep them.

The new management team also had to modernize the bank’s stale IT infrastructure to put it on a profitable growth path. Over the preceding decade, several attempts to build an IT system adequate to the bank’s needs had stalled. In December 2013, Mendelson decided to invest $35M in transforming the core banking system. This massive undertaking created a simpler IT infrastructure with better data integrity and automated processes which improved customer experience across the board. Every employee participated in the two-year process of implementing this massive change.

Cultural change: And of course, realizing the vision of a topflight boutique relationship bank called for a fundamental change in the company’s culture. Mendelson particularly wanted to inspire relentless focus on excellent customer service, willingness to take calculated risks, a refusal to accept mediocrity, and an eagerness to collaborate across functions. None of the bank’s previous leaders had paid deliberate attention to shaping its culture. Mendelson had already insured that all changes in strategy, structure, and systems would have a positive effect on culture, now he turned to more direct methods of driving cultural change.

Starting in early December of 2013, Mendelson convened a series of meetings with the top team to create an initial definition of the

Exhibit 3 – Leumi Core Values

<table>
<thead>
<tr>
<th>Caring</th>
<th>Excellence</th>
<th>Integrity</th>
</tr>
</thead>
<tbody>
<tr>
<td>for each other and our customers. Treating others the way they want to be treated.</td>
<td>in all we do. Continuously striving to achieve outstanding results.</td>
<td>in all our affairs. Doing the right thing when no one is looking.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accountability</th>
<th>Passion</th>
</tr>
</thead>
<tbody>
<tr>
<td>for our results. Proactively accepting responsibility, ownership of success and failures.</td>
<td>for all we do. Believing and loving what you do. Bringing energy, excitement and joy to it.</td>
</tr>
</tbody>
</table>
bank's core values (see exhibit 3). He knew that unless these ideas were embraced by all the bank’s leaders and embedded in their daily actions, they would be no more than “lip service values” and would not actually affect culture.

The employees needed to know how this time would be different and to believe that they were up to the challenge of their new CEO’s bold vision, apparent confidence, and steady conviction.

Dealing with Cynicism
With the team and the roadmap in place, the next challenge was to eradicate the cynicism that had arisen with the “Running for 10” program and to generate enthusiasm in its place. The employees needed to know how this time would be different and to believe that they were up to the challenge of their new CEO’s bold vision, apparent confidence, and steady conviction. It took a combination of elements to gradually turn the tide and change the conversation:

1) The leadership team was careful to frame the larger context for change simply and communicate it widely. As a result, most of the bank’s leaders understood and could articulate the “change story” - here is what we are aiming for (our vision) and here is how we will go about it (the roadmap).

If each of them engaged six others in the transformation, the whole organization would effectively be involved.

2) The Change Leadership Forum (CLF) was composed of highly influential leaders representing all functions and locations. They were charged with leading the transformation. If each of them engaged six others in the transformation, the whole organization would effectively be involved.

3) While totally realizing the vision was a hazy five years out, the transformation roadmap was framed as a series of change cycles with clear beginning and end points. The first cycle aimed simply to “build a better bank” with profitable growth by the end of 2016. This goal was further broken down into two phases: building the basic infrastructure by end of 2014 and using it to drive growth. The CLF limited the number of initiatives in each phase so that the team could execute them in a timely manner.

4) Each change initiative had clear owners who were highly visible to the rest of the organization. The owners of each initiative were charged with reporting their progress frequently to the organization as a whole. Early reports of quick wins lent the transformation much needed credibility and increased its momentum.

Launching Change: The Bridge to The Future
On March 24, 2014, in a dimly lit room in New York City, Mendelson welcomed the seventy members of the Change Leadership Forum to an off-site event themed “Bridge to the Future.” He urged them to lead the transformation actively, saying “This is a privilege and a responsibility.”

He had asked them to read Kotter and Rathgeber’s leadership fable Our Iceberg is Melting and to consider how it applied to them. At the meeting, members of the top team led small group discussions to establish the language of transformation and build a clear sense of urgency. Over the course of the two-day event the leaders defined the qualities that differentiated Leumi and formed a collective sense of what success would look like and how to achieve it.

On the second day CLF leaders also explored what the core values laid out by the top team meant to them and what they would look like in action. As change leaders, they committed to communicating and handing down these values to their teams and to validating them with their daily behavior.

This event also provided a first opportunity for leaders from different functions and divisions to meet each other and build a powerful team. They worked together for two solid hours to literally build a huge bridge across the room. As, one by one, they crossed the bridge that they had built, they left the meeting with a clear vision, a roadmap for transformation, and, most importantly, a collective mission to transform the bank and “create success together.”

Mobilizing for Growth
By January of 2015, an employee survey revealed that 77 percent of the bank already felt that its culture was changing. “A lot has been done, the bank has transformed itself 180 percent from where it was only a year ago,” commented one of the CLF leaders. The employees felt great pride in their accomplishments but recognized that they could still improve and expressed a collective ambition to do so.

In February 2015, the CLF once again gathered off site. The event began with a video of the previous year’s bridge to the future and of the commitments these leaders had made to one another. “Last year we set out on our journey to build a better bank. We are in the midst of a major transformation, and we need to take the time to reflect on progress, prioritize the
work ahead, and re-engage” said Mendelson in his opening remarks. “This year is about mobilizing for growth and execution. I see you all as carriers of the DNA of the new culture.”

For two days the CLF team celebrated their progress, shared stories about changes in the bank’s culture, and aligned their 2015 priorities. They discussed how to further improve collaboration throughout the bank. Having considered the business from all angles, they reflected on how they could win against competition and produced insights that would help them to accelerate the change.

Results of the First Cycle of Change
The bank completed its initial turnaround much sooner than expected. Within two years, it achieved strong double-digit growth in net income (33 percent CAGR), and solid increases in loan and deposit balances without increased expenses. The team completed all the initiatives listed in the first cycle of the transformation plan. By the end of 2015, the organization showed marked improvement over 2013 across the board (see exhibit 4). It had established client value propositions, made significant strides in tech financing, ventured into film publishing and other new sectors, and expanded its product and service platforms. Leumi was awarded a BBB+ rating in August 2015, earning a place in the top 50 of all S&P rated banks. “This is a reflection of the bank’s strength and stability and a recognition of the solid foundation built in the first two years of transformation” Mendelson remarked.

The Next Cycle of Change: From Good to Great
Still, this first two years’ success was just a start. Mendelson and his team had far more to do to become “the best boutique relationship bank.” The January 2016 employee survey showed unambiguously that accountability was still lacking in some areas and that mediocrity was still tolerated. The bank continued to lag behind the competition, and it had yet to deliver the desired customer experience. Indeed, customer satisfaction surveys were disappointing. In many ways, the challenge ahead was even tougher than what they’d already achieved. But now the bank was building momentum and had a formidable executive team who all shared the same ambition.

At the 2016 meeting of the CLF, leaders gathered to celebrate their progress to date, anchor successful changes, and commit to the “Journey to Greatness.” Everyone had read Jim Collins’ book Good to Great and prepared for the challenge of becoming the best boutique bank, not just a better bank. All members of the CLF (including those who were not in client-facing positions) had the opportunity to interact first-hand with a panel of diverse customers, listening to their ideas and coming to truly appreciate their needs. The team drafted plans to “delight the customer,” at the event, refined them with their teams, and put them into action within the month.

CLF leaders also acknowledged that the company had not made
sufficient progress on the culture front. Employees needed to refresh their culture and values and recommit to both. CLF members at the event discussed the pillars of the culture they wanted for Leumi (see exhibit 5):

To refresh Leumi’s values, the CLF discussed them at length, first in small teams and then all together, until they agreed on what those values meant and how they should be enacted in the daily life. After considerable debate and some heated discussion, everyone agreed upon a list of valued behaviors.

When they returned from the event, Etinger’s HR team launched a range of bank-wide initiatives to foster a high-performance culture. These included talent upgrades, performance management coaching, employee engagement events, value and performance-based reward and recognition, and investment in leadership development.

**Marking Progress: Great by Choice**

By the time they gathered in October 2017, the CLF leaders were ready to commit to the next leg of the journey, “Great by Choice.” Their focus turned to winning against competition, instilling “productive paranoia” and “fanatic discipline” (both terms drawn from Collins and Hanson’s book *Great by Choice*). They discussed how to build the culture that could use standardized practices, a lean mindset, and efficient processes to realize the ambition to create “the best boutique bank.” The book’s image
of a twenty-mile march proved a fitting analogy for their past progress and path forward. Having made steady progress over the past couple of years, they were prepared to continue to focus on the rigorous pursuit of long-term performance. As CFO Raja Dakkuri put it, this was not just a nice story, but proven facts.

**Sustaining the momentum**
The CLF’s yearly off-site meetings punctuated the bank’s change (see exhibit 6 for the transformation timeline), marked progress, and built the enthusiasm necessary to keep it going. They gave CLF members an opportunity to share their stories of success, celebrate their progress, reenergize, refocus, and recalibrate. Participants walked away from these events with new commitment and new plans of action, knowing that senior management would hold

<table>
<thead>
<tr>
<th>TABLE 1: LEUMI TRANSFORMATION APPROACH AT A GLANCE</th>
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<td><strong>Steps of the transformation</strong></td>
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<tr>
<td>Understand the current state of the business: <em>Where do we stand?</em></td>
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<tr>
<td>Articulate vision &amp; purpose: <em>What are we aiming for and why?</em></td>
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<td>Develop transformation roadmap: <em>How will we get there?</em></td>
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<tr>
<td>Focus on culture and values: <em>How must we behave?</em></td>
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<tr>
<td>Create a change leadership forum: <em>Who leads the change?</em></td>
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<tr>
<td>Drive accountability for change: <em>How do we ensure success?</em></td>
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<tr>
<td>Mark progress and celebrate success: <em>How do we sustain the momentum?</em></td>
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them accountable for delivering on those plans.

**Cycles of Change Punctuated by Change Leadership Forum (CLF) Gatherings**

By now, bank-wide initiatives had clear owners and were tracked quarterly in the bank’s balance scorecard. Annual employee surveys, biannual collaboration surveys, and quarterly business reviews reinforced the discipline of continuous improvement. The top team steadily tracked the progress of plans and required course corrections as needed.

They also helped to sustain momentum by instituting hiring for cultural fit, value-driven performance management, and value-based rewards. By continuously reinforcing desired behaviors and telling stories that highlighted the bank’s values in action, they inspired a virtuous cycle.

**Sustaining the momentum for continuous improvement is a never-ending challenge.**

With its top-notch leadership team, strong service and performance culture, good reputation and niche expertise, and sleek technology and operational structure, Leumi USA is now poised to go on to even greater successes. And the game is still not over. Sustaining the momentum for continuous improvement is a never-ending challenge. It is critical that the HR team continue to champion change.7 As the organization grows and its leaders change, the team will need to pay deliberate attention to bringing new members on board and building the capacity for change leadership. It will need to continue to hold CLF members accountable for sustaining the culture that makes Leumi the best boutique relationship bank.

**On Complex Business Transformations**

The case of Leumi illustrates a proven approach to complex business transformations. Its power comes from the coherence of all its elements. The approach’s comprehensive nature is best illustrated longitudinally. Drawing on both theory and practice, I designed the simplified framework of Table 1. The devil of transformative work is most certainly in the details and in the effectiveness of specific interventions. Because each business is unique, each team of leaders will need to emphasize, invest in, and attend to some elements more than others.

By marking progress along the roadmap regularly and taking time to celebrate successes, leaders infuse their organizations with the energy necessary to take on the next battle with renewed power and confidence.

One principle for complex transformations which is almost always useful, though, is dividing the transformation into change cycles with a clear beginning and end. By marking progress along the roadmap regularly and taking time to celebrate successes, leaders infuse their organizations with the energy necessary to take on the next battle with renewed power and confidence.

My hope is that this approach will provide you with powerful guidance for crafting the perfect recipe for your organization’s transformation and so increase your odds of success when you get cooking.

**Author Bios**

**Dr. Karen Ayas** is a founding partner of the Ripples Group and president of the Ripples Business Academy. She is a management consultant, educator, coach, and author with expertise in large-scale transformation and leadership development. Ayas has a deep passion for education and teaching and, for the past fifteen years, has been a professor of management practice at Babson College School of Executive Education, training over a thousand leaders.

**Endnotes**

3. See Philip Mirvis, Karen Ayas, and George Roth, To the Desert and Back: The story of one of the most dramatic business transformations on record, (San Francisco: Jossey Bass, 2003).
4. John P. Kotter and Holger Rathgeber, Our Iceberg is Melting (Macmillan, 2005).
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— DAVID J. TEECE, HAAS SCHOOL OF BUSINESS, UNIVERSITY OF CALIFORNIA, BERKELEY
Can Blockchain Manage Trust in Organizations?

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NUS Business School, National University of Singapore

Yan Pang
NUS Business School, National University of Singapore

David De Cremer and Yan Pang illuminate both the limitations and the potential of blockchain technology as the new currency of trust in organizational life. They have found that building trust within organizations requires leaving room for vulnerability, which makes blockchain unsuitable. For building trust between organizations, however, blockchain technology shows more promise because it acts as a regulatory middleman.
In today’s volatile and uncertain business environment, organizations must be fast and agile in decision and action. Schoemaker, Heaton, and Teece note that organizations today must be aware of how volatile and complex the business environment is in the short term, while simultaneously taking a long view. If top managers fail in this task, their organizations “may not be prepared when surprising events call for change.”1 Organizations that take an explorative approach to using fast, accurate technology to efficiently manage their functions will be better equipped to handle this challenge. Indeed, as Birkinshaw noted, “technological innovation inspires new approaches to management.”2 New technological approaches will help companies to navigate an ever-changing world.

Blockchain is one technology that could be beneficial. As Iansiti and Lakhani put it, “virtually everyone has heard the claim that blockchain will revolutionize business and redefine companies.”3 Scholars have suggested that blockchain, which is the underlying technology of such applications as Bitcoin, is already poised to radically change the nature of our companies. Blockchain could be used, among other things, to perform basic management functions in general and more specifically to motivate employees.4 A 2019 Deloitte survey of 1,386 senior executives in twelve nations revealed that it is not just scholars who believe blockchain technology can revolutionize our organizations, it is also those who lead them.5

Executives believe that blockchain technology can be broadly applied to the management and leadership of organizations. The survey focused specifically on the potential value that executives see in blockchain technology. Although blockchain was first applied to the cryptocurrency industry and then more generally to the financial sector, the survey found that executives see it moving in the direction of general management. Eighty-three percent of senior executives indicated that they see compelling ways for blockchain to be used in their organizations. Eighty-six percent of those executives believe that blockchain technology can be broadly applied to the management and leadership of organizations, while 53 percent, as of 2019, already see such applications as a priority.

This hype about blockchain as the new currency of trust is built largely on the technology’s ability to generate accountability, and thus trust, from almost nothing.

Blockchain Technology as a Driver of Trust

Many experts, then, expect blockchain technology to be an invaluable tool in optimizing business performance by facilitating management and establishing greater trust.6 Indeed, in 2015, The Economist ran a cover story about blockchain, calling it “the trust machine.”7 This hype about blockchain as the new currency of trust is built largely on the technology’s ability to generate accountability from almost nothing. Blockchain technology can thus provide valuable input for the promotion and regulation of trust in an organization.

Executives responding to the 2019 Deloitte survey indicated that blockchain technology was introducing new ways of recording and managing information about business transactions, individual employees, and their interactions. They could then use the resulting improved information about how employees work, collaborate, and fulfill contracts to turn the company’s focus toward optimization and creating greater value. According to Hawlitschek, Notheisen, and Teubner, “blockchain technology is said to facilitate ‘the exchange of value’”8 In the management of organizations, blockchain technology’s potential to create organizational value, in part by offering a new currency of trust, is widely recognized. Indeed, organizations perform better and create more value for stakeholders when managers promote a trusting work culture.

Behavioral research shows that organizations whose employees trust each other reap many benefits.

What Trust Does and Why

To make organizations effective, it is imperative that managers build the right work culture, allowing employees to create value for all their stakeholders. Within such a culture, employees work to promote performance and enhance the organization’s overall effectiveness. And trust matters! Indeed, within the literature of organizational behavior and management (particularly from the largely behavioral perspective), trust has been found to be critical both as a social lubricant or glue that facilitates cooperation between group members, and in allowing whole organizations to function effectively.9 Behavioral research shows that organizations whose employees trust each other reap many benefits. People who trust their
colleagues and managers are more likely to cooperate, share information, feel happier, and be satisfied with their jobs and their relationships. In short, the whole organization performs better.

Trust, then, is an important resource which management should actively encourage. The absence of trust costs the organization dearly, making interactions difficult and expensive. Without trust, transaction costs go up, employees are less prone to sharing information, and organizational dynamics, now colored by suspicion, slow down, suppressing the company's growth.

So trust is a positive organizational resource that promotes the growth of the right dynamics in a company. But why is trust so important? One of the most used definitions of trust in the behavioural sciences, refers to it as “a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another.” This definition is especially relevant when we talk about the challenge of managing trust within the organization. As employees develop relationships with their colleagues, both within and between departments, those social dynamics contribute to an overall trusting work climate.

People can only develop trust when there is an element of risk in their relationships.

Building on Rousseau et al.'s definition, we have identified several important qualities of the trust which interacting parties develop, and which we refer to as voluntary interpersonal trust. Understanding these qualities allows us to assess whether blockchain technology can effectively be applied to managing trust within organizations.

First, trust entails the social expression of one's positive expectations of others. Interacting parties who trust one another expect that each will be honest and reliable and thus not threaten one another's interests. With these positive expectations eliminating the fear of being exploited, all are willing to cooperate. Second, trust can only be built when people are vulnerable to each other's actions, and being vulnerable means running the risk of being hurt or exploited. Put another way, people can only develop trust when there is an element of risk in their relationships. The decision to make themselves vulnerable to others is considered a key element in employees developing mutual trust.

A behavioral analysis of trust thus reveals that risk is necessary to establishing trust. People cannot be vulnerable without risk, so they cannot build trust. This conclusion challenges the assertion that blockchain is a currency of trust. Indeed, blockchain technology reduces risk to virtually zero. By using blockchain, organizations create and signal a work setting that is basically risk-free. Using blockchain as a serious management tool, which, according to the Deloitte survey, many executives hope to do, may therefore not be a viable possibility. But only with a clear understanding of how blockchain works can we fully analyze its potential utility in building trust.

**Trust and the Function of Blockchain**

Blockchain is a distributed database composed of a chain of blocks. Each block is a set of data linked to the previous block. Blockchain thus records chronologically the actions of everyone in an interconnected network. The result is a platform that maintains a transparent and immutable record of all events within a shared network. By recording each user's particular data (decisions, actions, etc.) in a transparent manner, it creates a system in which each participant controls their own data in the context of existing social networks and big data.

Blockchain uses consensus and cryptography algorithms to build a safe and secure environment in which participants agree collectively to interact, peer to peer. It likewise updates its data continually and collectively, rather than at the word of a single central authority, so that it can be decentralized. The blockchain protocol uses strict criteria to validate any update made, adding updates to the chain only after participants reach consensus. The system's security services use cryptography to make the data blocks tamperproof. Once a new data block is added to blockchain, cryptographic hash functions, such as SHA (Secure Hash Algorithm)-256, assign it a hash value, a unique string of identifying characters. Cryptographic hash functions include collision resistance, ensuring that any change to the block, however minute, will result in a completely different hash value.

Each block also contains the hash of the previous block, confirming the data integrity of the chain up until that point. If anyone attempts to modify the established blocks, their efforts will be immediately detected and stopped. Indeed, it is not that blockchain focuses on tracking misbehavers, but rather that it discards any attempts to change blocks. Moreover, the fact that everyone immediately knows if someone tried to cheat should strongly discourage such
behaviour. Blockchain systems, then, use the principle of collective self-interest to ensure safe interactions.

The key quality of blockchain is thus that it creates a risk-free environment in networks of interaction. This quality is obviously important in light of the current focus on using technology to manage and promote trust. Indeed, if the network accounts for the past actions of every individual involved, minimizing the temptation to cheat, it creates a context in which the risk of being exploited by others is virtually zero.

And yet our theoretical analysis revealed that trust can only be built under a certain level of risk. How, then, can blockchain be a currency of trust? First, we must emphasize that we are not claiming that blockchain technology creates trust. Instead, trust is one result of the system that using blockchain technology creates. By using a monitoring and control system like blockchain, organizations unequivocally signal that they do not trust their employees.

Because of this assurance, blockchain is likely to fail in building trust among an organization’s workers. Indeed, research has shown that by using a monitoring and control system like blockchain, organizations unequivocally signal that they do not trust their employees to use company resources and information.\(^{17}\) In fact, the more people’s actions and decisions are scrutinized, the more likely they are to view the system as one that emphasizes rigid control rather than trust. A control system which does not allow employees the decision to be vulnerable to each other necessarily undermines their ability to voluntarily build trust.

In hailing blockchain as the new currency of trust, people seem to assume that total control over interactions will lead to trust. However, by adopting a behavioural perspective, we have found that the opposite may in fact be true. By creating a work environment so controlling as to be risk-free, organizations may actually prevent trust from being built. Our analysis has allowed us to identify several consequences of such efforts to use blockchain technology to manage trust in organizations.

### The Consequences of Using Blockchain to Manage Trust.

Many surveys and popular articles describe blockchain technology as having the potential to improve organizations in a wide variety of ways. Yet, the blockchain hype is already beginning to decline. As a sort of blockchain fatigue kicks in, the business world begins to realize that its expectations may be unrealistic when it comes to applying blockchain to a wide variety of business needs.\(^{18}\) In exploring how these technologies may help organizational management to thrive in a digital business environment we, as management scholars, recognized the need for open minds. Yet faced with concerns about unrealistic expectations, we also had a particular responsibility to think critically about the implications of technology-based management on worker motivation. In applying this careful rigor to our research, we reached four conclusions regarding the use of blockchain in managing trust within organizations.

**Blockchain makes interactions safe through control and verification, denying people the chance to build trust voluntarily.**

1. **Blockchain will not build trust between employees.** Building trust within organizations requires that people make themselves vulnerable to risk. Without the chance to choose vulnerability, they cannot develop trust. When applied to management, blockchain creates a risk-free record of interactions. In essence, blockchain makes interactions safe through control and verification, denying people the chance to build trust voluntarily. Blockchain technology would therefore lead to management that prevents the emergence of true interpersonal trust.

2. **Blockchain does build trust in the system.** Blockchain may thwart internal efforts to build interpersonal trust, but the same qualities become merits in inspiring workers to trust the system itself. By using decentralized principles to
guarantee and verify safe interactions, blockchain becomes a kind of middleman, regulating the safety of users’ interactions in a given network. In other words, it acts as a control mechanism, ensuring cooperation within the company. It is ironic that blockchain should take on the role of authoritative middleman, since blockchain itself does not rely on a central trusted authority. However, as our analysis shows, by taking up this position and status blockchain can be applied to a wide range of management functions.

3. Blockchain must be perceived as legitimate to build trust in the system.

In order for blockchain technology to work as a central authority system, securing safety, it is necessary that employees perceive the system as legitimate. If employees do not view the system as an appropriate regulator, its power to make them feel safe in the hands of a technological middleman is vulnerable. In other words, the blockchain system needs to provide assurance not only that interactions within the organizations are safe, but also that it is, itself, a legitimate regulator.

Any controlling authority is more likely to be accepted if it is perceived as procedurally fair. Employees will judge procedural fairness by determining whether the methods the authority uses to make decisions are fair. Research has shown that people judge procedural fairness by whether those procedures give them a voice and are neutral, unbiased, ethical, transparent, accurate, and consistent. Because blockchain handles information about those present in the social network, users must be assured, for example, of data accuracy, consistency of data collection, absence of biased principles, use of clear ethical guidelines, and the means by which those who are part of the social network can speak up and be heard.

4. Blockchain can build trust between organizations

Although blockchain does not create interpersonal trust within an organization, we conclude that it can be useful in building trust between organizations. Organizations have different qualities from people and the boundaries of inter-organizational trust, within which trust is built, function in different ways from those of interpersonal trust. Interactions between organizations tend to be shaped in cognitive rather than emotional ways, running through data flows. The transparency and reliability of these data therefore play an important role in building trust between organizations.

Since all participating nodes (i.e., organizations) in the network have the same copy of the entire blockchain, all data are added with the knowledge and approval of all the organizations and according to agreed criteria, with none having greater authority than the others. And blockchain’s cryptographic technology makes its data tamperproof, with any minor change being easily detectable so that it guarantees an immutable record of the information flow. All these unique features, then, make blockchain ideal for fostering trust between organizations by guaranteeing transparency and equilibrium.

Conclusion

In our conceptual piece we provided an analysis of interpersonal trust, which has a focus on being willing to be vulnerable to the actions of others, and used this perspective to interpret the relationship that blockchain has with the notion of trust. We conclude that blockchain is a system that in the organizational context will alter the nature of trust by changing the trust that exists between employees into trust that is given to technology.

Author Bios

David De Cremer is a Provost Chair and Professor at NUS Business School and founding director of the Centre on AI Technology for Humankind. GlobalGurus named him a World Top 30 Management guru and Thinkers50 identified him as a future management thought leader. Ranked among the world’s top two percent of scientists, he has authored over 300 academic pieces, his most recent book being, “Leadership by Algorithm: Who Leads and Who Follows in the AI Era?”

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Endnotes

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Artificial intelligence is rapidly transforming the world we know. Suresh Sethi describes the fascinating career of Herbert A. Simon, a father of artificial intelligence, renaissance man, and true polymath who made pioneering contributions to fields ranging from economics to psychology and from management to the philosophy of science.
Herbert Alexander Simon was born on June 15, 1916, in Milwaukee, WI. In 1978 he was awarded the Nobel Prize in Economics for his pioneering research into the decision-making process in economic organizations. His interests, however, went far beyond economics. Simon crossed disciplinary borders to influence many fields. His work expanded the information sciences beyond recognition, allowed computers to model the behavior of highly complex systems, and transformed psychology by exploring human information processing. A Royal Academy of Sciences citation described him as follows:

“Simon rejects the assumptions made in the classical theory of the firm of an omniscient, rational, profit-maximizing entrepreneur. Instead, he starts from the psychology of learning, with its less complicated rules of choice and its more moderate demands on the memory and the calculating capacity of the decision-maker. He replaces the entrepreneur of the classical school by a number of co-operating decision-makers, whose capacities for rational action are limited by a lack of knowledge of the total consequences of their decisions and by personal and social ties. Since these decision-makers cannot choose a best alternative, as can the classical entrepreneur, they have to be content with a satisfactory alternative. Individual firms, therefore, strive not to maximize profits but to find acceptable solutions to acute problems.”

Simon believed that scholars, in devising tools and techniques for modeling human behavior, had absurdly unrealistic expectations of the ability of humans to make rational choices. He argued that human rationality was bounded by the limits on available information and by the human mind’s capacity for processing information. As Simon put it, “we need a less God-like, and more rat-like, picture of the chooser,” adding, “decision makers can satisfice either by finding optimum solutions for a simplified world, or by finding satisfactory solutions for a more realistic world. Neither approach, in general, dominates the other, and both have continued to co-exist in the world of management science.”

"Decision makers can satisfice either by finding optimum solutions for a simplified world, or by finding satisfactory solutions for a more realistic world."

The tools he developed throughout his career were designed to create just such rat-like models of how people solve problems.

Simon earned both his B.A. (1936) and his Ph.D. (1943) in political science from the University of Chicago. From 1942 to 1949, he worked as a professor of political science at Chicago’s Illinois Tech, while transforming his doctoral dissertation into a book titled Administrative Behavior (1947). Although Simon had been in his twenties when he wrote the original material, the book challenged, essentially successfully and correctly, much of the received administrative theory of the time and provided a new conceptual framework of decision making. In it, he proposed the concept of bounded rationality to describe the human decision-making process in which, although they intend to be purely rational, people use expedients other than those prescribed by global rationality to make choices – specifically, they tend to choose a merely satisfactory solution, rather than insisting upon the optimal one. And the idea of bounded rationality applies to organizational as well as individual decision making. Simon later coined the term “satisfice,” a combination of “satisfy” and “suffice,” to describe this process.

During this period, Simon was also building his education in economics by participating in weekly seminars, organized by the Cowles Commission, in which no fewer than nine future Nobelists participated.

In 1949, he moved to what is now Carnegie Mellon University to collaborate with George L. Bach, William W. Cooper, and others in using W. L. Mellon’s gift of $5 million in endowment and $1 million for a building to create a new business school. Their goal was to construct an institution offering a foundation of studies in economics and behavioral science upon which business education could be built. With new management science techniques on the horizon and the emergence of the electronic computer, it was a heady time to launch such a venture. With the Graduate School of Industrial Administration, now the Tepper School of Business, they succeeded brilliantly.

Simon still felt the need for a better theory of human problem-solving. Around 1954, he and his doctoral student Allen Newell conceived the idea of writing computer programs to simulate problem-solving so they could better study it. That idea was the beginning. Simon’s research interests turned toward computer simulation of human cognition, a quest that would continue for the rest of his life. Holding that the programs are the theory, he became a fierce advocate of computer programs as the best...
Simon also developed and popularized heuristic programming. In 1955-56, he and Newell devised Logic Theorist (LT), the first successful artificial intelligence (AI) program, which successfully proved the theorems of Russell and Whitehead’s Principia Mathematica. Simon was so excited by the work that he famously announced to his January undergraduate class, “Over the Christmas holiday, Allen Newell and I invented a machine that thinks.”

By 1958, Simon had created another renowned program, the General Problem Solver (GPS). On the surface, both LT and GPS appeared to solve problems in much the same ways as humans. Simon insisted, however, that computer simulation was not an exercise in elaborating tautologies, but an empirical science that could teach us new and valuable things about ourselves and our world.

Beginning in the 1960s, Simon devoted his main research to extending the boundaries of artificial intelligence, particularly toward simulating human information processing, giving AI programs ever broader and less tightly structured tasks that called for increasingly substantial bodies of knowledge.

With a series of colleagues, Simon developed programs ranging from those that played chess, to the Elementary Perceiver and Memorizer (EPAM, co-created with Edward Feigenbaum) which simulated human sensory perception and learning, to BACON, which simulated the process of scientific discovery.

In 1972, he and Newell published a monumental book titled Human Problem Solving in which they introduced the notion of a program as a set of “production systems” or “if-then” statements. In 1975, they received ACM’s prestigious A.M. Turing Award for their basic contributions to artificial intelligence, the psychology of human cognition, and list processing. In light of his hugely influential work, Simon is justly considered one of the fathers of artificial intelligence.

Throughout his career, Simon believed that organization and structure were critical. Indeed, what his programs truly simulated was the structure of problem-solving. He concluded that human mental processes are hierarchical and associative. To replicate this hierarchical, associative model of the mind, Simon and Newell worked with J. C. Shaw (a programmer at RAND) to develop the first list processing language, IPL (Information Processing Language). While IPL was, in retrospect, a low-level assembly language for list processing, it was a major influence on the development of later list-processing languages, including Lisp itself.

Since the days of Simon’s early work, applications of AI have mushroomed. From Apple’s Siri, which uses natural language processing, to Google’s DeepMind, which uses deep learning, the impact of AI is ever increasing. In the business world, AI empowers businesses to work smarter and do far more with significantly less. AI reduces costs, increases efficiency, and boosts productivity while creating avenues for new products, services, and markets. According to IBM’s 2021 Global AI Adoption Index, 31 percent of companies are now using AI while 43 percent are exploring its use. Interviews with business leaders, IT managers, executive advisors, analysts, and AI experts mentioned smarter supply chains, smarter and safer operations, quality control, optimization, targeted marketing, customer service and support, contextual understanding, and more effective learning as just some of AI’s important applications. A recent piece in The Economist considered the controversy that would ensue if the Nobel prize in physiology or medicine were awarded to a non-human, in short, to AI.

Simon was a renaissance man, a true polymath, and a pioneer in artificial intelligence, computer science, decision making, economics, management science, operations research, organizational design and behavior, production smoothing, and the philosophy of science. Few people in history have made scholarly contributions of such depth and breadth. His writing was concise and lucid. And although he was an affable man, in professional arguments he would not readily give an inch.

While at Carnegie Mellon, I had the good fortune to take Simon’s course in Mathematical Social Sciences. There I discovered that Herb, as I came to know him, took pains to be extremely helpful to his students. One fine day, as I was crossing campus, I happened to encounter Herb. I spontaneously decided to ask him about an optimization problem I’d been working on and found to be unsolvable. He listened attentively, smiled, and said, “well then, make it simple.” His glib response suggested a philosophy of research, that the way to solve some intractable problems is either to simplify them enough so that they become tractable, while retaining their essence, or to change your goal from optimizing to satisficing. Indeed, in his writings, Simon observed that in pure science, if scientists cannot
answer their initial question, they “can modify and simplify it until it shows promise of being answerable.” In addressing a real-world problem, however, he pointed out that scientists “cannot substitute a simpler answerable question” if they cannot solve the one presented to them.

“To make interesting scientific discoveries, you should acquire as many good friends as possible, who are as energetic, intelligent, and knowledgeable as they can be. Form partnerships with them whenever you can. Then sit back and relax. You will find that all the programs you need are stored in your friends, and will execute productively and creatively as long as you don’t interfere too much. The work I have done with my more than eighty collaborators will testify to the power of that heuristic.”


In the coda of his autobiography, Models of My Life, he also revealed the one heuristic that was of the first importance to all his work: “To make interesting scientific discoveries, you should acquire as many good friends as possible, who are as energetic, intelligent, and knowledgeable as they can be.”

Author Bios

Suresh P. Sethi is Eugene McDermott Chair Professor of Operations Management at The University of Texas at Dallas. He completed his PhD at Carnegie Mellon University under the supervision of Gerald Thompson, learned Mathematical Social Sciences from Herbert Simon while there, and has benefitted greatly from Simon’s comments on his research over the years. He did his post-doctoral work with George Dantzig at Stanford University. In keeping with Simon’s heuristic of having many colleagues to work with, Sethi has coauthored with almost 200 valued colleagues so far.

Acknowledgments:

I would like to acknowledge the very helpful suggestions of Herbert Simon’s daughter Katherine Frank and of Kalyan Singhal and Tinglong Dai.

Endnotes

1. ‘Officially “The Alfred Nobel Memorial Prize in Economic Sciences”
5. In his 1956 article for the APS’s Psychological Review, titled “Rational Choice and the Structure of the Environment,” Simon described satisficing as follows: “Evidently, organisms adapt well enough to ‘satisfice’; they do not, in general, ‘optimize.’ And: ‘A satisficing’ path, a path that will permit satisfaction at some specified level of all its needs.”
7. https://cowles.yale.edu/about-us
9. https://amturing.acm.org/award_winners/simon_1031467cfm
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Kalyan Singhal is the Doris and Robert McCurdy Professor of Management at the University of Baltimore. Dr. Singhal founded the Production and Operations Management Society (POMS) in 1989. He also founded the society’s journal *Production and Operations Management* in 1992 and has since served as its editor in chief. Dr. Singhal is the publisher and coeditor in chief of the *Management and Business Review*. He is a fellow of INFORMS and POMS.

Dr. Singhal exemplifies the goal of this award, having pursued successful innovations in companies, conducted research which has produced innovations in both private and public sector organizations, and founded institutions and publications which have made enormous contributions to academia, business, and society.

Organizations competing for this award will be judged on the following criteria:

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1. The Mary E. Barth (Stanford University) and Christopher Ittner (University of Pennsylvania) Award for Research in Accounting

2. The K.P.K. Nair (University of New Brunswick) and Gang Yu (111, Inc.) Award for Research on Africa, Asia, and Latin America

3. The Herbert A. Simon (Nobel Laureate, Carnegie Mellon University) Award for Research in Artificial Intelligence

4. The Cynthia Barnhart (MIT) and Tom Davenport (Babson College) Award for Research in Business Analytics

5. The Subodha Kumar (Temple University) and Geoffrey G. Parker (Dartmouth College) Award for Research on Digital Transformation

6. The Kenneth Arrow (Nobel Laureate, Stanford University) Award for Research in Economics

7. The Melanie Hopp Award for Innovations in Management and Business Education

8. The Raj Gupta (formerly of Rohm and Haas) and Erika James (University of Pennsylvania) Award for Publications for Executives, Managers, and Professionals

9. The Teck-Hua Ho (National University of Singapore) and N. R. Kamath (Indian Institute of Technology, Bombay) Award for Research in Engineering and Technology

10. The L. Beril Toktay (Georgia Institute of Technology) and Luk Van Wassenhove (INSEAD) Award for Organizational Research into the Environment and Sustainability

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16. The Stephen C. Graves (MIT) and Mark L. Spearman (Strategic Project Solutions) Award for Research in Manufacturing
17. The Philip Kotler (Northwestern University) and Yoram (Jerry) Wind (University of Pennsylvania) Award for Research in Marketing
18. The Linda Argote (Carnegie Mellon University) and Henry Mintzberg (McGill University) Award for Research in Organization Science
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21. The Charles Corbett (UCLA) and Sunder Kekre (Carnegie Mellon University) Award for Research that Unites Theory and Practice
22. The Howard Kunreuther (University of Pennsylvania) and Paul Slovic (University of Oregon) Award for Research in Risk Management
23. The Uday Karmarkar (UCLA) and Costis Maglaras (Columbia Business School) Award for Research on Services.
24. The Vijay Govindarajan (Dartmouth College) and Gary Hamel (London Business School) Award for Research on Strategy and Corporate Governance
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