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A New Application of *TRUE* Math Programming Optimization for Finance: The Optimized Income Statement (OIS)

And Why It Is Very Important for Finance to Get Started Now!

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The time has come for Finance to get started to apply optimization/advanced analytics. By applying advanced analytics to the income statement, the "one report every organization needs," it is now possible to optimize it, creating an optimized income statement (OIS). The key deliverables of an OIS are an updated forecast that is maximally profitable and an updated supply chain that is the optimally feasible one required to make and fulfill the new forecast.

The time is *now* for Finance to get started to apply optimization/advanced analytics. Quoting Gary Cokins, performance management author, consultant, and Institute for Management Accountants' Executive in Residence, stated:

> **Get on the bus or be under the bus.** … Now I will change my tune from skeptic to advocate regarding the urgent need for modeling and prescriptive analytics capabilities leveraging optimization… The world is no longer flat.[1]

Further, according to Mary Driscoll, Senior Research Fellow, American Productivity and Quality Council (APQC):

> "What is really sad is that 20 years ago, when I was at *CFO* magazine, we were writing about the need for improvement in this area… The research shows that most CFOs are willing to invest in better financial systems and data models, but they are not necessarily inclined to **develop analytical talent** or polish their FP&A process models.[2]

Finally, Robert Kugel, SVP Research, Ventana Research, has commented "Optimization analytics is a breakthrough technology with the potential to improve business performance and create a competitive advantage."[3]

This article is divided into four sections: (1) The Primacy of the Income Statement, (2) Why Analytics Are More Important than Ever

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for Finance, (3) How an OIS Model Is Created and Solved, and (4) Conclusion.

PRIMACY OF THE INCOME STATEMENT

In *Painting With Numbers,* Randall Bolten states:

> The "balance sheet"—is the response you'll get if you ask a group of accountants and auditors to choose the most important financial statement of any organization.… It tells one the financial condition of an enterprise *right now*, as well as the state of its assets and liabilities, and who actually owns it … it affirms the financial condition of the enterprise as of a specific date.…
>
> The balance sheet is certainly important, but to most people involved with managing an enterprise, the main use of financial statements is to help them understand how the organization is performing, not just to provide a snapshot of how it *is* or *was* at a single moment. After all, management is about *doing,* not *being*. Reports that describe the flow of revenue and expenses over a period of time are called *income statements*.[4]

Elaborating, income statements contain flow variables; that is, those variables that represent changes in those accumulations (e.g., revenue; cost of goods sold [COGS]; sales, general and administrative [SG&A]) and are represented in the income statement." Underscoring their significance, the author describes an income statement as the "one report *every* organization needs."

Traditionally, math programming optimization has been applied to balance sheet items, however. For example, on the title page of *Optimization Methods in Finance,* the authors note that: "Optimization models are playing an increasingly important role in financial decisions."[5] The book makes no mention of the income statement. What, then, were the topics the authors considered suited for optimization analysis up until now?

> Modern finance has become increasingly technical, requiring the use of sophisticated mathematical tools in both research and practice.… Below, we introduce topics in finance that are especially suited for mathematical analysis and involve sophisticated tools from mathematical sciences: 1) Portfolio selection and asset allocation; 2) Pricing and hedging of options; 3) Risk management and 4) Asset/liability management.

While these topics are certainly important, it is clear these are *not* the "one report *every* organization needs."

With this article, I hope to persuade the reader of three things:

1. Using advanced analytics, it is now possible to create an optimized income statement (OIS).
2. OIS results provide: (a) an updated forecast that is maximally profitable and (b) an updated supply chain that is the optimally feasible one required to make and fulfill the new forecast.
3. The time to create an OIS is now.

WHY ANALYTICS ARE MORE IMPORTANT THAN EVER FOR FINANCE

What follows are extensions of the three quotes cited in the Introduction as well as a fourth citation.

1. In "Why Embrace Optimization and Predictive Analytics" Gary Cokins, performance management author, consultant and Institute for Management Accountants' Executive in Residence, states:

> Which type of capability is more critical? Management methods or analytics?
>
> I personally go back and forth on wondering if applying analytics now is an urgent imperative for an organization to survive or if it is a "nice to have" relative to other more critical "must have" capabilities that an organization should ideally possess or need to improve them.…
>
> The answer to the question, in my opinion, is critical capabilities involve modeling methods and prescriptive analytics.… **Now I will change my tune from skeptic to**

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advocate regarding the urgent need for modeling and prescriptive analytics capabilities leveraging optimization. … I am rapidly recognizing that embracing optimization is becoming an imperative for successful organizational performance.… C-levels that have deployed prescriptive analytics on a company-wide basis will agree it not only has doubled or tripled their shareholder value, but it has also given them a unique competitive advantage by spreading knowledge and moving faster than the competition.

Get on the bus or be under the bus.

Throughout my career I have been an active and loud advocate, even cheerleader, for deploying the integrated business planning methods. I still do make noise about their high value and nag organizations who still use primitive precursors (e.g., management by objectives, standard cost accounting, and quality management).

However I now choose prescriptive analytics and optimization capabilities as more critical than traditional capabilities.… I myself am now getting pumped up–excited. It's here. Optimization can be done …

It is no longer a dream. It is no longer theory.… The type of managers, hopefully only a few, who do not embrace having a strong quantitative capability will risk the consequences of being classified as Medieval. The world is no longer flat.[1]

2. In "Advanced FP&A: An Easy Case to Make but a Difficult Vision to Realize," Mary Driscoll, Senior Research Fellow, APQC, in notes from her presentation to CFO Dimensions Conference, October, 20, 2015, says:

> "What is really sad is that 20 years ago, when I was at CFO magazine, we were writing about the need for improvement in this area. The message was: to be relevant in the pursuit of strategic objectives, finance teams had to become stronger business partners and **generate analyses** that help decision makers **increase** economic **profit**. Today, a lot of work remains untouched. The research shows that most CFOs are willing to invest in better financial systems and data models, but they are not necessarily inclined to **develop analytical talent** or polish their FP&A process models. Indeed, only half of the survey takers reported that the business entities they serve are committed to expanding the mission of finance so that it adds more value to decision-making.[2]

3. In "Optimization Analytics Comes to the Mass Market," Robert Kugel, SVP Research, Ventana Research, states:

> Optimization is the application of algorithms to sets of data to guide executives and managers in making the best decisions. It's a trending topic because using optimization technologies and techniques to better manage a variety of day-to-day business issues is becoming easier.…
>
> Optimization analytics is a breakthrough technology with the potential to improve business performance and create a competitive advantage. You can't do optimization in your head, and it's not feasible in desktop spreadsheets for anything but the most basic use cases, such as linear programming optimizations on relatively small data sets. This is a good reason for almost any company to consider adopting optimization software.…
>
> Another reason why companies will find it attractive to apply optimization analytics broadly is that the results of applying optimization routines may be superior to using common rules of thumb or relying on instinct and experience. One of the most important lessons for executives about optimization analytics is that optimal solutions are sometimes (but—crucially—not

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always) counterintuitive to established norm.[3]

4. In "Why the CFO Should 'Own' Analytics," Frank Friedman, CEO and former CFO of Deloitte, LLP, in CFO Magazine, October 29, 2014, states:

> **Why CFOs Should Lead the Analytics Effort**
> As with any business process, there must be a system underlying the analytics effort and a leader in order for it to be effective. CFOs are the logical choice to own analytics and put it to work to serve the organization's needs.
>
> First, CFOs "own" most of the unprecedented quantities of data that companies are collecting from their own operations, supply chains, production processes and customer interactions. Many CFOs are already using analytics to better understand where the business is strong and where it needs improvement, and how to allocate limited resources more effectively. Analytics empowers CFOs to exercise more centralized control of operational business decision-making. As profit can fall between the operational cracks, analytics can be a game changer by leading to improved operational discipline.
>
> Second, many CFOs are already using analytics to address their organization's strategic issues. By owning analytics, they can continue to expand their strategic leadership role in growing the top line, strengthen their ties throughout the business and expand their influence outside the finance function.
>
> Third, CFOs' position as the steward of value and impartial guardian of truth across the organization gives them the credibility and trust that is needed when analytics produces insights that debunk some of the myths or accepted wisdom that can reside within the business, or about constraints on business performance. When people are provided observations that do not align with their thinking, there is a tendency to say, "That can't be right," and it can be challenging to convince them that the results and the data they're based on are accurate. If they don't trust the messenger, they are unlikely to trust the message.[6]

HOW AN OIS MODEL IS CREATED AND SOLVED

For true optimization, every line item in the income statement must be described as a variable; it has to be "driver based." Outside the world of optimization, I found the clearest expression that the preferred drivers should be units in a report by Robert D. Kugel, published on April 25, 2011, on the modeling structure of an Financial Planning and Analysis (FP&A) firm, Alight, in which he stated:

> The most distinctive feature of Alight's software—an explicit unit-times-rate structure for building plans—does a great job of supporting a more advanced approach to planning and budgeting that is consistent with a performance driver planning methodology. The unit-times-rate method disaggregates the planning of "things" (for example, how many units will be sold and how many sales calls it will take to sell this many units) from the financial consequences of those activities (that is, revenues and cost of selling). Keeping units and rates explicit during the planning process can lead to a more effective allocation of resources.[7]

The "Unit × Rate = Cost" structure is precisely the one used in an OIS model but not in the way envisaged by Kugel. The difference in the Alight model is that the units are fixed while in the OIS model the units are necessarily variable, as described above. This relation between units and costs is sometimes referred to as a cost relationship model; however, for the rest of this article, it will be referred to as cost functions.

Further, in one of those serendipitous arithmetic planning truths that emerge from time to time, the rate of the Unit × Rate = Cost structure is precisely the slope required for OIS's cost functions.

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In a further serendipitous planning truth, it turns out the arithmetic of activity-based costing also creates the very same cost function slopes. Specifically, by multiplying the three key activity-based costing analysis factors (activity consumption rate, resource consumption rate, and cost factor), the same cost function slopes are created.[8]

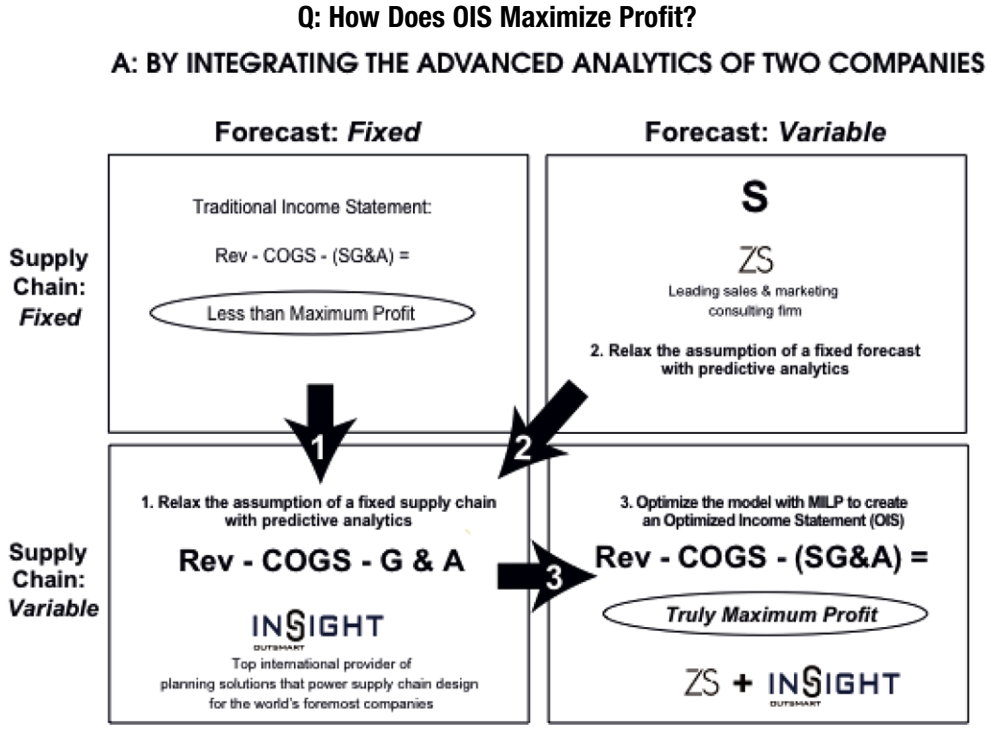
These cost functions, whether developed from activity-based costing data, the rate in the Units × Rate = Cost structure, or from accounting data, relax the assumption of fixed COGS and G&A in the OIS model.

However, cost functions are not uniformly applicable across all the line items in the OIS model. It works for COGS and G&A; it does not work for the S of SG&A. This is because, while the independent variable for cost functions for COGS and G&A is units and the dependent variable is cost, the cost functions for S are exactly the opposite. Here, cost is the independent variable and units are the dependent variable. These S cost functions are sometimes referred to as forecasting models; however, for the rest of this article, they will be referred to as marketing response functions. These functions relax the assumption of a fixed forecast in OIS.

The term for the analytics that are used to develop both cost functions and market response functions is *predictive analytics* (PA).

So while all the line items in OIS are variables, they are variable as a function of different

Exhibit 1



The three steps required to create an Optimized Income Statement ***(OIS)*** are:

1. Build a model of the income statement as traditionally developed in supply chain network design software, **relaxing the assumption of a fixed supply chain** with driver-based cost functions.
2. Integrate into this model marketing response functions which **relax the assumption of a fixed forecast**.
3. Optimize the model with mixed integer and linear math programming (MILP).

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things. In the trade press's terminology, this makes OIS both "demand driven" (S) and "driver based" (COGS and G&A).[9]

Once the OIS model has been created it must be solved. There are, broadly speaking, three classes of model solvers: descriptive (aka enumeration, what-if analysis, scenario analysis), heuristic (rules based) and prescriptive (mathematical programming). *Descriptive solvers* answer the question: "What will happen if we do X?"

Prescriptive solvers answer the question: "What is the best X?" Thus, prescriptive solvers are the only ones capable of mathematically demonstrably optimizing complex models.

The OIS model containing the two PA functions is then optimized using a prescriptive mixed integer and linear mathematical programming solver.

Finally, since *all* the line items in OIS are variable, OIS's solution is *truly optimal* because of the principle of suboptimization. It states that the sum of optimizations (e.g., optimization (COGS and G&A) + optimization (S)) is always less than the optimization of the sum (e.g., optimization (COGS and SG&A)).[10]

The result is that OIS generates not only the *truly* maximally profitable forecast but also the *truly* optimally feasible supply chain required to make and fulfill the new forecast. See Exhibit 1 for a summary of how OIS's PA models (i.e., cost functions and marketing response functions) and a prescriptive math programming solver (MILP) create an OIS. It requires partnership between two advanced analytics companies, as no one company has all three of the necessary analytics.

CONCLUSION

As outlined at the outset, it is hoped the reader has been persuaded of three things by this article:

1. By applying advanced analytics to the income statement, the "one report every organization needs," it is now possible to optimize it, creating an optimized income statement (OIS).
2. The key two deliverables of an OIS are: (a) an updated forecast that is maximally profitable and (b) an updated supply chain that is the optimally feasible one required to make and fulfill the new forecast.
3. The time to start is now.

If I haven't persuaded the reader of these points, I would direct the reader's attention to Note 11 below. It was written specifically for the chief financial officer and includes some of the material covered in this article as well as further OIS explanatory details.

Finally, I want to conclude with a point that has not been made, previously. Specifically, that the essential characteristic that allows an OIS to be optimized is that it is a new kind of an income statement.

The traditional income statement is one of dollars, it is a financial income statement. As a new or second kind of income statement, OIS is an operational income statement. It is an income statement of things, of activities. As will be described in a forthcoming book, this will allow Finance to exercise operational cross-functional leadership in ways never before possible. Any one interested in more information on this new kind of income statement is welcome to get in touch with the author. See contact information below.

NOTES

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