Data-Driven Denim: Financial Forecasting at Levi Strauss

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> *"We are utilizing AI to revolutionize forecasting in finance. This will change how we leverage our finance teams within our organization. Instead of focusing on generating manual forecasts, they can use the algorithm as a validation point. This will enable them to dedicate more of their time to understanding how to drive revenue and responding to emerging trends."*
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> — Harmit Singh, Chief Financial & Growth Officer of Levi Strauss & Co. ("Levi Strauss")

In early 2023, Harmit Singh, the Chief Financial and Growth Officer of Levi Strauss, was analyzing Levi Strauss's most recent financial forecasts. Singh managed Levi Strauss's finance, strategy, information technology, strategic sourcing, real estate, and business services functions globally. The 170-year-old apparel company was coming off a solid year in 2022, with revenues up 7% over the previous year. However, the company faced potentially strong macroeconomic headwinds for the remainder of 2023. Inflation, declining consumer confidence, rising interest rates, and lingering effects of the COVID-19 pandemic were generating concerns about the health of the macroeconomy. These macroeconomic factors made it challenging, and even more important, to forecast where Levi Strauss was headed for the remainder of 2023.

Over the past few years, Levi Strauss had been incorporating machine learning and artificial intelligence (AI) into its forecasting process with the help of Wipro, who provided information technology and business process outsourcing services to the company. Singh had reached out to Wipro in 2018 to help improve Levi Strauss's forecasting process in anticipation of Levi Strauss's 2019 public offering. By using machine learning and AI, the hope was that Levi Strauss could streamline its forecasting process and improve its forecasting accuracy to support the external guidance expectations of a publicly traded

company. Singh championed a broader digital transformation initiative at Levi Strauss, which incorporated machine learning and AI into Levi Strauss's forecasting process.

While 2023 had been off to a strong start, Levi Strauss's machine learning-based forecasting algorithm began to suggest that the second half of 2023 might prove more challenging than initially expected. While the algorithm suggested this change in trend, it inherently could not provide the rationale or specific data driving the change. Separately, the manual forecasting process identified a similar shift based on the feelings of the finance team. Given this updated information, Singh needed to first assess both forecasts and identify the drivers of pessimism, both fact and feeling based. Second, Singh and CEO Chip Bergh needed to decide if and how Levi Strauss should respond.

Levi Strauss

Levi Strauss, an immigrant from Germany, founded Levi Strauss & Co. in San Francisco during the height of the California Gold Rush in 1853. While initially operating as a dry goods store, the company struck gold in 1873 when it secured the key patent for what would ultimately become blue jeans. One of Strauss's customers was a tailor named Jacob Davis. Based on the idea from a client, Davis approached Strauss with the idea of using metal rivets to reinforce the construction of trousers to improve durability. Davis and Strauss worked together to patent the riveting process and began selling riveted pants. While workers had been wearing denim trousers for many years, the introduction of rivets marked the birth of the iconic jeans. Over the next 100 years, blue jeans evolved from workman's wear to a closet staple for men and women across the globe.

Levi Strauss became a publicly traded company for the first time in 1971 and remained public until 1986, when descendants of Levi Strauss and other initial stakeholders orchestrated the largest ever leveraged buyout (LBO) in the apparel industry. Under the leadership of Bergh and Singh, the company went public again in 2019. As of 2022, the company generated $6 billion dollars in revenues and employed 18,000 people. Exhibits 1 and 2 display Levi Strauss's financial statements as of year-end 2022.

With some of the most recognizable brands in the world, Levi Strauss operated a "Brand Led" business strategy. The company managed a portfolio of five apparel brands: Levi's, Signature by Levi Strauss, Denizen, Dockers, and Beyond Yoga. The core brand, Levi's, was famed for its blue jeans and, in particular, the original 501 jeans. The Signature by Levi's and Denizen lines targeted Levi Strauss's more value-oriented and cost-conscious consumers. These three brands generated 93% of the company's revenues in 2022. The remaining brands included Dockers, a brand established in 1986 and known for its signature khaki pants and other types of business casual wear, and Beyond Yoga, a premium athleisure brand that Levi Strauss acquired in 2021.

The company distributed its products through wholesale and direct-to-consumer (DTC) channels. Historically, most of the distribution was done through third-party retailers (i.e., the wholesale channel), which included department stores, specialty retailers, third-party e-commerce sites, and brand-dedicated franchised locations. Wholesalers accounted for 62% of Levi's total sales in 2022. Recently, the company had been pivoting towards a "DTC

First" strategy. Direct-to-consumer sales constituted 38% of revenues in 2022, up from 25% in 2014. These sales were mainly driven by Levi-branded brick-and-mortar stores, which accounted for 81% of DTC sales, while e-commerce accounted for the remaining 19%. As of 2022, the company operated approximately 1,089 mainline and outlet stores, generating 26% of total revenues. Levi's also sold products online through brand-specific websites such as levi.com, dockers.com, and beyondyoga.com. Exhibit 3 displays Levi's 2022 sales by segment and channel.

Digital Transformation

Over the past few years, Levi Strauss had been undergoing a digital transformation that, according to Singh, made the firm seem like a "170-year-old startup." One of the first steps in the transformation was to recruit new talent and create new digital-focused roles at the firm. Dr. Katia Walsh joined Levi Strauss in 2019 as the firm's first Chief Global Strategy and AI Officer to help expand Levi Strauss's analytics and digital capabilities. More recently, Jason Gowans was appointed as the firm's first Chief Digital Officer. In addition to hiring new talent, Levi Strauss also focused on upskilling its existing employees by offering a series of AI and coding boot camps.

The digital transformation led to several efficiency improvements at Levi Strauss. Dr. Walsh and her team used AI to help identify trends and optimize pricing and shipping decisions. For example, AI could be used to help optimize online order fulfillment. Whether an order should be shipped from a retail store, or a distribution center depended on a variety of factors, including ship-to location, on-hand inventory, and projected future demand at nearby retail stores. AI helped Levi Strauss optimize these decisions. The company also established a Robotic Process Automation (RPA) Center of Excellence that would help find and implement opportunities to automate labor-intensive and mundane tasks.

Levi Strauss's digital transformation targeted all facets of its operations, including its finance function. Singh worked to incorporate AI into Levi Strauss's financial processes and launched a roadmap to implement a new enterprise resource planning (ERP) system globally over a number of years. The ERP provided numerous benefits, including enhanced data accessibility, financial process consistency, and inventory management. Singh outlined four lessons learned during Levi's digital transformation in a recent Harvard Business Review article: avoiding perfectionism in favor of progress; leapfrogging the competition; fostering a data-driven mindset across all tiers of the organization; and allotting time for the cultivation of technological savviness.

Reflecting on his experience, Singh recalled challenges in getting everyone to embrace the digital transformation: "At first, some of our employees were concerned that technology might replace their jobs. We had to reassure them that our goal was to enhance their abilities through technology. Our goal was and is to harness technology to free up their time for higher-value tasks that are both more rewarding for them and the firm."

Financial Forecasting at Levi Strauss

One area that Singh initially identified as ripe for digital transformation was the financial forecasting process at Levi Strauss. Accurate forecasts were critical for the business unit finance teams and the corporate FP&A teams at Levi Strauss.

The business unit finance teams relied on internally produced financial forecasts for their resource planning processes, which included determining head counts, making product and store investment decisions, capacity planning, and managing working capital. Inventory management was a vital component of working capital that many companies, including Levi Strauss, had challenges in managing with the supply chain disruption in the post-pandemic period.

Inventory planning was undertaken on a season-by-season basis, typically 9-12 months in advance, and often occurred before the formulation of a financial plan. Mistakes in this phase could result in substantial costs to the business. This is because, on the one hand, insufficient inventory on-hand constrains sales and may lead to additional charges for expedited product shipping, while, on the other hand, excess inventory ties up capital and generates additional storage costs and operational inefficiencies throughout the supply chain. For instance, if the company had more inventory on hand than its distribution centers had storage capacity to hold, inbound merchandise shipped from overseas might incur demurrage costs when containers remained in port for long periods of time waiting for room to receive in distribution centers, as well as detention costs for prolonged container usage. Neethling Prinsloo, Vice President and CFO of Levi Strauss Americas, added, "Excess inventory also carries substantial efficiency costs. For instance, it slows down and sometimes precludes the picking and shipping of items in distribution centers. While these efficiency costs might not be immediately evident, they bring about tangible and substantial repercussions over time."

Singh and the corporate FP&A team relied heavily on the internally produced forecasts when developing financial projections and issuing external guidance. As a newly publicly traded company, Singh recognized the increased significance of providing accurate guidance to investors. For a well-established company like Levi Strauss, even a one percent forecast error, which might seem trivial, could be significant in the context of internal and external growth expectations.

Traditional Bottom-Up Forecasting

The business unit finance teams helped forecast key financial metrics, such as revenue and earnings, formally on a quarterly basis and informally every month. The teams were focused on projecting quarterly figures for the remainder of the fiscal year.

The finance teams began by collaborating with sales and demand planning teams, which would provide unit sales forecasts at the product code-by-customer level. These forecasts were shaped by discussions with Levi's wholesale customers, who indicated their projected orders for the upcoming seasons.

The first step involved the finance team adjusting the projected unit sales based on historical trends in differences between projected and actual sales. Unlike a "cut to order" model, Levi Strauss had a "cut to forecast" model. Under this approach, Levi's sales personnel collaborated with wholesale customers to anticipate future orders, which could be canceled or changed by the customers at any time. These forecasts would then dictate the volume of production, followed by the sales teams gathering the final customer orders. However, due to the time lapse between production and the receipt of firm customer orders, differences often existed between the initial expectation and final amount of inventory needed. In addition to customers ordering more or less than the initial discussion, the mix of the types and sizes of garments produced also might not align exactly with the wholesalers' final orders.

After adjusting projected unit sales, the finance team's next step was to translate the projected unit sales into revenues after accounting for the anticipated Average Unit Retail (AUR), the average sales price for merchandise. While the team had information on the listed prices of each item, the actual sales prices would have been affected by various discounts, sales incentives, and promotional activities that largely depended on business conditions throughout the year. To estimate the AUR, the finance team relied on historical data and collaborated with sales and demand planning teams.

While this process generally yielded fairly accurate forecasts, it had its challenges. Firstly, it was time-consuming; developing a financial forecast at the country level could require a week's work from a team of 5-10 employees. Secondly, the process heavily relied on human judgment, which was often prone to behavioral biases and influenced by an inherent conservatism of those making forecasts. Management noticed that their internal forecasts often exhibited overreactions to short-term events, both favorable and unfavorable, even if they were anticipated to be transitory. Individuals would often extrapolate short-term trends and events for the remainder of the quarter and year.

Partnership with Wipro

Although Levi Strauss had a partnership with Wipro dating back to 2014 for information technology and business process outsourcing services, Singh's decision to partner with Wipro to help with Levi Strauss's forecasting process only occurred after a presentation that the CEO of Wipro made to its strategic clients in 2018. Wipro had recently begun utilizing machine learning and AI technologies to forecast their financial metrics and was able to provide revenue guidance with higher confidence using the machine learning model. Given that Levi Strauss was in the planning stages of going public, a process that would necessitate providing financial guidance externally, Singh decided to explore a similar approach to use machine learning to forecast revenues for Levi Strauss. Singh asked Pavan Pamidimarri, Senior Vice President of Finance Operations and Sourcing at Levi Strauss, who oversaw the Wipro relationship, to explore starting a pilot project on AI revenue forecasting with Wipro. Pamidimarri worked with Wipro to set up a co-development model to adapt the work Wipro had done on its own professional services business and adapt it to the apparel business, with apparel financial planning experts from Levi Strauss working closely with the data scientists from Wipro. This venture marked Wipro's debut in offering this service to other companies, fostering a unique collaborative

opportunity between the two firms. Under the plan, Wipro would analyze data from Levi Strauss to forecast gross revenue, dilution (discounts), net revenue, and net sold units for the current fiscal year on a monthly basis. Pamidimarri asked Stacie Clarkson, then Director of Governance & Transformation in Global Business Services at Levi Strauss, to lead the project, oversee the collaboration with Wipro, and manage the updated forecasting process.

The first significant hurdle Clarkson faced was the issue of data management. Although Levi Strauss had a wealth of data from its direct-to-consumer and wholesale channels, it was not housed in a central repository. Much of the data was fragmented across business units. Clarkson also needed to work with Wipro to determine the types of data that were needed to forecast revenues. Despite Wipro's experience with their own business forecasting, they initially found it challenging to grasp the intricacies of Levi Strauss's operations. With some iteration and fine-tuning, Clarkson and Wipro assembled a dataset with 25-30 distinctive attributes. The final data set included historical information regarding revenues, dilution, unit levels, returns, and order fulfillment rates, with certain details provided at the customer and product levels. The data set also included forward-looking information about Levi's upcoming promotional calendar and internal unit-sales forecasts. These were the same internal unit sales forecasts that Levi's finance teams used as a basis to construct the manual bottom-up forecasts. Exhibit 4 displays the internal unit-sales forecasts for 2022. (See the spreadsheet supplement HBS No. 224-736 for historical data and realized sales over the period 2014-2022).

Wipro employed a long short-term memory model, a type of neural network model adept at recognizing patterns in sequences of data. One challenge with utilizing machine learning and AI models was their often inherent "black box" nature, making them difficult to interpret. This was particularly challenging for Levi Strauss since they were not the ones building the model and had to depend on Wipro to help interpret the forecasts. Wipro used data spanning from 2013 to 2017 as a training sample and data from 2018 as a testing sample. After fine-tuning the data and model, Levi Strauss went live with the model in the US in 2019, with plans to implement it globally in the subsequent years. To ensure the security of Levi Strauss data, the model developed by Wipro ran on Levi Strauss servers within its secured data center environment.

The partnership with Wipro introduced its own set of hurdles. Language presented the first barrier, as the data science team at Wipro and the finance teams at Levi Strauss didn't speak the same professional "languages." Moreover, the former lacked an understanding of the apparel industry's economics, just as the latter had limited knowledge of machine learning and AI. This issue was exacerbated by a lack of trust between the two groups. As Clarkson pointed out, "bridging the gap between business understanding and technological proficiency was critical."

Getting the finance teams at Levi Strauss to embrace the new forecasting methodology proved to be a considerable challenge. Initially, finance team members at Levi Strauss were reluctant to collaborate with Wipro because they were skeptical of and did not want to be displaced by machine learning and AI. Reflecting on this skepticism, Pamidimarri recounted an individual's comment: "I have been in the apparel business for 40 years, and I

have a hard time predicting where revenue will go. I don't see how AI will be able to do this." Many were skeptical that the model would be nuanced enough to capture all the idiosyncrasies vital to Levi's business. For instance, a celebrity sporting a Levi's garment and going viral might turn that product into a hot trending item, increasing demand and driving revenues up. Would the algorithm be capable of accounting for such idiosyncrasies? More generally, there were concerns about the model's inability to integrate "soft" information, such as the health of their wholesalers and fashion trends.

Despite these reservations, the management at Levi Strauss was confident that showcasing the accuracy of the AI model compared to manual forecasts would gradually win over the finance teams. As Pamidimarri reflected, "Finance people understand that the numbers do not lie."

Manual vs. AI Forecasts

After rolling out the live forecasting process for the US market in 2019, management quickly found that the AI model produced remarkably accurate forecasts. One of the primary metrics Levi Strauss's management used to evaluate forecasting models was the mean absolute percentage error (MAPE), calculated as the absolute value of the difference between the actual and forecasted values divided by the absolute value of the actual value (i.e., MAPE=|Actual-Forecast|/|Actual|).

Exhibit 5 displays the accuracy of Levi Strauss's manual and AI-generated revenue forecasts over the period 1Q2021-2Q2022. The forecasts correspond to the quarterly revenue forecasts made at the start of each quarter (i.e., forecasted revenue for 3Q2021 made at the beginning of 3Q2021). Accuracy is measured relative to realized quarter sales and is measured as 1-MAPE such that accuracy ranges from 0 to 1, and a higher number corresponds to a more accurate forecast (i.e., lower forecast errors on average). The finance team at Levi Strauss found that the AI model, though not always more accurate, was closer to the actuals more often than the manual forecast. Management also anticipated that the model's accuracy would likely improve over time with more data.

Considering that the algorithm was generating forecasts with similar accuracy and required significantly less manual effort than the bottom-up forecasting process, Singh considered discontinuing the bottom-up forecast entirely in favor of the algorithmic approach. The major advantage was the algorithm's accuracy and efficiency. However, the bottom-up forecasting process helped uncover new information for business leaders that might otherwise go unnoticed.

As management mulled over the future of Levi's forecasting processes, the COVID-19 pandemic emerged globally in March 2020. Unfortunately, the machine-learning algorithm was ill-equipped to navigate the uncertainties of the pandemic, resulting in a significant spike in forecast errors. Although the algorithm had maintained a reliable 1-5% error margin pre-pandemic, the mean absolute prediction errors soared over 40-50% during the crisis. The AI model erroneously projected robust growth even as economies worldwide were grinding to a halt. Despite concerted efforts by Levi Strauss and Wipro to enhance model performance, progress was minimal. This setback effectively paused discussions regarding the potential discontinuation of bottom-up forecasts.

As circumstances began to normalize in 2021 and fresh data was incorporated into the model, the model's forecast accuracy began to recover. In 2022, the refined Wipro forecasts were implemented globally, becoming a vital tool in the planning process. It was agreed that the tool would not replace bottom-up forecasts but would serve as an additional data point and a means to verify the accuracy of their projections.

Navigating Levi's Path Forward in 2023

Management at Levi Strauss entered 2023 with cautious optimism. 2022 was a strong year for the company; income rose 7% year-over-year, and Levi Strauss surpassed its earnings per share expectations in the fourth quarter. At the start of 2023, management projected revenue growth of 1.5-3% year-over-year, contingent upon no significant worsening of the COVID-19 pandemic, inflationary pressures, supply chain disruptions, or further worsening currency impacts. The first quarter of 2023 signaled a promising start, with revenues up 6% year-over-year, amounting to $1.7 billion. This was partly due to the initiation of Levi's new ERP system, which effectively shifted approximately $100 million of wholesale shipments from the second quarter to the first quarter. For that quarter, the algorithm's prediction for the US business was more optimistic than the bottom-up manual forecast.

As the year unfolded, the algorithm's forecasts for Q2 and beyond hinted at potential challenges ahead, including the possibility of lower-than-anticipated sales in the latter part of 2023. The finance teams also identified risk to the latter half of 2023, which was reflected in their manual bottom-up forecasts. What was driving this pessimism? The algorithm generated a revenue forecast, but it did not provide explanations for its predictions, therefore making it difficult to assess what to do next. The bottom-up analysis depicted similar signs of emerging challenges, which were offset by actions the commercial teams could initiate to counteract the weaknesses. This presented a dilemma for management. Singh and Bergh needed to first decide whether these algorithmic forecasts were reliable and, second, determine the appropriate course of action, if any, and the likelihood of success of the actions, to mitigate the potential challenges.

Exhibit 1: Levi Strauss Consolidated Statement of Operations

	2022	2021	2020
Net revenues	$6,168.60	$5,763.90	$4,452.60
Cost of goods sold	2,619.80	2,417.20	2,099.70
Gross profit	3,548.80	3,346.70	2,352.90
Selling, general and administrative expenses	2,893.20	2,652.20	2,347.60
Restructuring charges, net	9.10	8.30	90.40
Operating income (loss)	646.50	686.20	(85.10)
Interest expense	(25.70)	(72.90)	(82.20)
Loss on early extinguishment of debt	-	(36.50)	-
Other income (expense), net	28.80	3.40	(22.40)
Income (loss) before income taxes	649.60	580.20	(189.70)
Income tax expense (benefit)	80.50	26.70	(62.60)
Net income (loss)	$569.10	$553.50	$(127.10)
Earnings (loss) per common share			
Basic	$1.43	$1.38	$(0.32)
Diluted	$1.41	$1.35	$(0.32)
Weighted-average common shares outstanding:			
Basic	397,341,137	401,634,760	397,315,117
Diluted	403,844,782	409,778,169	397,315,117

Source: 2022 Levi Strauss Annual Report.
Note: Numbers in millions except per share amounts.

Exhibit 2: Levi Strauss Consolidated Balance Sheet

	2022	2021
ASSETS		
Current Assets:		
Cash and cash equivalents	$429.60	$810.30
Short-term investments in marketable securities	70.60	91.50
Trade receivables, net	697.00	707.60
Inventories	1,416.80	898.00
Other current assets	213.90	202.50
Total current assets	2,827.90	2,709.90
Property, plant and equipment, net	622.80	502.60
Goodwill	365.70	386.90
Other intangible assets, net	286.70	291.30
Deferred tax assets, net	625.00	573.10
Operating lease right-of-use assets, net	970.00	1,103.70
Other non-current assets	339.70	332.60
Total assets	$6,037.80	$5,900.10
LIABILITIES AND STOCKHOLDERS' EQUITY		
Current Liabilities:		
Accounts payable	657.20	524.80
Accrued salaries, wages and employee benefits	246.70	274.70
Accrued sales returns and allowances	180.00	209.40
Short-term operating lease liabilities	235.70	245.40
Other accrued liabilities	662.00	615.30
Total current liabilities	1,981.60	1,869.60
Long-term debt	984.50	1,020.70
Postretirement medical benefits	36.30	51.50
Pension liabilities	113.10	155.20
Long-term employee related benefits	104.90	108.50
Long-term operating lease liabilities	859.10	969.50
Other long-term liabilities	54.60	59.40
Total liabilities	4,134.10	4,234.40
Total stockholders' equity	1,903.70	1,665.70
Total liabilities and stockholders' equity	$6,037.80	$5,900.10

Source: 2022 Levi Strauss Annual Report.
Note: Numbers in millions except per share amounts.

Exhibit 3: Levi Strauss 2022 Revenues by Segment and Channel

	Americas	Europe	Asia	Other Brands	Total
Wholesale	$2,193.70	$879.80	$458.30	$297.90	$3,829.70
Direct-to-consumer	993.70	717.40	493.80	134.00	2,338.90
Total net revenues	$3,187.40	$1,597.20	$952.10	$431.90	$6,168.60

Source: 2022 Levi Strauss Annual Report.
Note: Numbers in millions.

Exhibit 4: Levi Strauss Projected Unit Sales in the US and Canada

Year	Month	Internal Unit Sales Projections
2022	January	7,500,000
2022	February	8,700,000
2022	March	8,800,000
2022	April	6,900,000
2022	May	6,100,000
2022	June	7,700,000
2022	July	7,900,000
2022	August	8,100,000
2022	September	9,200,000
2022	October	9,100,000
2022	November	8,000,000
2022	December	6,700,000

Source: Company documents.
Note: The internal unit sales projections are for illustrative purposes and have been modified from internal documents.

Exhibit 5: Levi Strauss Revenue Forecast Accuracy for the US-Canada business unit: Manual vs. AI Forecasts

	AI Forecast	Manual Forecast
1Q2021	99.37%	95.55%
2Q2021	93.10%	86.24%
3Q2021	97.08%	95.59%
4Q2021	99.51%	95.51%
1Q2022	99.57%	99.94%
2Q2022	98.35%	98.93%

Source: Company documents.
Note: Forecast accuracy is computed as one minus the mean absolute percentage error. Forecast accuracy corresponds to the accuracy of the revenue forecast made at the start of the quarter for quarter-end revenue.

Endnotes

1. Levi Strauss, "The History of Denim," 2019, https://www.levistrauss.com/2019/07/04/the-history-of-denim/
2. Levi Strauss, "2022 Annual Report," 2022, https://www.levistrauss.com/2023/03/07/our-2022-annual-report/
3. Singh, Harmit, "4 Lessons from Levi's' Digital Transformation," Harvard Business Review, 2022, https://hbr.org/2022/02/4-lessons-from-levis-digital-transformation.