THE CHANGING BALANCE OF EFFICIENCY AND RISK OF GLOBAL SUPPLY CHAINS

Timothy A. Manuel, University of Montana
tim.manuel@business.umt.edu

Nader Shooshtari, University of Montana
nader.shooshtari@umontana.edu

ABSTRACT

Improvements in technology combined with an openness to trade, cross border investment and free markets have allowed many firms to reduce labor and other costs by employing globally dispersed operations. Increased trade barriers, growing geopolitical concerns and supply disruptions caused by the pandemic are requiring a greater focus on supply chain and operational resiliency. Some managers are considering moving operations closer to their home markets, foregoing the cost economies and relationships built up over many years. The purpose of this paper is to argue that increases in technology such as artificial intelligence, strategic and operational planning and integrated business planning make it possible for many firms to continue to manage global supply chains and still have resiliency and efficiency.

INTRODUCTION

The growth of globalization of supply, trade and investment have led to huge benefits for much of the world's populace and firms (Zitelmann, 2023; Sundaram et al., 2020; Genereux, 2017). After the financial crisis of 2008-09 the benefits of globalization and free trade began to be challenged and countries' support for both began to decline. Nevertheless, competitive pressures led many firms to continue to expand their global presence in production and sales, especially as China developed rapidly into one of the world's largest markets. Competition between China and the U.S. grew, and firms began facing pressure to shift production closer to home markets. The pandemic resulted in unprecedented procurement and transportation problems for global supply chains and many firms began considering 'reshoring' or 'nearshoring' production and supply even if this meant giving up valuable competitive advantages and losing invested capital and hard-won relationships built up over the years (Kalish & Buckley, 2023).

The purpose of this paper is to support and make a case that with the application of new technologies and integrated planning, global supply chains can be managed without abandoning the many benefits firms received from operating globally. These benefits include cost efficiencies, proximity to local markets, gaining local market knowledge and having diverse suppliers while also creating jobs in developing economies. The next section outlines the growth of global supply chains, followed by the challenges to globalization from the financial crisis of 2008-09 and the COVID 19 pandemic that ensued. We then discuss balancing the efficiency of operating globally with the need to add resiliency in an era of heightened geopolitical tensions.

GROWTH OF GLOBAL SUPPLY CHAINS

During the two decades prior to the financial crisis of 2008 and 2009 global trade intensity grew as firms utilized low-cost labor in China and elsewhere. Reductions in transportation and communication costs also lowered the cost of moving inventories around the world (Lan et al., 2022). Low trade barriers and the ability to invest in many countries further encouraged firms to operate globally. This growth was made possible by countries' openness to trade and capital flows and the growth of Asian and South American markets. These factors led to the global operations that took many different forms such as outsourcing, joint ventures, acquisitions of foreign firms, and de novo investment.

Managing global supply chains was made easier by technology that allowed better tracking and managing of inventory. For example, in retail trade, Radio Frequency Identification (RFID) tags and smart shelves that employed weight sensors to determine which items customers were picking up and ultimately buying allowed clothing manufacturers to quickly produce more of the product that customers were buying and fewer styles and colors that customers did not want (Smith, 2022). Rapid communication and transportation allowed manufacturing to be located overseas thousands of miles away from retailers in order to exploit significant labor cost advantages. Better inventory management also reduced costs and improved asset efficiency. This in turn improved firms' return on assets (ROA) and return on equity (ROE). Competition led firms to pursue economic advantages offered from outsourcing and globalizing their supply chains.

Firms began to use Just-In-Time (JIT) inventory management to reduce inventory investment even further, with as many as 70% of U.S. manufacturing firms using JIT policies, which in aggregate reduced the inventory to sales ratio by 35% between 1980 and 2018 (Ortiz, 2022). JIT requires relatively low fixed order costs, including transportation and communication costs, and reliable sources of supply. Firms that can employ JIT inventory management are able to reduce their carry cost in inventory and reduce the obsolescence risk of stored inventory. Firms can also better match consumer demand for items without as large an investment in process inventory, which often has very low value and can quickly become obsolete (Lambert & LaLonde, 1976; Ross, et al., 2023). Over time managing these costs can significantly improve cash flow and profitability.

IMPACTS OF THE FINANCIAL CRISIS AND THE PANDEMIC

The financial crisis of 2008-09 reduced demand for goods and services for many firms' products. The crisis also undermined the public's belief in the benefits of globalization as even with the recovery, economic growth remained slow, unemployment stayed high, and U.S. real median incomes declined for years after the crisis was over. The falling popular support for globalization and the election of President Trump in 2016 led to the U.S. increasing barriers to trade by raising tariffs and withdrawing support for the World Trade Organization that promotes global free trade. Not surprisingly, the crisis resulted in declines in global trade intensity and then the pandemic further reduced trade. Trade peaked at about 61% of output in 2008 and fell to about 57% of output by the time of the pandemic (Hilsenrath & DeBarros, 2023). Growing wages in China, along with the U.S. tariffs, were also reducing that country's cost advantage. Wages in China doubled over the decade before the pandemic and were more than twice the wage costs in Vietnam, Malaysia and other competing countries (Lund et al., 2019).

Increase in Sino-U.S. tensions and the COVID lockdowns in China during the pandemic exposed vulnerabilities in the global supply chain networks, many of which overly relied on production in China. While movements to JIT systems can improve asset efficiency and potentially increase a firm's ROA, it often makes the firm more vulnerable to external supply shocks such as those that occurred during the pandemic (Ortiz, 2022). Potential output losses can be quite large. Even during normal times, the frequency of supply shortages is larger than many realize with shortages lasting for at least one month occurring on average every 3.7 years and shortages lasting 2 months or more occurring every 5 years. In total, Lund et al. (2020) estimate that a firm can expect to lose about 40% of annual profits over a 10-year period due to supply shortages. The pandemic led to even greater losses than normal from shortages. Nikookar and Yanadori (2022) report the financial impact of supply chain issues in 2020 led to between a 5% to 10% drop in global GDP which is quite significant.

Some industries, including the auto industry, were hit particularly hard by pandemic induced shutdowns. With plant closures in 2020 many auto manufacturers canceled JIT orders for semiconductors, which led to manufacturers of semiconductors to produce chips for other uses that had continued chip demand. When automakers began to ramp up production of autos after the stay-at-home orders were lifted, they found they could not obtain the chips needed. This resulted in a shortfall of about 4.5 million autos being produced in 2022. Lack of chip availability and weakening demand for autos in 2023 after the Federal Reserve raised interest rates are likely to have resulted in further declines in the production of automobiles. The shortfall may be as much as 3 million fewer autos produced and sold than expected (Dutt et al., 2023; Gitlin, 2022). The automobile production process is highly globalized with multiple tiers of suppliers used for design, parts, assembly, and production. A shortage of a critical component such as "chips" can sideline a large number of suppliers in multiple countries.

In response a number of countries, including the U.S., Japan and European countries, are attempting to reduce their dependency on global suppliers for what they consider essential industries such as semiconductors. It is important to note that the semiconductor production process is highly specialized and globalized. Design may occur in the U.S. or Europe, while the design implementation may be done by a different firm that does not produce the chips themselves. Using inputs from the U.S. and other countries, fabrication and testing typically occurs in Japan, Taiwan and elsewhere in Asia where specialized factories have been developed that employ highly skilled labor. Assembly of chips into finished goods such as smartphones or 3-D printers may occur in other locations, in China or elsewhere (Varas et al., 2021).

To bring home more of the semiconductor manufacturing process, the U.S. government is offering up to $52.7 billion in subsidies to encourage the production of semiconductors in the U.S. (Sohn, 2023). The estimated cost to build one semiconductor fabrication plant is about $10 billion. The Semiconductor Industry Association (SIA) and the Boston Consulting Group have estimated that if the U.S., Europe and Asia duplicated the full production process in each region rather than allowing the global trade currently in place to produce semiconductors, the capital investment costs would be in excess of $1 trillion dollars. Production costs could be as much as $125 billion more per year resulting in somewhere between a 35% to 65% increase in the cost of semiconductors (Varas et al., 2021).

Aside from any macroeconomic effects on the U.S. economy from all this additional spending, surely the price of automobiles would have to rise substantially. General Motors has been working on reducing the number and type of chips required in its automobiles. Other producers such as Toyota stockpiled inventory of these crucial components. The point is companies can learn how to manage these risks and can do so far more cheaply than relying on the government to provide costly subsidies to foreign chip manufacturers such as TSMC (Sohn, 2023).

Efficiency may argue for working closely with one or only a few suppliers, but doing so may increase supply chain risks, especially if the suppliers are in regions subject to frequent production shutdowns, climate or weather risks and are located in countries with unstable political systems. This does not mean that the alternative is to abandon globalized supply chains. Stockpiling critical inventory may be at least a partial solution. Stockpiling adds to costs, but inventories can serve as a shock absorber from supply disruptions. (Low Technology Institute, 2021; Ortiz, 2022). However, with the increases in interest rates and inflation in 2022 and 2023, capital costs of inventory investment and other carrying costs have increased significantly, so stockpiling may prove to be only a short-term solution. The Hackett Group 2022 Working Capital Survey Midyear Update reports that the largest U.S. nonfinancial firms reduced their first quarter cash cycle by reducing their days sales in inventory and in receivables relative to their first quarter 2021 levels (Hamburger & Blair, 2023). This may be in response to higher capital costs.

Advances in technology such as robotics, artificial intelligence (AI) and the Internet of Things (IoT) are now allowing firms to reduce their labor costs and move to a more capital-intensive business model. These changes have encouraged firms to locate production more regionally or even within their home markets where labor costs are higher. Hence, many firms have begun "re-shoring" or "near-shoring" production. This may make sense for some firms, but we do not believe this is warranted for many or even most firms. For most there is a more balanced approach that firms can take that retains the advantages of global sourcing while reducing supply chain risk.

A THIRD WAY: BALANCING EFFICIENCY AND RESILIENCY

Efficiency in supply chain management is focused on minimizing investments in inventory and other current assets and sourcing supplies and processing in the most cost-effective way regardless of location. Efficiency is critical to provide customers with an affordable product. If your firm is not efficient, customers will eventually switch to a lower cost substitute product. Resiliency is the ability to handle supply and process disruptions without compromising production or failing to meet customer needs (Alicke et al., 2022; Shih, 2022; McKinsey Business Resilience, 2023). Resiliency can provide a significant competitive advantage to a firm. Imagine if Ford could have continued to produce vehicles to meet demand in 2022 and 2023 when Toyota and General Motors could not. Given that customers often remain loyal to the brand of their most recent purchase, this could have led to a lasting competitive advantage for Ford.

Efficiency and resiliency should not be thought of as an either/or proposition. They are best thought of as a continuum where managers must balance the cost savings of minimizing inventory and selecting suppliers in lower cost locations against the risk of shortages and supply disruptions (See Figure 1). Much has been written of employing risk management practices to identify the cost and risk in managing the supply chain and inventory levels. See for instance El Baz and Ruel (2021), Leibovici and Dunn (2022), Lund et al. (2020) and Nikookar and Yanadori (2022). There are multiple aspects to these tradeoffs.

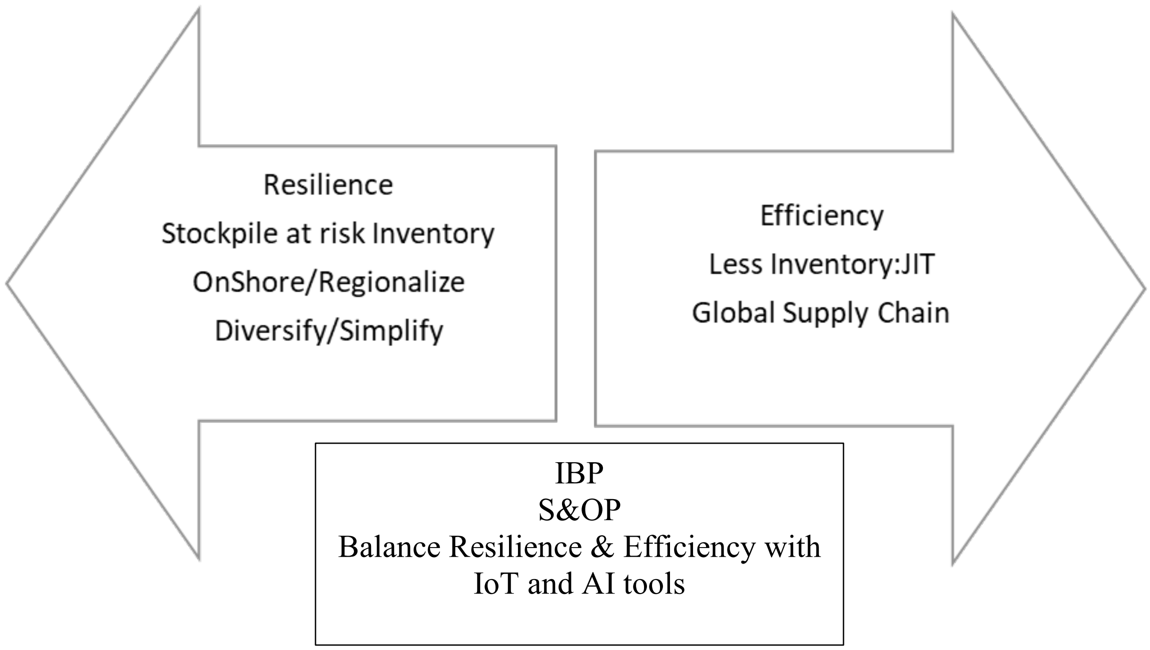

FIGURE 1. MANAGING THE NEW TRADEOFFS BETWEEN RESILIENCE & EFFICIENCY

First, the decision to stockpile inventory adds to the carry cost of the inventory, but reduces the likelihood of shortages, at least in the near term. Second, utilizing globalized supply chains can improve profitability by locating production, distribution and/or assembly in areas with lower labor costs, and/or employing suppliers with specialized R&D, engineering or fabrication skills that would be costly to duplicate otherwise (Sharma et al., 2022). Firms also get exposure to new markets for their product by locating parts of production close to major markets and gain local knowledge by operating in different cultures. The benefits are too large to give up, and the cost to move to autarky solutions would be very significant (Shih, 2020).

Firms have already shown that they are capable of managing global supply risks. The International Monetary Fund estimated that in 2022 firms that actively managed their global value chains and experienced supply disruptions during the pandemic were already learning to adapt by diversifying sources of supply, stockpiling the more critical inventory parts and investing in technology to better understand their critical supply risks (Lan et al., 2022). Firms can manage supply risks on a global scale and the pandemic has created the impetus for them to better understand and manage both demand and supply risks in their production processes. Subsidies such as those offered for semiconductor production in the U.S., Japan and Europe are reminiscent of industrial policy and thus difficult to justify on economic grounds.

Admittedly, the pandemic caused longer and more severe supply disruptions than normal. Some consider the pandemic a one-off event; however, heightened geopolitical, weather and climate risks indicate that supply disruptions are likely to continue to significantly impact businesses. We argue that this does not mean firms (and countries) should seek to eliminate global sources of supply and produce everything in their home country. This would lead to many costly and inefficient redundancies that would unnecessarily raise the cost of goods and services. It could also actually increase the risk of supply shocks. According to the IMF, many Western firms already source over 82% of their intermediate products domestically (Lan et al., 2022). Thus, globalization that diversifies away from predominantly domestic supply sources may in some cases actually increase resiliency. Reshoring production and supply could increase the risk of disruptions from an overconcentration of supply and an overreliance on the domestic market. The better solution is using technology and processes to manage supply chain risks more effectively as we discuss below.

TECH BASED MANAGEMENT OF THE PROCESS: S&OP AND IBP

Firms can develop strategic and operational plans (S&OP) that provide a blueprint for supply chain management to ensure that supply matches demand. Quite a few support firms and products exist to assist in this planning, some of which we list below. The goals of these plans include avoiding excess inventory buildup and shortages and ensuring the firm will have the necessary financial resources to pay for supplies, thereby avoiding business disruptions while still meeting customer demands (Riverlogic, n.d). More firms should employ such plans. These can be especially beneficial for Small and Mid-Sized Enterprises (SMEs).

S&OPs are generally at a transactional level and are often highly detailed plans that are specifically adapted to the firms' needs. Rethinking a firm's supply chain to add resiliency may also require a more strategic focus, particularly with the higher levels of capital investment that may be involved in diversifying supply chains and considering other strategic factors. Post pandemic, the public expects firms to consider other factors in their operations such as adding environmental, social and governance (ESG) considerations to the management of supply chain investments.

USING THE IOT AND AI TO IMPROVE TRANSPARENCY AND RESILIENCY

One of the largest roadblocks to managing supply chains with efficiency and resiliency is ensuring transparency in the supply chain. Transparency requires digitizing the supply chain management process. It requires extensive use of items such as RFID tags and tracking software to trace inventory components through the procurement, processing, and sale processes. Kilcourse and Rowen (2023) argue that these are widely available now and are cost effective for many firms. Retailers in particular can use RFID tracking to improve inventory management as mentioned above and tailor inventory procurement and distribution to markets where supply is needed.

With a growing number of customers resorting to online shopping as a first choice (think Amazon or Google), even if the purchase is completed at a retail store, online sellers want to know what causes customers to respond to their products and why they follow through with a purchase or not. AI can play a crucial role in identifying characteristics of buyers and nonbuyers to improve marketing and tailor production to what is actually selling in real time. The ease of online searching and purchasing along with rapidly changing consumer tastes means that identifying popular products quickly is essential to meeting customer demand in multiple markets simultaneously. This is practically impossible without technology assistance. Firms can use inventory management software such as NetSuite, Fishbowl or Flowtrac among many others, to better track and analyze costs associated with inventory management, including order and transportation costs (Software Advice, n.d.). RFID tracking can also identify supply bottlenecks and thus improve inventory management, identify sources of disproportionate amounts of returns and track lost or stolen inventory.

Planning for product demand has always been an important part of effective supply chain management, but the COVID pandemic and recent increases in geopolitical turmoil makes planning even more important. AI processes such as predictive analytics using real time data can update demand and supply forecasts on a daily basis. This helps reduce disruptions to supply and improves the probability of meeting evolving customer demands in various markets. Machine learning tools readily available now can be used to predict supply chain disruptions, design optimal logistics routes, assess supplier performance and minimize inventory and demand mismatches (Kazancoglu et al., 2022; Aggarwal & Singh, 2019). There are many firms that can assist in supply chain management of this type using advanced AI methodologies including IBM Watson Supply Chain, Oracle SCM Cloud, S&P IBP, and the new Amazon Supply Chain, just to name a few (OpenAI, 2023).

Optimizing a global supply chain also requires input from a strategic financial perspective (Kazancoglu et al., 2022). This can occur by layering on Integrated Business Planning (IBP) onto an S&OP. IBP adds financial goals such as profit growth, improving return on equity or economic value added to the process of managing production. IBP also provides a means of encouraging cross-functional coordination among marketing teams, finance teams and production engineers. Optimizing working capital and production decisions requires digital data from all aspects of the firm's production and sourcing process and cooperation among the functional areas of the firm. The latter is not automatic and requires managers to build in processes that encourage and reward improvements in items such as the percentage of deliveries to customers that are on time and meet quality standards. Adding resiliency in a cost-effective manner will require identifying critical supply points and building in redundancies that reduce costly supply disruptions while still meeting the firm's financial goals. The IBP process can provide a framework to evaluate these tradeoffs by rewarding decisions that meet financial goals of balancing efficiency and resiliency (Dumitrescu et al., 2022).

RESILIENCY AND COMPLEXITY

Operating global supply chains can add substantial value to a firm, although managing a network of global suppliers is complicated. Suppliers that provide items directly to the main firm are called Tier 1 suppliers. Firms that supply Tier 1 firms are called Tier 2 firms, etc. Many large firms have 3 or more layers of suppliers underlying their production process. Managing multiple Tier 1 suppliers for similar items provides flexibility if one or more suppliers faces its own disruptive event. Encouraging communication between Tier 1 firms can identify cost efficiencies, gain local market knowledge and improve performance (Sharma et al., 2022). Nevertheless, it can be difficult to manage a large geographically dispersed supply chain. Baumgartner et al. (2020) estimate that car makers can have over 200 Tier 1 suppliers and over 10,000 Tier 2 suppliers. That is a large number of relationships and logistics to manage. Aggarwal and Singh (2019) have developed a multiple objective net present value (NPV) based supply chain model that includes third party logistics firms that help manage a global supply chain. Their model incorporates demand uncertainty and presents a means to balance NPV and cost minimization. One of their main results is to recognize the benefits of using third party logistics firms to exploit cost efficiencies in managing global supply chains.

Complexity adds to vulnerabilities that can result in supply disruptions, especially if a firm does not have the capability to understand its suppliers' risks and bottlenecks. However, firms learn much about foreign markets from their contacts with foreign suppliers that they would not learn otherwise. A firm's ability to manage the complexities of global supply chains depends critically on their information processing capabilities (El Baz & Ruel, 2021). Firms invested heavily in 2022 in building transparency among suppliers (Townsend & Bodo, 2022). In 2023 the top priority in investment in supply chain management appeared to be forecasting demand and optimizing inventory, as well as further reducing supply risks to improve resilience. Some firms are focusing on improving vertical integration through the supply chain by encouraging consultations with 1st and 2nd Tier suppliers in product design and eliminating potential supply bottlenecks.

If feasible, firms can design products that can accept a greater variety of inputs from different sources, or firms may standardize components of similar products to reduce the need for specialized inputs that aren't widely available. As noted above, GM is working on reducing the many types of computer chips required in their vehicles down to only 3 types and is contracting with GlobalFoundries to ensure a steady supply of chips in the future (Boudette, 2023). Reducing the amount of product variation can simplify inventory and demand forecasting requirements as well. The cost-benefit of providing many varieties of goods for niche markets may change when the needed supplies may not be readily available (Shih, 2020; Lund et al, 2020).

As firms rethink their supply chains, it may be a good time to integrate ESG considerations into their sourcing decisions. Investors are rewarding firms that can demonstrate they are committed to improving the environment and society along with producing their product. Amazon's new supply chain tool incorporates identifying elements of ESG in the procurement process (https://aws.amazon.com/aws-supply-chain/features/). Demonstrating that a firm is actively considering ESG investments can result in stock price improvements and lower financing costs because stock and bond investors continue to expect companies to be actively involved in improving the lives of stakeholders (Keeley, 2022). Because of this scrutiny, firms may wish to avoid investments in locations that do not have environmental protections or adequate labor standards.

To the extent possible firms may wish to invest in countries with stable political systems while avoiding autocracies that have few human rights protections or those that marginalize women and minorities. Similarly, experiences in the pandemic show that countries with better digital infrastructures that allow remote working and have automated systems to manage inventory and logistics had smaller declines in GDP than otherwise (Lan et al., 2022). As climate risks increase firms should also value suppliers in countries with institutional structures to handle weather and health disruptions. Investing in firms located in countries that value trade and free capital flows is another means of reducing political risk in the supply chain.

CONCLUSION

The purpose of this paper is to argue that firms that operate globally should not be too quick to abandon the efficiencies and relationships they have built from operating globally over the years. This is the case even though the operating environment is less friendly to global trade and climate and political risks have increased. For instance, about 80% of global trade is from or flows through countries with falling political stability (Lund et al., 2020). Firms must consider that the new norm of higher geopolitical risk in much of the world today is not likely to decline anytime soon.

Businesses will have to place greater weight on building in more geographic dispersion of suppliers across different tiers to preserve resiliency. If this is not possible then stockpiling critical inventory may be necessary, even at the risk of incurring higher financing costs and increasing the risk of inventory obsolescence. Managing instability and political risk also means operating in countries with stable political climates that welcome investment and trade can be more valuable in the long run than simply choosing the lowest cost provider at the moment. There will be less political risk and chance of costly tariffs and non-tariff barriers if businesses work with firms that are allies of their own country and with those that have trade agreements (Foroohar & Raju, 2022). Supply chain risks can also be reduced by choosing firms located in countries with a strong digital infrastructure and the ability to respond to health related or weather and climate related events (Lan et al., 2022).

Managing global supply chains in today's environment is more complicated than in the past. Fortunately, rapid improvements in AI and other technologies have given firms the ability to better manage their global supply chain risks through investing in technology and employing S&OP and

IBP software. All firms, and especially SMEs, can use technologies such as the IoT and AI to understand and better manage the desired balance between supply chain efficiency and resiliency without abandoning valuable long-standing relationships with their suppliers. Investing in digital tools will allow firms to successfully navigate the changes and disruptions that will happen in the future and maintain both efficient and resilient supply chains.

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JOURNAL OF INTERNATIONAL BUSINESS DISCIPLINES
www.jibd.org

Volume 19, Number 2 November 2024

Published By:
University of Tennessee at Martin and the International Academy of Business Disciplines

ISSN 1934-1822 WWW.JIBD.ORG