# 6 APOTHEOSIS

From ECsoft to OpenVision, the foundation was constructed for the creation of BEA Systems: as a business, one of the most crucial engines of transformation at the core of the digital economy, and as an investment, one of the all-time great successes in the history of venture capital. The story of BEA dramatizes the complex dynamics of the Innovation Economy. The engine of its initial growth was research funded by a state-sanctioned monopoly that, when liberated to compete commercially, had no idea how to do so. Its phenomenal growth was also a function of the maturation of the internet, offspring of the Defense Advanced Research Projects Agency, as an environment for commerce. Its competitive success was conditioned on the inability of IBM, the dominant force in computing, to cannibalize its own proprietary products and the profits they generated. And the extraordinary investment returns that it delivered were due in good measure to the speculative excess of equity investors who had recognized the emergence of a new, digital economy. BEA, that is to say, represented the apotheosis of the Three-Player Game's fostering of the Innovation Economy.

At the more mundane level where the practitioner labors, BEA's success both as a venture investment and as an operating business did not emerge in a vacuum. On the contrary, to identify and realize the opportunity it represented was the combined and contingent consequence of multiple strands of education: in the alternative architectures of the computer industry, in the evolving technologies of computer systems, in the different business models available to start-up companies, and in the recurrent inefficiency of the stock market's manner of valuing enterprises under the recurrent pressures of speculation. From my perspective, BEA emerged from a context thirty years in the making.

In yet more narrow terms, the story began with a dinner with Bill Coleman in San Francisco in the early autumn of 1994, when OpenVision teetered on the brink. Bill and I had been introduced by a specialist executive recruiter, Nancy Albertini. Not long before, Bill had left Sun Microsystems, where, as head of its integration services business, he and his team had pushed client–server computing to its limits in the effort to support the application requirements of Sun's major corporate customers. As Bill described the software necessary to enable client–server computer systems to handle the transaction volumes required by business-critical applications, my experience with IMI and SHL resonated.

Bill and I had had a close encounter some years earlier, but without actually meeting. He had been the visionary director of engineering of VisiCorp in the early 1980s. While the company's spreadsheet franchise was being subjected to devastating attack, Bill's focus had been on a far horizon. Sharing Xerox PARC's imaginative sense of how the human–machine interface had to evolve, Bill had been working on VisiOn, the first-ever implementation of a graphical user interface on an industry-standard, general-purpose microprocessor. The Xerox STAR had delivered responsive performance, but the custom processor that was designed especially for it had rendered the machine prohibitively expensive. The sluggish responsiveness of VisiOn was the necessary consequence of the limited performance of the microprocessor technology of the time. I recall that when I encountered VisiOn at the COMDEX trade show in the summer of 1982, the latency was so bad that it made me want to start smoking again while waiting for the screen to refresh.

When I finally met Bill face to face a decade later, he had standing with me as a far-sighted entrepreneur who could anticipate the need for software that the world would discover it had to have, and who had also survived a failed start-up. And so the first step toward the apotheosis of my career as a venture capitalist – funding the creation of BEA Systems, where Bill was the initial B – began in the wreckage of the first generation of PC application software.

Bill recognized that the vast majority of the world's work that involved moving money between buyers and sellers was transacted and recorded by monolithic, centralized, inflexible IBM mainframe computers. The distributed client–server systems that constituted OpenVision's target market could not scale to handle that traffic and could not be trusted with the traffic they did handle. Bill had reflected on Sun's slogan: "The network is the computer." If that were the case, then the network needed an operating system: software to distribute the workload across all of the resources connected through the network, to control the utilization of each resource, and to ensure the fail-safe reliability of the distributed system. Moreover, he could hope with some confidence that IBM, still swimming in the monopoly profits from its vast population of proprietary mainframe and mid-range computers, would not address the emergent challenge of open, distributed computing, given the radically lower profit margins that it offered.

By the time we finished dinner, Bill and I were finishing each other's sentences, and we had agreed to expand the conversation to include the two proto-partners whom Bill had recruited to his project. Ed Scott, then still executive vice president of Pyramid, a middling computer company that was in process of being sold, had co-founded Sun Microsystems Federal with Bill ten years earlier. Alfred Chuang, an incandescently intelligent young technologist, had been the architect of Sun Microsystems' "Sun on Sun" project, which had attempted to move all of Sun's business applications from IBM mainframes to Sun's own machines; he knew firsthand the limits of client–server computing. Together, the team had conceived an audacious plan to address the need for "an operating system for the network," a market hole of potentially staggering size.

Bill and Alfred had mapped the technology necessary to fill that hole. Alfred had designed a wall chart to illustrate the components of an "object transaction monitor" (OTM) and the ancillary functions necessary to the task. Alfred's OTM was a modernized generalization of the technology that IMI's engineers had invented to scale up the capacity of Oracle's database. Its purpose was to enable client–server networks to run the same sort of large-scale, transaction-intensive applications as mainframe computers, with the same degree of reliability. Under strict confidentiality, my Warburg Pincus colleagues and I were exposed to the design and the plan to implement it during a long day at the Saratoga Inn in the foothills that enclose the south-west corner of Silicon Valley. The discussion begun there continued through the autumn. We all agreed on the magnitude of the market need and the feasibility of the technical solution. But building a software platform from scratch would take years. Moreover, customers were unlikely to commit their most critical business processes to newly released, unproven technology delivered by a start-up.

## The Research Project

Collectively, we worked through my multi-decade experience of the perennial excess supply of technology relative to currently perceived market needs and, as well, the imperative to create a cash-positive business as rapidly as possible. By the end of the year, we had agreed on a project. Warburg Pincus would fund $750,000 to enable Bill, Ed and Alfred, supported by Stewart Gross and Cary Davis of our IT investment team and selected consultants, to conduct a six-month research program. In return, Warburg Pincus would have first call on financing the venture thereby defined.

The deliverables were an exhaustive set of market and technology assessments of existing distributed mission-critical computing solutions (collectively dubbed the "Red Book") and, second, a complementary synergy and business-model analysis (called the "Blue Book"). As I write, I have the two books in front of me, each an exercise in integrating strategic understanding with tactical detail to an extent unmatched in my professional career. The team demonstrated that there were indeed potentially available technologies, currently occupying marginal market niches, whose acquisition would accelerate the venture by years. In parallel, working back from its comprehensive survey of relevant business and financial applications, the team also constructed a prioritized map of the market, a subject too often ignored by technologists.

The significance of this work transcends the founding of BEA. By simultaneously focusing on both the technology and its applications, the team was acting out the nonlinear way that innovation actually evolves. Novel technology stimulates the invention of new applications. But as the applications are defined and deployed, they feed back to put new demands on the enabling technology. That feedback can reach all the way upstream to induce innovative research and discovery in the underlying science: from the steam power of the First Industrial Revolution through electrification and on to information and communications technology, the historical record is replete with instances of such complex systemic behavior.[1]

In the more narrow terms of the BEA project, the dual research exercises did more than generate documents. The process itself was a mutual and reciprocal education in how we all thought about the world and an opportunity for constructing hypotheses for exploring it and protocols for testing those hypotheses. Given our contemporaneous experience with OpenVision, it was comforting that both Bill and Ed had extensive experience with start-ups and understood the critical need for operational discipline, no matter how grand the mission. Moreover, all of the founders had been through the near death of Sun Microsystems, which had itself faced an enormously challenging transition from workstations to compute servers some years before.

The research project was completed in June 1995. In parallel, following the OpenVision model, we worked through the terms of line-of-equity financing, this time scaled to $50 million. If the company came to be fully funded, Warburg Pincus would own a substantial majority of it. With studied lack of imagination, we had referred to the research effort as Project BEA, a title based on the co-founders' first initials. The name stuck when we officially launched the company.

## Acquisition of Tuxedo

The business plan that emerged from the research project was audacious in the extreme, for it proposed to attack the core of IBM's commercial computing citadel. It could not have been implemented – it would not even have been conceived – without a different sort of intervention by the American state in the market economy. This was action by the Anti-Trust Division of the Department of Justice affecting two of the primary sources of technological innovation: IBM and AT&T. IBM's monopoly of the punched cards used in its pre-computer data-processing machines had been ended by a consent decree in 1936. In 1959, a second consent decree required that IBM agree to sell its products rather than make

1 See T. Bresnehan, "General Purpose Technologies," in B. H. Hall and N. Rosenberg (eds.), *Handbook of the Economics of Innovation*, 2 vols. (Amsterdam: North-Holland, 2010), vol. 2, pp. 770–782.

them available only on lease; leasing the machines had been a powerful competitive tool that both locked in customers and disadvantaged potential competitors who lacked IBM's financial resources. But the most important event occurred in 1969. When the Justice Department launched a third assault that would last for thirteen years until abandoned by the Reagan Administration in 1982, IBM preemptively responded by unbundling software from its computers. The creation of an independent software industry followed.

As for AT&T, its position as the monopoly provider of long-distance telephone service had been established in 1913 by the Kingsbury Commitment, whereby the company agreed to allow independent phone companies to connect to its network and to deliver "universal service" across the country. In 1956, a consent decree with the Justice Department confirmed the Kingsbury Commitment, but the price was AT&T's agreement to restrict its activities to the regulated business of the national telephone system. The Anti-Trust Division's persistent focus eventually led, in 1982, to the break-up of AT&T. But, in the meantime, the result of the 1956 agreement was that AT&T broadly licensed a range of powerful innovations that were applicable to the emerging computer industry, to the benefit not only of BEA Systems and Warburg Pincus but of the Innovation Economy broadly defined.

The success of a technology start-up is contingent on countless variables. A path we did not take exemplifies just how contingent it can be. One of the technologies identified in the Red Book was UniKix, an emulation of IBM's mainframe transaction-processing platform, Customer Information Control System (CICS), which was implemented for computers running UNIX. It was owned by Bull, the French national champion of computing, which was a perennial competitive failure except when the customer was a direct or indirect arm of the French state. Bull had been kept alive then, and still is to this day, by episodic injections of cash by the French state.

The UniKix management team, based in the United States, yearned for liberation, and given our intense desire to launch BEA Systems with actual revenues and customers, we listened to their entreaties almost too well. To our exceptional good fortune, Bull rejected our offer to acquire UniKix. Retrospectively, our offer was far too generous, as Bull would have received no less than 37.5 percent ownership of the venture. Starting with the second-rate UniKix technology and encumbered by Bull as a major shareholder, BEA would likely have been far less successful operationally, and the stock market's valuation of the company would likely have been far lower. In any case, we were saved by the senior management of Bull, whose overvaluation of their asset allowed us to reconsider this mode of entry into the market and happily walk away.

That was the path not taken. The actual launch of BEA came with the acquisition of two independent value-added resellers of the market-leading relevant technology, Tuxedo, known technically as a distributed transaction processing monitor. This move brought our start-up some $15 million of annualized revenues, a set of major corporate customers, and a cadre of technologists skilled in the deployment and tuning of Tuxedo. They also delivered a very valuable option.

Tuxedo had been developed in AT&T's Unix Systems Laboratory, a component of Bell Labs, and had been designed to enable AT&T's UNIX operating system (which was originally oriented toward scientific and engineering applications) to support large-scale, transaction-intensive applications. As with UNIX, under the pre-divestiture rules of the game, AT&T had been required to license Tuxedo widely. Both of our service-company acquisitions had legal right to the software code, and one of them had a license to the brand name. But the core development team of first-class software engineers still resided within Unix Systems Laboratory.

I had first encountered Tuxedo in circumstances that demonstrated AT&T's utter inability to comprehend competitive commercial markets. At one of Esther Dyson's PC Forum conferences in the early 1990s, Tuxedo was displayed as a desktop working environment on the client side of a client–server network. It was conspicuously out of place in this setting. It was true that Tuxedo could support the graphical user interface that was becoming mandatory for all enterprise as well as consumer software applications. But Tuxedo was deep infrastructure software whose deployment and maintenance required skilled and experienced systems engineers. It had no business showing up at PC Forum as a potential competitive alternative to Microsoft Windows.

AT&T's inability to exploit UNIX or Tuxedo had been presaged a decade earlier. Then, a fundamental rationale for AT&T's agreement to divest the Regional Bell Operating Companies in settlement of the federal antitrust litigation had been to end the regulatory prohibition on AT&T's application of its enormous technical resources to computing. However, although the Bell System knew how to deliver reliable communication services to captive customers, investments by AT&T and its former subsidiaries in competitive commercial computing failed without exception.

This doom was evident at the internal launch of AT&T's strategy for competing with IBM, a multimedia extravaganza laid on for top management by the leaders of the newly chartered AT&T Information Systems. Someone who was present told me that while all in attendance waited in breathless silence for the reaction of CEO Charlie Brown, who had negotiated the divestiture agreement with the Justice Department, Brown was heard to address his immediate subordinates: "Jesus Christ! We just gave away the wrong half of this goddamn company!"[2]

AT&T ultimately accepted the failure of its dream of competing with IBM. In June 1993, it sold the entire Unix Systems Laboratory to Novell, a vendor of software for networking personal computers that also had a daunting dream: to contend with Microsoft for ownership of the architecture of PC-level software. For this, both UNIX and Tuxedo were wildly unsuited. Like Microsoft's products, Novell's were either bundled with PCs or sold through hands-off distribution channels, including retail stores. As complex, enterprise-class infrastructure software, Tuxedo was typically purchased as a component of a multimillion-dollar project and required on-site engineers for installation. When I heard that Novell proposed to sell a shrink-wrapped version of Tuxedo, I wondered whether it would micro-miniaturize a couple of systems engineers to package in the box along with the software.

Through the autumn of 1995, Ed Scott sought to convince Novell's management of these truths. BEA now controlled some 80 percent of Tuxedo's modest revenues and was planning to use its license position to attack the market aggressively. These factors contributed to his bargaining position, but BEA could still benefit both from bringing on board the Tuxedo technical team and controlling the future intellectual property they created. At our board meeting

[2] Some years later I met an executive who had sold his software company to AT&T and seen it fail utterly. He asserted that such was the insight of AT&T's marketing team that, were the company to acquire Kentucky Fried Chicken, it would take the lead spot at half-time of the Super Bowl to advertise that "AT&T Sells Cold, Dead Chicken!"

in January 1996, Ed reported a breakthrough. Novell's new CEO, Bob Frankenberg, had risen to senior executive level at Hewlett-Packard and knew the world of enterprise computing well enough to agree with BEA's analysis. Characteristically, Ed had created a transaction that would enable BEA to bootstrap the purchase: Novell would grant BEA a comprehensive license to all the intellectual property on a basis that would yield royalties equal in projected amount to the profits that Novell forecast it would earn over the next several years, together with an option to acquire the intellectual property outright. As we collectively congratulated Ed, I assured all that before the deal was done, Novell would require Warburg Pincus to guaranty the minimal payments due under the proposed contract, some $40-plus million that would take our exposure well above the agreed $50 million commitment.

In anticipation, I invited Bill, Ed and Alfred back to New York to lay out the deal and its significance for John Vogelstein. This they did with compelling and comprehensive force. As he left the conference room, John signaled me to join him, "Of course, we have to do this," he said, "and you should get some warrants for doing it." That is, Warburg Pincus should be compensated with additional equity for providing the guaranty. As we already were entitled to some 75 percent of the ownership of BEA Systems and as the founders had more than fulfilled our highest expectations during the year of study and execution in which we had collaborated, I decided not to argue with John. Instead, I emulated Admiral Nelson at the Battle of Copenhagen, although in this case it was a deaf ear rather than a blind eye that I turned to my commander.

Subsequently, I learned how critical to BEA's future success our ability to respond in real time had been. One of AT&T's licensees of Tuxedo was Tandem Computer, still a formidable presence in the computer industry with its fault-tolerant systems. Its CEO at the time was Roel Pieper, whose previous job had been running Unix Systems Laboratory when it was still owned by AT&T. Thus, Pieper was uniquely equipped to grasp Tuxedo's value. He told me that he had called Bob Frankenberg as soon as he learned that Tuxedo was for sale, only to be told it was already under contract.

Yet a further demonstration of the role of contingency and chance accompanied this critical step in the construction of BEA. A bit more than a year later, Eric Schmidt succeeded Bob Frankenberg as CEO of Novell, on a path that would lead him from Sun Microsystems to the executive chairmanship of Google (now Alphabet). Eric had been an unusual executive at Sun: he was a "software guy" in a company whose leader, Scott McNealy, was notorious for valuing hardware above all ("if I can't kick it, it's not real."). At Sun he had known Bill Coleman and Alfred Chuang and shared their strategic understanding of the shift in value from hardware to software. More than once in subsequent years, Eric advised me that if he had been Novell's CEO in 1996 he would have never sold us Tuxedo.

By acquiring all of the commercial rights to Tuxedo and the supporting technical resources, BEA was transformed into a business with annualized revenues in excess of $100 million by January 31, 1997, the end of its first full fiscal year, and was reaching positive cash flow from operations. With Tuxedo as the engine of market penetration, BEA was attacking exactly the enterprise markets and applications where the default option for all customers was IBM's CICS, native to its proprietary mainframes. IBM was aware of the possibility that UNIX-based client–server systems would encroach on its turf. In 1994, it had acquired a small software company out of Carnegie Mellon University in Pittsburgh with a distributed transaction process monitor called Encina. BEA was doubly fortunate. Not only did Encina perform poorly on the key "-ilities" – reliability and scalability – relative to Tuxedo, IBM felt no incentive to make it competitive, given the enormous cash flows generated by CICS and the hardware and service revenues CICS dragged along.

For several months, one strategically minded senior executive in IBM's software business, John Swainson, pursued discussions with BEA. Swainson correctly foresaw that BEA and the alternative, innovative computing architecture that Tuxedo represented posed an existential threat to IBM's mainframe franchise. But he never was authorized to name a number and enter negotiations to acquire BEA, so we were saved from the possibility of selling too soon.

Instead, BEA went public. April 14, 1997, was the worst day on NASDAQ that year. BEA had filed with the SEC to sell 5 million shares at an expected price in the range of 10 to 12. The underwriters, led by Goldman Sachs, advised that the financing could not be completed above 6. Jointly with BEA's founders, Warburg Pincus agreed to accept the terms, minimizing the dilution of equity ownership by refusing to increase the number of shares. Critically, we could afford to accept the reduction in proceeds because the company was already cash positive from operations. Only three months later, BEA's shares had tripled from the offering price, and the company had executed what effectively was the second half of its IPO, this time selling 6 million shares to the public at 17 and establishing both a liquid market and a meaningful war chest. The successful, though haphazard, IPO had been contingent on the acquisition of Tuxedo.

## Acquisition of WebLogic

The second decisive acquisition that made BEA successful was contingent on that timely IPO. By 1998, the explosive growth of the internet as an environment for conducting commerce was visible to all interested parties. But none of the extant technologies had been designed to accommodate online electronic transactions with literally millions of simultaneous users. As BEA worked to augment Tuxedo to enable it to support eCommerce, a number of start-ups surfaced and almost as rapidly were acquired. One was snatched up by Sun, and another by Netscape, which was facing Microsoft's challenge for ownership of the web browser market. Alfred Chuang, who was running BEA's engineering operations, identified a third start-up whose technology met his exacting standards, and he convinced Bill of the strategic value of the proposed acquisition.

The venture and its product were called WebLogic. As of September 1998, it had cumulative revenues of $500,000. As the bubble began to inflate with the promise of the economic transformation being wrought by the internet, so did the valuation of start-ups. WebLogic's asking price was no less than $150 million, or some 15 percent of BEA's then $1 billion market valuation, which was itself inflated by speculative fever. Had BEA not been able to use its own stock as the currency for the acquisition, it could not have happened.

As it was, the discussion at BEA's board meeting was contentious in the extreme. Carol Bartz – then CEO of Autodesk, former head of worldwide operations at Sun, and a powerfully supportive presence on the board since the launch – assured Alfred and Bill that they were insane to propose such a transaction. She added me to that assessment when I supported them. But Alfred's deep analysis of both the market and the technology prevailed, especially because Warburg Pincus, by far the largest stockholder, was committed to the deal.

The acquisition of WebLogic represented a conscious decision to refuse to accept the terms of the innovator's dilemma and instead to attack our own core business before anyone else could. Tuxedo, whose development reached back some fifteen years, was a massive software platform whose installation and tuning took months of work by teams of highly trained engineers. It was typically sold as the core technology of a major project, a sales process that itself typically took many months. WebLogic incorporated the most advanced software engineering techniques to achieve rapid deployment and high performance; it could be readily scaled from single-user to very large application environments. BEA was now a trusted source of mission-critical software for the enterprise market, and word spread across the technical communities that WebLogic was the way to transform the internet into an effective and secure platform for commerce.

The success of WebLogic was so great that it generated intense internal conflict. In return for convincing the board to bet 15 percent of the company on WebLogic, Alfred was tasked with turning it from a product into a business. This he accomplished by leveraging free downloads of single-user versions over the internet to proliferate the software inside enterprises large and small. The proliferation happened so rapidly that the Tuxedo sales force was sideswiped. Multimillion-dollar deals that had been in the works for months were shelved as the alternative technology seized customers' attention.

The visceral ferocity of the war within BEA was brought home to me at a company-wide meeting in downtown San Francisco that I attended with Nancy Martin. I had recruited Nancy from SHL Systemhouse following the company's acquisition by MCI. At Warburg Pincus, she created an internal Information Technology Strategy and Assessment (ITSA) function in order to reduce our dependence on outside consultants. Nancy was a favorite of the WebLogic team because she understood the breakthrough innovation embodied in their code; I was well known to the Tuxedo team. Now we found ourselves literally back to back and under assault. Nancy was assailed by her WebLogic friends, who denounced the "dead-in-the-head dinosaurs" from AT&T, while the latter yelled at me about the "undisciplined cowboys" who were destroying Tuxedo's value.

Bill responded creatively, by making Alfred head of sales. Alfred resolved the conflict by constructing a multitiered sales model across both products. At the same time, key elements of the Tuxedo technology were reimplemented in WebLogic to enhance the latter's performance over all the functional attributes important to customers – scalability, reliability, availability, security – further confirming WebLogic's and BEA's market leadership. The result was phenomenal growth: from $290 million in the fiscal year ended January 31, 1999, to almost $500 million the following year, and more than $800 million in the fiscal year ended January 31, 2001.

The conjuncture that linked BEA's growth as a business with the stock market's evaluation of the "new economy" made BEA one of the all-time great venture investments. BEA's stock, having been split 2:1 in December 1999 and again in April 2000, reached an all-time peak of 85 in December 2000, or 320 on the shares originally issued to the public in April 1997 at 6. In August 1999, Warburg Pincus began to distribute its ownership: within sixteen months, the $54 million cash investment had been transformed into liquid, freely tradable shares with cumulative value at time of distribution of $6.5 billion. Our effort to declare victory was strenuous: in only sixteen months, we made twelve distributions, the two largest of which each amounted to $1.3 billion and were made only two weeks apart in February 2000. Even so, we had disposed of only 85 percent of our holdings when the bubble specific to BEA's stock deflated in early 2001.

As a company, BEA did not escape the general retrenchment in technology markets that followed the bubble. In BEA's case, that retrenchment was reinforced by the fact that IBM finally responded to the technological revolution that had undermined its generation-long franchise in enterprise computing. But BEA continued to generate substantial cash flow while investing in new technology. In April 2008, even as it was establishing market leadership in the third wave of distributed computing, technically known as service-oriented architecture (SOA), BEA was acquired by Oracle for $8.5 billion, more than five times its then annual revenue.

## BEA and the Innovation Economy

The BEA story yields multiple lessons in the dynamics of the Innovation Economy. First, Schumpeterian revolutions do not announce themselves in advance. Timely identification of the emergent force at the frontier of successful innovation is a function of hard work, immersive education and repeated – seemingly endless – exercises in trial and error. In retrospect, the concatenation of contingencies on which my hugely fruitful 1994 dinner with Bill Coleman turned seem so improbable as to define the operation of blind chance. The narrative that took me and my colleagues from ECsoft and IMI to SHL and OpenVision and on to BEA draws only on the experience directly relevant to reading the market for commercial computing at enterprise scale. And yet there were and are heuristics to guide the venture capitalist. The most important that I learned along the way revert back to the fundamentals set out by those students of capitalism: Braudel and Marx, Schumpeter and Keynes.

The super-profits available to any capitalist at any time are a function of necessarily transient and contingent opportunities for extreme arbitrage. For the founders of BEA and for Warburg Pincus, the arbitrage was defined by technology, mastery of which promised to move the world of commerce to an entirely new world of distributed transaction generation, capture and processing. To identify the practical potential for that arbitrage and its economic significance turned on deep engagement both with innovative computing technology and its capabilities and with the stressed structure of the overlapping markets that that technology could be directed to address. At a deep level, this double task is no different from what Braudel described: the evaluation in parallel of the capabilities of maritime navigation and the forecast conditions of demand for and supply of pepper 500 years ago.

Successful as BEA was as a venture, and conjoined as the founders and Warburg Pincus were as partners in that venture, the relevance of Marx at this level of analysis demands respect. From Marx, I take the separability of financial capital from the assets – physical and digital – in which it transiently instantiates itself. That this separability is never absolute is, of course, what places an enormous burden on the concept of liquidity. Marx's assumption that the capitalist can always exchange commodities for more money is a hypothesis subject to the test of the market, and all too often it fails the test when it must most be relied on. But what Marx got entirely right is that success for the capitalist can be defined in theory and – at least sometimes – realized in practice regardless of the fate of the venture as an operating enterprise.

In the establishment of BEA, the entrepreneurial founders and the capitalist financiers at Warburg Pincus directly addressed

Schumpeter's challenge with respect to the relationship between the entrepreneur and the financier. Bill and Ed had survived failed start-ups, and each had an earned respect for the value of access to capital. The research project had created the opportunity for all of us to calibrate our qualities as collaborators. Our joint decision to extend the OpenVision line-of-equity financing model reflected our several positive conclusions and was decisive in enabling Warburg Pincus to commit in timely fashion to the opportunity to take control of Tuxedo. In turn, that decisive move transformed a project into a business – one substantial enough to go public and therefore able to acquire WebLogic in time to ride the wave of eCommerce into the bubble. But the very success of this partnership between entrepreneurs and financiers, represented by a radically non-standard financing model, should exemplify its rarity and emphasize, too, the potential for conflict that Schumpeter identified.

And so, as is only to be expected when considering the returns to financial capital, we come to Keynes's appreciation of stock market valuation driven by speculation rather than the calculation of "the prospective yield of assets over their whole life."[3] Thanks to the bubble and, equally, to our recognition that it *was* a bubble, the return on Warburg Pincus's investment in BEA amounted to more than 120 times the cost, or an internal rate of return of 225 percent over an average life of just more than four years. At the time we commenced our distributions in August 1999, Warburg Pincus owned slightly more than 168 million shares. If we had held that position all the way to the company's acquisition by Oracle in April 2008 for $19.375, we would have received $3.26 billion in cash, approximately half the return actually realized; moreover, because the average life of the investment would have been three times as long, or more than twelve years, the internal rate of return would have been only 40 percent, less than one-fifth of that actually earned.

Along the way, the shares traded as low as $4.95. Had we been forced by circumstances (no doubt unanticipated!) to liquidate then and at that price, our position would have been valued at $833 million, and the investment would have generated a realized profit of less than

[3] J. M. Keynes, *The General Theory of Employment, Interest and Money*, in E. Johnson and D. Moggridge (eds.), *The Collected Writings of John Maynard Keynes*, vol. 7 (Cambridge University Press and Macmillan for the Royal Economic Society, 1976 [1936]), p. 158.

one-eighth of that actually earned. As it turned out, the timely realization of our investment in BEA was largely responsible for generating a net internal rate of return to our limited partners from the fund in which it was held of almost precisely 50 percent, thereby contributing to the firm's ability to raise another fund during the post-bubble valley of disillusionment.

Doing capitalism successfully thus turns to an extraordinary extent on reading the market for financial assets, as much as it does on the seemingly more fundamental tasks of reading the markets for physical assets while assessing the technological innovations that will render new assets more productive and old assets obsolete. And here is found a pair of framing facts that are profoundly counterintuitive to anyone trained in the discipline of neoclassical economics, where efficiency is the prime virtue in theory and in practice. The success of BEA as a company and as an investment turned on capitalization of the results of two processes, each of which was decoupled from any calculus of economic return.

In the first instance, the foundational technology – Tuxedo – on which the company was built had been funded by the monopoly profits of AT&T, which had been diverted to support the scientists and engineers of Bell Laboratories rather than returned to AT&T's customers in lower prices or to its stockholders in higher dividends. Moreover, the world of digital computing and microelectronics, on which the technology was based, and of the internet, through which it transformed the economy, had been directly shaped and funded by the federal government, which was motivated by concern for national security, not return on investment. In the second instance, the climax of the investment was driven by a frenzy of short-term speculation entirely focused on riding the psychology of the market and no longer interested in the prospective cash flows from the business represented by the common stock. In other words, as investors in this triumphant example of the Innovation Economy, Warburg Pincus was a beneficiary of what to a narrowly focused economist would appear to be the generation of waste.

Even more, this history is powerful confirmation that excessive pursuit of efficiency is the enemy of innovation. Within the neoclassical framework, the efficient allocation of resources is conducted by ranking projects in the order of the net present value of their expected future cash flows, that "fundamental" definition of value. In such a ranking, the projects whose future returns are most certain will be at the top. Such projects are bound to represent merely incremental improvements on what already exists with proven commercial appeal. The genuinely innovative projects will be penalized, given the penalty to net present value generated by the increase in the discount rate required to take account of greater uncertainty with respect to future returns. And, indeed, success at the frontier requires multiple essays in radical innovation, much of which can be expected to fail. This is the necessary waste at the core of the Innovation Economy and unrecognized by conventional economic theory.[4]

The historical context in which BEA was built and valued was, of course, unique: the intersection of the technological revolution in distributed computing with the realization that the internet is an environment for conducting commerce in a new way. But the elements of the Three-Player Game of innovation were the same as they have been since the First Industrial Revolution. As before, the Innovation Economy depended on sources of funding that tolerated apparently wasteful investment both in advancing the frontier of scientific discovery and in exploring the new economic space created when derived technology was deployed. Upstream in the process through which the market economy was again transformed, the state indirectly sanctioned the monopolies whose profits funded discovery and invention, and then took on direct responsibility for investment in research when those monopolies were legislated or competed away. And downstream, at critical historical moments, a bubble in the financial markets provided funding to construct and explore new economic space before any rational calculus could be applied to quantify the returns available from its exploitation. In all their wasteful excess, bubbles have been necessary drivers of economic progress.

[4] One creative effort to define the difference between less uncertain "exploitative" R&D and more uncertain "exploration" R&D is to be found in U. Akcigit and W. Kerr, "Growth through Heterogeneous Innovations," *Journal of Political Economy*, forthcoming (draft of September 2016). Available at https://static1.squarespace.com/static/57fa873e8419c230ca01eb5f/t/57fd92f590dc5d39708aea59/1476236023160/AK_rev2.pdf.