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The Politics of Innovation Policy: Building Israel's "Neo-developmental" State

Erez Maggor
New York University

Abstract

This article contributes to an emerging literature on the "neo" or "entrepreneurial" developmental state that emphasizes the role of innovation policy in promoting the structural transformation of industry. It finds further evidence that supports this approach and advances it by making two unique contributions. First, it highlights an essential yet underappreciated feature of contemporary innovation policy: the state's capacity to *condition* public assistance and *discipline* private firms that do not adhere to government guidelines. These capacities are necessary to guarantee that the benefits of public investment in innovation—the social and economic *spillovers*—are not appropriated by private actors but shared more broadly within society. Second, it highlights that politics—reflected in the relations between innovation agencies and key social actors—represents an important causal factor in both the formation and subsequent transformation of these institutional capacities. These points are illustrated through a historical analysis of a crucial case: the state-led development of Israel's thriving high-tech sector.

Keywords

innovation, Israel, developmental state, policy, discipline

Corresponding Author:
Erez Maggor, New York University, 295 Lafayette St. 4th Floor, New York, NY 10012, USA.
Email: erez.maggor@nyu.edu

Industrial policy is back on the political agenda. From Germany's "Industrie 4.0" to "Made in China 2025," policymakers worldwide are advancing ambitious innovation policies that aim to transform industry, foster the development of cutting-edge technologies, and promote inclusive growth. These policies also seek to harness innovation to address formidable social and global challenges, including the demographic aging crisis, widening economic inequality, and adverse climate change. Such policies call for a wide range of measures often identified with a "neo" or "entrepreneurial" developmental state.[1] They include targeted government investment in R&D and training, support for marketing and exporting, networking and brokerage services, and building of facilities and science parks. They follow a period in which such proactive state targeting was avoided for fear it would encourage rent-seeking behavior, waste taxpayer money, and distort market competition and resource allocation. Yet a growing literature on innovation has found that, in contrast to Washington Consensus policy prescriptions, such bold and transformative strategies have in fact been essential for the economic success of some of the world's most innovative economies. That was the case not only for developing nations such as Korea, Taiwan, Ireland, Finland, and most recently China[2] but also for advanced economies such as Germany and even the United States.[3]

This article finds evidence that supports the state-led account of innovation and advances the literature by making two specific contributions. The first contribution is to highlight a crucial, yet underappreciated, feature of contemporary industrial strategy: the state's capacity to *condition* public assistance on the fulfillment of specific terms and obligations and *enforce discipline* when private firms do not adhere to government guidelines. I find that, much like the catch-up developmental state of the postwar period, the effectiveness of innovation policies has depended on these specific capacities. Whereas state assistance was historically tied to maintaining strict performance standards, mainly in the realm of export promotion, contemporary innovation-targeted strategies require conditioning assistance on the domestic commercialization of state-sponsored innovation.[4] As will be discussed at length below, these capacities are necessary in order to guarantee that the social and economic "spillovers" produced by the state's investment in innovation are not appropriated by private actors but rather distributed more broadly within the domestic economy.

The second contribution involves returning to the fundamental debate about the role of politics—reflected in the relations between the state's developmental agencies and key societal actors—in development. With some notable exceptions, such as recent work by Richard Doner and Ben Schneider on the political economy of development, the scholarship on innovation has not paid much attention to how state action is constrained (or enabled) by its relationship with various social groups.[5] By incorporating an analysis of the politics of policy formation and institutional change, I highlight that politics represents a key causal factor in both the implementation and potential transformation of innovation policy. After all, the political sphere is where the institutions that govern policy are formed and potentially reformed.

To illustrate these points, I offer a critical exploration of a crucial case,[6] previously regarded as a "neo-developmental" state and commonly referenced in

the literature on innovation policy: the state-led development of Israel's high-tech sector.[7] First, I demonstrate the central role that conditionality and state discipline played in the success of Israel's thriving innovation economy. Next, I trace these institutional capacities to the emergence of a political coalition that was formed by Israel's leading developmental agency and included key members of industry, finance, and labor as well as former military elites and leading entrepreneurial scientists and engineers. Whereas the failure to build similar upgrading coalitions served as the main political obstacle to development efforts elsewhere, in Israel this coalition underpinned the state's efforts to restructure industry in the direction of a knowledge-based economy and played a pivotal role in the successful implementation of the state's innovation policies.[8] Finally, I depict how changes within this coalition due to the appearance of Israel's venture capital industry—a powerful new actor with distinctly different policy preferences—eventually eroded vital institutional capacities and led to significantly fewer public rewards. Thus, in addition to enhancing our understanding of the role of conditionality and discipline in contemporary industrial policy, this study also contributes to growing debates on the "political economy of innovation,"[9] as well as to the robust literature on the role of politics in institutional change.[10]

The article begins with a review of the relevant literature. This section highlights why innovation-led development brings about unique challenges requiring that the state condition its assistance and gain the capacity to discipline uncooperative firms. I follow with a historical illustration using the case of Israel. I begin with an outline of the relevant historical background and then proceed to the main empirical sections. Here, I outline the unique institutional capacities of Israel's Office of the Chief Scientist—a "Schumpeterian developmental agency" that has received international acclaim for stimulating the growth of Israel's thriving high-tech industry.[11] Next, I discuss the political origins of these capacities and outline how they have changed over time. I do so by leveraging an in-case comparative analysis demonstrating how a shift in the original upgrading coalition worked to erode the central pillars of Israel's original innovation policy and how those changes, in turn, have had a negative impact on developmental outcomes.

From "Catch-Up" to "Innovation-Based" Development

The Catch-Up Developmental State: Goals, Strategies, and Capacities

Starting in the 1980s, investigations into the "miraculous" economic success of a number of East Asian countries—first Japan, later South Korea, Taiwan, and Singapore—challenged the widespread commonsense of the Washington Consensus. That scholarship demonstrated that the unprecedented success of those newly industrialized countries rested not in their commitment to free market principles but rather in their reliance on a comprehensive industrial program implemented by a developmental state. Such industrial policies generated an economic transformation by targeting investment in select industrial sectors and fostering

national champions that could catch up to, and eventually outcompete, leading international firms.[12]

A central challenge of the traditional industrial strategy was ensuring capital would be channeled in the appropriate direction and at benchmark levels of efficiency. Because in a capitalist economy final investment decisions are the prerogative of the owners of capital, this required states to construct institutional mechanisms through which they could exert effective influence over private firms' investment process. One method for inducing investment was to provide a myriad of publicly financed subsidies—generous tax breaks, cheap loans, export incentives, and trade protection—to industrialists willing to sink new funds in targeted industries. More crucial, however, states had to guarantee that firms viewed subsidies not as "gifts" but rather as "implicit contracts."[13] Whereas the former runs the risk of subsidies' being diverted to operations in less productive sectors, the latter obligates private enterprises to invest in specified lines and on benchmark technology or be disciplined by state managers. In other words, effective industrial policies required that states gain the capacity to *condition* subsidies on monitorable performance standards and to impose *discipline* on firms that did not meet the targets.[14]

In Korea, to use a well-known example, surpassing export targets was rewarded with further licenses to expand into more lucrative sectors, whereas poor performers or bankrupt firms were heavily penalized, either by the government's refusal to bail them out or by the transfer of their assets to other enterprises.[15] Only in this manner, with both carrots and sticks, were developmental states able to dislodge industrial elites from final stage assembly and move them into the more sophisticated and riskier, yet far more dynamic, realm of high-value manufacturing.

Neo-developmental States: New Strategies, New Challenges

Despite its seemingly waning relevance throughout the 1990s and early 2000s, industrial policy has been repopularized by a recent wave of new scholarship as an effective instrument in the advancement of technological and economic change.[16] The fundamental goal of the developmental state—producing an economic transformation—has remained the same, but these studies highlight several key differences in development strategies that have presented policymakers with new challenges.

Postwar developmental states undertook coordinated efforts to help domestic firms catch up to their developed counterparts in established, capital-intensive industries such as steel, shipbuilding, and automobiles. Rather than helping firms compete in already existing markets, "neo-developmental" states are mostly geared toward generating *new* markets by fostering innovative technologies and products.[17] Since the goal is to produce novel technological or scientific breakthroughs, long-term planning and targeting investment in existing industrial sectors is not applicable. Instead, successful interventions require policy measures that are far more "experimental" and "discovery-based,"[18] along the lines of Albert Hirschman's call for a more "open-ended, eclectic, skeptical inquiry."[19] Such interventions include the provision of targeted funding and other public resources to groups that have promising ideas for products that can compete at the technological

frontier.[20] Often they rely on a far more "decentralized" and "networked" institutional structure that coordinates public and private initiatives, cultivates new networks, facilitates business connections, and builds bridges between innovative firms and scientists and engineers working in university, military, or government laboratories.[21] Such policy programs have been introduced by Singapore's A*Star, Finland's Sitra, the United States' Defense Advanced Research Projects Agency (DARPA), and—as will be discussed at length below—Israel's Office of the Chief Scientist.[22]

The changing nature of industrial policy has presented policymakers with a host of new challenges. One of the fundamental difficulties is to ensure that early public investment in industrial R&D will generate positive economic spillovers in the local economy: good jobs, stable tax revenue, and high-value-added exports. The creation of jobs in the manufacturing sector is particularly important because manufacturing, relative to other economic sectors, tends to have a much larger multiplier effect, producing demand for additional jobs in both upstream and downstream industries.[23] For these effects to materialize, however, it is not enough for R&D to occur locally; it is essential that the externalities and payoffs of the original public investment be more broadly shared. However, particularly in today's globalized economy, there is little assurance that that will indeed be the case. Profit-oriented firms—which in the context of a capitalist economy are nearly always the owners of new technologies—will seek to maximize their return by appropriating the fruits of innovation. They will often relocate certain business functions related to the commercialization of R&D to places where they are more economically beneficial for private investors. But that, in turn, will inevitably result in what the economist Mariana Mazzucato refers to as "socializing the risk, yet privatizing the rewards": meaning that while government takes on most of the risk, the fruits of innovation remain in private hands.[24]

The conflict of interest between states and private firms creates what Dan Breznitz and Amos Zehavi aptly termed the "spillover problem."[25] It is most often pertinent in middle-income economies where local firms experience a "dual external pull"—on the one hand, they stand to benefit from relocating their operations to places with cheaper labor costs and more lax safety and environmental regulations; on the other hand, they seek to locate their marketing and sales departments within the larger and more developed markets of the advanced economies, particularly the United States.[26] Recently, this issue has also become a problem for advanced economies. Many American firms, for example, have severed R&D and design from production and shifted virtually all their manufacturing process to Asia. The transition from an "innovate here/produce here" model to one of "innovate here/produce there" led the number of Americans employed in manufacturing to fall precipitously between 2000 and 2010, by almost one-third, from around 17 million to under 12 million. Furthermore, since many sectors still require a close connection between research, design, and production—for example, capital goods, aerospace, energy, and pharmaceuticals—there are growing concerns that innovation may soon follow production offshore to produce an even more disruptive "produce there/innovate there" model.[27] Upending these trends, therefore, represents a notable challenge for both developing and developed nations that engage in innovation-led growth.

Using Conditioning and Discipline to Overcome the Spillover Problem

How can policymakers overcome the challenge? Recall that the main task for states pursuing catch-up growth was making sure firms invested state subsidies, and later reinvested profits, in the direction and volume specified by state planning. The challenge of innovation-led development, on the other hand, is quite different. Making sure awarded R&D funds are fully invested is far less a concern. This is because, rather than channeling large sums to a handful of "national champions," innovation policy often follows the logic of "letting a hundred flowers bloom," providing a large number of small grants to scientists and engineers working in university, government laboratories, or business settings, with the knowledge that only a small minority will actually succeed.[28] What mostly troubles policymakers is not the R&D process itself but rather what happens once an R&D project is successful. As stressed earlier, it is only at that stage that the broader social benefits of innovation can start to be realized. However, that is also when firms usually enjoy the most leeway regarding how and where to commercialize their R&D and when the temptation to offshore manufacturing or sell their proven technology to larger, more established firms begins to increase. Further complicating the matter is that, in contrast to firms in traditional industrial sectors such as steel or chemical manufacturing, firms operating in R&D-intensive industries such as software or information technology are far more footloose, making it an even greater challenge to keep them local.[29] In short, the new policy tools, goals, and challenges outlined above require a unique set of conditions and mechanisms of discipline.

In this article, I argue that overcoming these challenges necessitates that the state's developmental agencies find ways to condition generous state R&D funding on the future development of a domestic industry. Such conditions may include manufacturing requirements stipulating that beneficiaries of state funding must produce certain goods domestically or source from local suppliers; ownership requirements ensuring that firms keep certain key activities local; or conditions on how knowledge is governed, specifying that firms must transfer or license the most up-to-date technology to indigenous firms.[30] Accordingly, states must also develop institutional mechanisms by which they can discipline firms that ignore or fail to meet these obligations. Surprisingly, the recent literature on contemporary industrial policy has remained relatively silent regarding the role that state conditions and discipline play in the realm of innovation.[31] Aside from some mostly anecdotal evidence,[32] systematic investigation of these specific institutional features and their operation and effects has yet to be carried out.

To contribute toward filling the gap, I analyze how one of the world's most renowned innovation economies, Israel, used conditions and discipline as a means to overcome the spillover problem on its way to fostering a highly dynamic high-tech industry. It is worth focusing on this specific case study for three reasons. First, Israel's tech-sector is considered a global success story, and its growth model has been imitated by both advanced and emerging economies.[33] In fact, Israel is one of only thirteen developing economies that managed to escape the "middle-income trap" and transition to high-income status.[34] Second, Israel can be seen as a natural laboratory, in that it was the first developing economy to pursue an active policy of industrial

promotion through R&D policies.[35] Being a pioneer in the realm of innovation policy meant it could not simply imitate proven and ready-made policies. Rather, policymakers had to experiment with innovative industrial strategies in an extended period of trial and error. Various policy proposals, debates, and evaluations resulted that make Israel a fruitful site for an in-depth investigation of such polices. A third and final reason has to do with Israel's small size and the "clustered" nature of its innovation industry, which is often compared to Silicon Valley.[36] It is effectively possible to study most of the original policymakers, as well as founders, entrepreneurs, and investors, who took part in the growth of Israel's high-tech sector from its embryonic through its mature stages.

Beyond these reasons, it is also important to stress that Israel's capacity to condition state assistance effectively cannot be explained simply by the existence of its national security state (NSS). Counter to Linda Weiss's argument regarding the American NSS, in which industrial and technology policies are sustainable *only* because of the "commercial activism of . . . national security agencies," this article highlights the leading role and capacity of Israel's *civilian* agencies.[37] Although there is no doubt that Israel's security apparatus was an essential component in the development of the state's technological edge, it alone cannot account for the effectiveness of Israel's R&D policies. As will be demonstrated below, most of Israel's key innovation policies were orchestrated by a civilian innovation agency oriented toward the advancement of strategic economic imperatives and that largely resembled other well-known examples such as Finland's Sitra or Ireland's Forbairt (later "Enterprise Ireland").[38] In that regard, the Israeli case is generalizable beyond the narrower scope of the NSS framework and can be studied alongside other neo-developmental states.

Methodologically, my analysis of Israel's innovation-led development strategy employs historical process tracing that relies on government policies and policy debates documented in original archival materials gathered from Israel's state and Knesset (legislative branch) archives. The archival study includes an analysis of more than 225 government files, comprising thousands of original documents, declassified for the purpose of this study. To allow for triangulation, I also conducted thirty-five semistructured interviews with senior civil servants from all the relevant government ministries and agencies, both current and past, as well as founders and top executives of prominent technological firms and leading venture capitalists. While the interviews were open-ended, I used an interview protocol of twenty questions organized around subthemes. Interviews lasted from forty-five minutes to three hours. Additional materials included newspaper coverage, autobiographies of key figures, and both published and unpublished government reports.

My analysis finds that Israel's leading position in the world of technological innovation can be traced to its ability to make the domestic commercialization of R&D a central pillar of its innovation policies. Although private firms enjoyed ownership of the knowledge that resulted from state-funded R&D, their control over the intellectual property (IP) was limited in key ways. First, recipients of R&D subsidies that were successful in developing innovative products were obligated to manufacture them locally. Second, such firms were prohibited from transferring (i.e., selling) their IP to

firms operating beyond Israel's borders. To enforce those obligations, Israel's central innovation agency, the Office of the Chief Scientist, was endowed with the capacities necessary to exert effective discipline over uncooperative firms. This worked to contain the realization of successful R&D within the domestic economy and led numerous indigenous start-ups, as well as local subsidiaries of multinational corporations, to scale up and continue operating from Israel. In this manner, state planners were successful in ensuring that public investment in R&D would indeed produce public rewards.

Examining the origins of these capacities, I find that their success can be traced back to political support from an emerging alliance of domestic elites who took an active role in their institutionalization. As recent literature on the topic has stressed, the underlying structural obstacle to the institution building required to generate such capacities is often the absence of a strong "upgrading coalition."[39] My analysis finds that, in Israel, this barrier was overcome when the Office of the Chief Scientist established a political alliance with an emerging cohort of domestic elites whose economic interests aligned with the developmental priorities of the state. Aside from the leadership of the office, this partnership included diverse social partners, including vanguard investment bankers, leaders of established industrial conglomerates, sections of labor, and entrepreneurial scientists and engineers looking to commercialize electronic or software applications developed in public research universities or the military.

Finally, I show how changes within this social alliance due to the appearance of a new set of economic actors with distinctly different policy preferences, mainly the venture capital industry, triggered a political dynamic that resulted in the eventual erosion of the key pillars of this policy. My findings illuminate a once well-known, now commonly underappreciated fact—that like any industrial strategy, innovation policy is political in nature.[40] A complete understanding of its effectiveness, therefore, cannot be attained without bringing politics explicitly back into the analysis.

The Origins of Israel's R&D-Based Development Model

In the two and a half decades following Israel's independence in 1948, its economy experienced extraordinary growth rates, on a par with the East Asian Tigers. That growth was the result of several factors, but it certainly would not have occurred without Israel's robust developmental state, which implemented a highly successful import-substitution-industrialization developmental strategy.[41] By the mid-1970s, however, Israel was dealing with intensifying economic stagnation and a balance of payment deficit projected to reach $3.5 billion. Recognizing the limited potential for further growth of traditional industrial sectors—mainly textiles and clothing—along with the risks of an economy dependent on the export of one or two basic products, state planners at the Ministry of Trade and Industry argued that Israel's economy was in "urgent need" of "rapid technological development" requiring "an accelerated effort in the field of industrial R&D." As a result, it was in this period that industrial R&D first became a "high-priority national goal." Fully aware of the limited size of Israel's industrial firms, both in annual turnover and manpower, as well as the inherent risk of

investment in R&D, state planners also noted that "industrial R&D in Israel will not be able to develop fully without massive government aid."[42]

The decision to target civilian R&D as a means of jump-starting economic growth and narrowing the state's chronic trade imbalance would not have been possible without Israel's relatively advanced research infrastructure and highly skilled workforce. By the mid-1970s Israel already possessed one of the highest ratios of scientists and engineers to total population in the world—40 per 10,000—almost on a par with that of the United States.[43] Yet the vast majority of this skilled workforce was confined to Israel's public research universities and its security sector, both of which produced very limited spillovers into civilian industries.[44] Israeli universities did try to promote research commercialization, setting up subsidiary technology transfer firms a full decade before the United States. Until the 1990s, however, only a small number of scientists actively engaged in commercial activities, and academic commercialization remained "low-key, hesitant, and modest," mostly on the margins of universities' operation.[45]

The bottlenecks were even narrower in the case of Israel's security sector. The R&D capacities of the state's military and defense industries were already highly advanced by the mid-1970s, in large part the result of the Israeli government's risk-averse defense technology policy. Following a French embargo on the sale of arms during the 1967 Six-Day War, Israel aimed to achieve independent local capacity for defense R&D and production, a policy that led to an extraordinary rise in defense expenditures and enabled the security sector to absorb a large share of the country's trained scientists, engineers, and technicians.[46] But publicly funded technologies and capabilities developed through military R&D rarely found their way into civilian industries, and commercialization of defense technologies by defense firms was chiefly viewed as a failure. Technology transfer across the boundaries of the military industry was limited to the private initiative of individual entrepreneurs who left defense firms or technological army units with the knowledge, and often proven prototypes, to start their own businesses.[47] In short, although state managers initially hoped that state support of military industries would produce spontaneous spinoffs, in practice the security sector had a "crowding out" effect that dampened the growth of the civilian high-tech economy.[48]

By the 1980s, the fact that bottlenecks were impeding the development of a technologically advanced civilian industry, and economic development more generally, was acknowledged by various public committees and planning agencies. For example, in 1984 a government committee appointed to examine the management of government-financed R&D emphasized the lack of institutional mechanisms for defense conversion and stressed the need for a "coordinated national technology policy" and "active and unconventional" government involvement.[49] It was at this point that policymakers began to pursue a national science and technology policy that aimed to overcome the existing bottlenecks by rechanneling public resources rapidly and mobilizing private investment in civil industries.

Charged with the task of accelerating investment in nonmilitary R&D was the newly created Office of the Chief Scientist (OCS). Housed within the Ministry of Trade and Industry (MOTI), this agency was responsible for initiating a myriad of

innovative risk-sharing programs that supplied public funding for cutting-edge industrial R&D in a variety of science-based industries. The OCS's flagship program, the R&D Grants Program, initiated in 1968, offered early-stage funding in the form of matching grants for the development of an innovative, export-targeted industrial product or process. Only firms that produced successful projects (i.e., those that led to sales) were required to repay the original grant in the form of royalties (usually 3–5 percent of annual sales), which were capped to the dollar-linked amount of the original grant. Throughout the 1970s, the R&D program grew in both impact and resources and in 1984 was consolidated with the Encouragement of Industrial Research and Development Law (hereafter the R&D Law), which has defined the parameters of government policy toward industrial R&D ever since.[50]

In addition to the grants program, the OCS provided further financial and institutional support through binational industrial R&D programs. The largest of these was the Binational Industrial R&D (BIRD) Foundation, which supported joint ventures between Israeli and American firms. In addition to subsidizing R&D in a way similar to standard OCS R&D grants, these programs facilitated technological transfers from foreign companies to the domestic economy, helped open key export markets for Israeli tech firms, and provided much-needed mentoring in both business management and product design, skills that were highly lacking in the industry's first decades.[51] In the early 1990s the OCS created two additional channels of institutional support for R&D activities. The first was the Technological Infrastructure (MAGNET) Program, which supported the formation of an R&D consortium that included both tech firms and academic institutions. The second was a technological incubators program that offered both resources and institutional support for novice entrepreneurs, including many recent immigrants from the former Soviet Union, looking for an opportunity to translate their innovative ideas into commercial products. These programs not only encouraged the development of generic, precompetitive technologies but also helped foster university-industry collaboration and forged new technological and business networks.[52]

Finally, it should be stressed that since the early 1980s, increasing public investment in the civilian technology sector was accompanied by dramatic cutbacks in domestic defense procurement. Defense purchases as a share of GDP dropped from 9.1 percent in 1982 to 6.1 percent in 1987, and then to 3.5 percent by 1995. Made possible largely by the de-escalation of regional conflict following the signing of the Israel-Egypt peace treaty in 1979, such cutbacks were advanced, first and foremost, in response to Israel's worsening economic difficulties, described above. Yet economic state managers also supported these measures because they viewed them as a necessary step in the advancement of a *civilian* high-tech economy.[53] As a result, by 1994, "military equipment" accounted for just 8 percent of government R&D subsidies (down from 26 percent in 1988), whereas "electronics and communications" and "programing and software" combined to represent the highest proportion of subsidies, at 48 percent (up from 19 percent in 1988).[54] As one of the economists who produced these figures concluded, "Israel's high-tech revolution was in large measure a shift of economic resources from a technologically advanced but commercially unprofitable defense sector to civilian manufacturing based on similar technologies."[55]

The cuts in military spending resulted in the termination of hundreds of military projects, most famously the discontinuance of the Lavie fighter jet development program in 1987. Tens of thousands of skilled workers were released into the labor market and quickly absorbed by the emerging civilian high-tech sector.[56] The transfer of human capital from the security sector to the private sector also served as an informal mechanism of technological transfer. Aided by R&D grants from the OCS, entrepreneurs could convert high-level, defense-related R&D into profitable civilian products, mostly in electronics, aviation, electro-optics, and computers.[57] Finally, the government cutbacks in defense spending sent a clear message to the military sector—which previously enjoyed lucrative cost-plus government contracts on large-scale projects—regarding the state's changing economic priorities. Many key figures in the business elite began to explore new, more outward-looking investment outlets.[58]

As a result of these efforts, starting in the mid-1970s, Israel experienced a remarkable increase in high-tech exports, from a mere $422 million in 1969 (in 1987 dollars) to $3,316 million in 1987.[59] By the end of the 1990s, products of information and communication technologies (ICT) accounted for 54 percent of Israel's manufactured exports, compared to 28 percent in the late 1980s and only 14 percent in the late 1970s.[60] In fact, Israel was finally able to close its chronic current account deficit largely because of high-tech exports, and in 2003 it became a net exporter.[61] Notably, those achievements were accompanied with the creation of new high-paying jobs. Between 1995 and 2011, the number of workers employed in high-tech more than doubled, from 98,000 to 215,000. By 2014, Israel's high-tech workforce consisted of 280,000 people, representing 9 percent of total employment or 12 percent of employment in the business sector, more than double the OECD country median.[62]

Over the years, various economic studies have demonstrated the direct relationship between the OCS's R&D programs and these impressive developmental outcomes. One comprehensive econometric study concluded that the OCS R&D Fund played a "key role" in the success of Israel's high-tech sector, serving as a primary source of investment capital for Israel's technological entrepreneurs. The study found that 1,200 firms in the years 1987–94 received $1,400 million of subsidies in support of $3,500 million of R&D (in constant 1996 dollars) and estimated that this R&D generated more than $31 billion of sales, increased industrial employment by about 10 percent, and contributed almost $22,000 million to the balance of trade.[63] Another study analyzing data between 1972 and 1996 found that industrial R&D expenditures were closely linked (with a reasonable lag) with OCS R&D grants and concluded that the grant programs were "key to the emergence and early success" of Israel's innovation economy.[64]

The OCS's Institutional Capacity

Scholars called on to explain the success of the OCS have often highlighted two key elements. The first is the agency's "neutrality" or "horizontal policies,"[65] referring to the OCS's open-ended approach to innovation, which encouraged industrial R&D irrespective of industrial branch or technological field and gave the agency the flexibility to shift support to different technological sectors. The second element is the agency's

principle of risk sharing. Because the government did not claim an ownership stake in the products it helped create, and because grant repayment via royalties was capped and conditioned on actual economic success (sales), the OCS significantly lowered risk for private firms that were hesitant to make the initial investment in R&D.[66]

Although those two elements were undoubtedly important, I find that an additional factor played a crucial role in the organization's success, particularly in its ability to retain the benefits of R&D within the national economy and produce public rewards. That factor was the OCS's capacity to stipulate conditions and limitations on the realization of publicly funded R&D and then to enforce those conditions effectively via discipline. Most important in this regard were requirements that stipulated that (a) all products emerging from an OCS-funded project be manufactured exclusively in Israel and (b) the knowledge created during the R&D stage (the intellectual property, or IP) not be transferred beyond the state's borders. Both stipulations existed as early as 1975 and became integral parts of the R&D Law of 1984.[67] These conditions were also incorporated into the standard contract agreement signed between R&D grant recipients and the OCS.[68]

The logic behind these requirements was to ensure that once a state-funded R&D project succeeded, its fruits—the jobs, taxes, and exports, as well as any future innovation it spawned—would remain in and benefit the domestic economy. As Dr. Shuki Gleitman, former chief scientist, explained at the time,

> The state of Israel is investing a significant sum of money and is doing it when the risk is at its highest. . . . It wants to then reap the economic benefits of this investment. We are not interested in recouping our investment; we want to help nurture an industry that will employ workers.[69]

In other words, although the state permitted grant recipients to patent prototypes without itself asserting any ownership, IP rights were limited in ways that aimed to preserve the broad benefits of R&D within the domestic economy. Since the R&D Law became the binding legal framework for all OCS operations, the same conditions applied to almost all other funding schemes administered by the OCS over the years, including the Technological Incubators Program and the technological infrastructure consortia outlined above.[70]

To guarantee that the conditions and obligations attached to the R&D Law would not remain a dead letter, starting in the early 1980s Yigal Erlich, former chief scientist, initiated a process of institution building that endowed the agency with capacities necessary to oversee R&D investment effectively as well as to discipline firms that breached the law's stipulations. It was in this period that the OCS set up an in-house unit responsible for oversight of R&D and the collection of royalties.[71] Thereafter, financial and technological representatives from the OCS would visit beneficiary firms in order to inspect progress of funded projects and examine financial records to see whether royalty payments were made accurately.[72] The fact that R&D grants were distributed piecemeal and in accordance with a prearranged payment scheme, not in advance as one lump sum, allowed the OCS to set benchmarks and withhold payment when projects did not progress as planned.[73]

Most significant, however, were the institutional capacities ascribed to the OCS following the 1984 R&D Law, which specifically empowered the OCS unilaterally to withhold or cancel previously awarded funds and even to demand full repayment (with interest).[74] In 1995, at the request of the chief scientist, a new amendment to the R&D Law classified the unauthorized transfer of state-funded IP beyond Israel's borders a criminal offense, punishable by up to three years in prison.[75] Although no case is known in which an individual or firm was prosecuted for such an offense, the law nonetheless gave the OCS a threatening stick to go along with all its various carrots.

Another highly effective mechanism of discipline was the OCS's ability to withhold or delay all pending or future grant applications from firms that violated the conditions of the R&D Law. Because almost all large and medium tech firms in this period submitted R&D projects to the OCS annually, and because many of them depended on continuous state backing of R&D, the threat of delaying or withholding future proposals served as very effective leverage over disobedient firms.[76] At least in some years, the OCS kept track of such "troublesome firms" and shared information with other departments within MOTI.[77] It should also be stressed that OCS oversight and discipline were not limited to the initial stages of R&D. Because royalty payments were due on future sales, the R&D Law empowered the OCS to follow up firms continuously and provided access to their financial records long after the actual R&D was complete. Payment of royalties thus became the OCS's main method of oversight. The agency could ensure not only that royalties were paid accurately but, more important, that firms abided by the local manufacturing and IP retention requirements.[78]

This form of monitoring allowed the OCS effectively to discipline firms that tried to transfer their IP or failed to pay royalties. For example, in October of 1994 the OCS withheld R&D funding from Tadiran—then one of Israel's largest ICT firms—for what it saw as underpayment of royalties.[79] In March of 1995 it intervened in a partnership deal signed between the OCS-funded Telrad and the Canadian firm Nortel (formally Northern Telecom) that included unauthorized transfer of knowledge from the former to the latter.[80] In 2001, the OCS again withheld R&D funds from two of Israel's largest ICT firms, ECI Telecom and Comverse Technology, for disputes over royalty payment.[81]

As was intended, such conditions were instrumental in the expansion of Israel's high-tech sector. The case of Given Imaging, which pioneered the capsule endoscopy technology that visualizes and detects abnormalities of the small intestine, is a good illustration of how these requirements conditioned local commercialization. Founded in 1998 by Dr. Gabi Iddan—previously a scientist in the missile division of the state-owned Rafael Advanced Defense Systems—the start-up received funding of up to $5 million through the R&D Law. In 2001, once the R&D was successful and Given Imaging was cleared by the US Food and Drug Administration, the firm sought to begin mass production. The technology required to manufacture the sophisticated capsules, however, did not exist in Israel. Because the R&D Law prohibited the transfer of production abroad, realizing the firm's patented technology required establishing a large production facility in Israel, which Given Imaging did with the help of the American firm Pemstar.[82] By November of 2001 the manufacturing plant erected in Yokneam Illit[83] was producing 1,400 capsules a month and was projected to increase

production to 80,000 capsules by year's end, directly employing close to a thousand workers in manufacturing.[84]

The key conditions of the R&D Law highlighted above did more than compel domestic firms to scale up operations locally. A number of multinational corporations (MNCs) that had opened R&D centers in Israel and received funds through the R&D Law expanded their local operations to include advanced manufacturing.[85] As Breznitz notes, this process was almost the exact opposite of the usual model for MNCs in emerging economies, in which they first open assembly and manufacturing lines and with time develop more technologically sophisticated operations.[86]

An illustrative example is National Semiconductor, an American MNC (currently owned by Texas Instruments), which in 1978 received OCS R&D funding to set up an R&D center in Herzliya dedicated to the design of integrated circuits. In 1983, following the successful development of the NS32332 and NS16032 microprocessors, the firm made a $60 million investment (in 1983 dollars) to set up a top-of-the line wafer fabrication facility in Migdal Ha'emek dedicated to the manufacturing of the microprocessors developed in the firm's design center.[87]

The American multinational Motorola followed a similar path. Initially, the OCS was hesitant to approve the telecommunication giant's R&D grant requests, fearing it was likely to transfer the production of its most successful products abroad. To overcome this barrier, Elisha Yanay—the former president and general manager of Motorola Israel—obtained a commitment from the firm's US headquarters that products originating in OCS-funded R&D projects would be manufactured exclusively in Israel. That allowed Motorola Israel to comply with the R&D Law and enjoy significant public subsidies that led to the expansion of its local operations.[88] At its peak, 88 percent of Motorola's R&D in Israel was backed by OCS grants. By 2001 Motorola's local branch enjoyed total exports of over $3 billion and employed more than 5,000 Israeli workers, 1,200 of them in its manufacturing plant in the peripheral town of Arad.[89]

These examples are far from unique. Until the mid-1990s, when venture capital financing first became available in Israel, the OCS served as virtually the only source of R&D financing.[90] As a result, the number of firms that received state assistance and were therefore obligated to adhere to the conditions of the R&D Law was significantly high. One study found that in the years 1990–95, about 60 percent of all R&D performers received some kind of government subsidy, with grants from the OCS accounting for 87 percent of this support.[91] A follow-up study for the years 1997–2005 found similar results, with 56 percent of all firms engaged in R&D receiving OCS funding.[92] Data concerning earlier years are not available, but interviews with former senior personnel from the OCS attest to even higher rates of state-supported firms throughout the 1980s.[93]

The Politics of Israel's R&D Policy

The Creation of Israel's Upgrading Coalition, 1975–85

How was the OCS able to amass the unique capacities to condition state-provided benefits and discipline private firms that did not abide by those conditions? In this

section I argue that fully accounting for the effectiveness of innovation policies requires looking beyond their specific form and content to pay attention also to their institutional origins. Specifically, it entails examining how these institutional capacities were shaped and conditioned by politics, particularly by the emergence of an "upgrading coalition."

Such a coalition was established on the initiative of Itzhak Yaakov, Israel's first full-time chief scientist, who in 1975 had the OCS partner with the Manufacturers Association of Israel—the umbrella organization of Israel's private industry—and the holding company of Israel's General Federation of Labor Enterprises (Heverat Ha'ovdim) to form the Israeli Industry Center for R&D, or MATIMOP.[94] From its inception, this organization was made up of prominent leaders of industry, finance, and labor and included former military elites, entrepreneurial scientists, and heads of leading academic and scientific institutions. Aside from the chief scientist, MATIMOP's founding members included key figures such as Dan Tolkowsky, a former commander of the Israeli Air Force, then the managing director of the Discount Bank Investment Corporation (the investment arm of Israel's largest private bank), instrumental in moving the financial sector into high-technology investment; professors Uzia Galil and Avraham Suhami, both formerly of Israel's Institute of Technology and founders of the most successful first-generation innovation-based firms (Elron Electronic Industries, Elbit Systems, and Elscient); and Naftali Blumenthal, general director of the labor-owned industrial conglomerate Koor, a pioneer in the high-tech sector through its ownership of Tadiran and Telrad Networks, which became telecommunication giants.[95]

MATIMOP became a key forum for intragroup coordination and state-business cooperation. It held monthly board meetings and biannual conferences, at which policy suggestions and strategies were debated and collective decisions were made. Whereas the inability to forge strong social coalitions was a main obstacle of development efforts in other middle-income countries, MATIMOP illustrates the kind of broad social coalition that, in Israel, facilitated the institution-building and upgrading policies outlined above.[96]

In addition to interest-group coordination, MATIMOP also became a central political vehicle promoting the interests of the embryonic high-tech sector. As the organization's charter from 1976 stated, one of MATIMOP's main goals was to "coordinate between Israeli industry and the government" on "all issues related to industrial R&D."[97] Arie Lavie, former chief scientist, wrote a letter to the then minister of trade and industry to request that representatives of the association be included in the minister's technological council, explaining that "MATIMOP's central role is to . . . represent R&D intensive industries" and to "influence public opinion and policymakers."[98]

MATIMOP's many activities included sending representatives to participate in important parliamentary committees, coordinating meetings with senior state officials and ministers, and arranging formal tours and visits of science-based industries for various state elites and other political figures. These offered opportunities to raise problems and discuss possible policy solutions. In addition, in this period MATIMOP issued a quarterly periodical to "inform the public about all government initiatives in the realm of industrial R&D, inform policy makers on new developments in the

industry, and share . . . hardships faced by industrial developers."[99] In all these forums, representatives of the organization would advance various policy proposals aimed at bolstering state involvement in the development of the high-tech industry and increasing government spending on R&D.

MATIMOP not only represented the interests of this emerging sector but also played an essential role in the OCS's success by providing the agency with the political clout necessary for implementing its most important policy programs. When necessary, the organization lobbied to increase government spending on R&D or mobilized to defend attempts to curtail it. This was acknowledged, for example, in a government report written by Israel's National Council for Research and Development, which observed that "the success of the Chief Scientist in the Ministry of Trade and Industry" and its ability to "safeguard, and even increase its budgets" were largely due to the "presence of powerful organized interests" that operate "outside the ministry and view the encouragement of industrial R&D to be one of the Ministry's central tasks."[100]

Over the years MATIMOP advanced numerous policy proposals, yet their most noteworthy achievement was advancing the legislation of the R&D Law in 1984. Aimed to provide a legal and binding framework for the OCS's various funding programs, the R&D Law was at the top of MATIMOP's agenda. In fact, it was the leadership of MATIMOP who first proposed the law.[101] Already in 1981, the organization assigned a subcommittee the task of examining the existing means of government support for industrial R&D. In a letter addressed to the minister of trade and industry, the committee maintained that "the importance of R&D to the future economic development of Israel requires a law of encouragement of industrial R&D." Such a law, it stressed, was necessary for two reasons. First, it would "solidify once and for all the national efforts to advance industries engaged in R&D." Second, "it would strengthen the institution of the 'Chief Scientist' which would be entrusted with advancing this domain."[102] Less than two years later, representatives from MATIMOP also participated in the parliamentary debates of the law in the Knesset's Finance Committee. As reported by the organization's leadership,

> The highlight of our involvement . . . is our active participation in all stages of legislation, including in the original formulation of the law, through its advancement in the parliamentary debates . . . and up to our intensive participation these days in the preparation of comments to the proposed law prepared by the Ministry of Trade and Industry.[103]

It is interesting that during the legislative process, MATIMOP and its representatives offered no resistance to articles mandating local manufacturing and limiting the transfer of IP. A five-page document with comments responding to the proposed law submitted by the organization in 1982 included just one item (out of thirty-two) on the topic of local production and no items regarding transfer of IP. In the document, the organization's leadership acknowledged the importance of encouraging local manufacturing of state-funded R&D and did not push back against this guiding principle.[104] Similarly, little resistance was offered during the legislative debates in the parliamentary committees,

where most of MATIMOP's energy was concentrated in attempts to resist the Ministry of Finance's desire to place the R&D Law under its firm budgetary control and to guarantee the OCS would remain largely autonomous in deciding how to distribute its funding.[105] As a result, the original blanket restrictions remained in the final legislation.

How can we account for this lack of resistance? Three main factors help explain why industry not only supported the two requirements outlined above but found it in their own self-interest to do so. First, it is important to stress that when the R&D Law was first legislated, high-tech firms still operated within the vertically integrated "Fordist" mode of production associated with the international economic order of "embedded liberalism."[106] In the context of that model, which preceded the "fragmentation of production" common in today's "global production networks," the co-location of R&D and manufacturing was still very much the modus operandi of the industry.[107] In that regard, such conditions only reinforced the business model most local firms were already operating within.[108]

Firms chose to scale up their operations and manufacture in Israel not only because they were used to doing so but also because they were strongly incentivized to do so by the state. Already in the mid-1970s, the OCS requested and was given authority to grant "approved enterprise" status to any recognized science-based firm, affording it all the benefits provided under the Law for the Encouragement of Capital Investment (Investment Law). In effect, this made any firm (local or foreign) that received R&D funding from the OCS automatically eligible for additional financial assistance through an existing law traditionally used to subsidize the construction of manufacturing plants in peripheral cities.[109] In the mid-1980s, a number of amendments to the original Investment Law were legislated, mainly regarding tax relief, with the goal of making it more relevant to knowledge-based firms.[110] Those actions made the legal obligation to scale up manufacturing in Israel or refrain from selling their IP a much easier pill for private firms to swallow. Indeed, many high-tech companies that erected manufacturing facilities in Israel at the time, including leading Israeli companies such as the Scitex Corporation and Tower Semiconductor and MNCs such as Intel and National Semiconductor, did so with the help of generous public funding provided through the Investment Law.[111]

Finally, although these two factors explain support on the part of representatives of the private sector, the fact that Israel's General Federation of Labor Enterprises was a founding member of MATIMOP helped cement industry's support of the domestic requirements. At the time, the Labor Federation represented thousands of workers in the high-tech sector whose jobs would be protected by the proposed conditions of the R&D Law. Thus the state and labor enterprises enjoyed a shared interest in keeping production at home.

Considered together, these three factors help explain why members of MATIMOP showed little objection to these conditions when they were introduced. Indeed, the consensus around state conditions and discipline in Israel's upgrading coalition was not unlike that in other developmental states. One case in point is Korea, where the state's developmental agenda was not imposed but rather advanced "in alliance with domestic business," as a result of mutual self-interest.[112]

As we will see in the sections below, only when the industry started taking off in the early 1990s did opposition to these conditions began to mount. The most dramatic shift occurred following the appearance and rapid growth of Israel's venture capital industry, a watershed moment that dramatically altered the very structure of Israel's high-tech economy. As a result, for the first time since the sector's inception, the interests of the state and of leading fractions within the high-tech industry began to diverge.

Initial Erosion of the R&D Law's Manufacturing Requirements, 1995

Only a decade after the original enactment of the R&D Law, with Israel's high-tech sector growing by leaps and bounds, the issue of domestic production first became a point of contention. In 1995, the Knesset's Finance Committee held multiple debates on a series of proposed amendments that centered on the R&D Law's blanket prohibition on the transfer of production abroad.

The position advocated for by industry—now represented by the Manufacturers Association of Israel (MAI)—was that the R&D Law should give firms more leeway regarding when and if production could be offshored. Such a decision, they argued, should be based on "comparative advantage." This viewpoint was articulated by the MAI's representative to the committee debates, Moshe Ortas (CEO of Elta Systems, a subsidiary of Israel Aerospace Industries), who explained,

> From our viewpoint, it would be preferable to have us make the decision [about how much production to transfer abroad] and then come with it to the [research] council [for approval]. Because when we make these decisions we ask: where can I get the best *comparative advantage*?[113]

By this, Ortas meant to emphasize that decisions regarding where to locate production should be made in accordance with the price mechanism and not government decree. The competing viewpoint, which pertained to safeguarding developmental interests, was advanced by Efi Perry, a lawyer representing InterPharm. An Israeli subsidiary of the Swiss-based pharmaceutical firm Ares-Sorono, InterPharm was set up to carry out the manufacturing in Israel of a breakthrough drug to treat multiple sclerosis that emerged from OCS-funded research at the Weizmann Institute of Science. Local manufacturing facilities arising from state-sponsored R&D, such as InterPharm, were exactly the outcome policymakers envisioned when they required that production of state-funded projects remain in Israel. Any change to the local manufacturing requirements represented a threat to its very existence, as well as to other manufacturing facilities like it. Speaking to the Finance Committee, Perry defended the logic of the domestic production requirement:

> When is the state of Israel due to reap the fruits [of its investment in R&D]? . . . Only once manufacturing takes place do you start reaping the fruits [of the investment] in the form of taxes, foreign currency, and the brand name of Israel. And since manufacturing often produces new knowledge—also the prospect of additional R&D. If we offshore manufacturing, there will not be a future for Israeli technology.[114]

Responding more specifically to the issue of "comparative advantage" raised by Ortas, Perry countered that creating an opening to relocate some of the production will only weaken Israel's international competitiveness:

> When Israel is the exclusive producer [of an innovative technology], it is also competitive in price. But when the same exact product can be manufactured abroad, even if some portion of the production remains local, Israel can no longer hold the same price advantage as it once did.[115]

The amendments legislated in 1995 reflected a compromise between these two contrasting views. On the one hand, the law still stipulated that beneficiaries of R&D grants were obligated to manufacture in Israel. However, whereas the original law outlawed outright any transfer of production beyond the state's borders, the new amendments opened the door for that possibility. To do so, firms were first required to receive approval from the OCS.[116] If their request was approved, they were then obligated to pay increased royalties of up to three times the sum received in R&D grants (for details, see Table 1).[117] Such a penalty was easily enforced by the OCS, since it was already effectively collecting royalties from funded firms. Putting a price on transferring production abroad aimed to serve as a disincentive that would offset the benefits of offshoring and thus discourage firms from pursuing the practice. The transfer of IP remained prohibited at that point, as such a demand was not brought up during parliamentary debates in 1995.

The Erosion of the R&D Law's IP Retention Requirements, 2001–5

In 2000, a second round of amendments to the R&D Law began to be discussed. This time, however, the discussion took more than five years to finalize. Debates were carried out mainly in the Knesset's Finance and Science and Technology Committees and centered, once again, on the domestic commercialization of R&D. Again, the merits of the domestic manufacturing requirement were questioned. More important, however, for the first time since the enactment of the R&D Law in 1984, demands were made to eliminate the blanket prohibition on transferring state-funded IP.

One major difference was that by this period, the landscape of Israel's high-tech industry looked remarkably different from that just five years earlier, primarily because of the establishment of Israel's venture capital industry, which began operating in Israel around the time the previous amendments to the R&D Law were legislated. As with the high-tech sector itself, the main catalyst in the formation of Israel's venture capital sector (VCS) was a government initiative—the "Yozma" program—designed and administered by the OCS and the Ministry of Finance. The program created a $100 million government-owned venture capital fund that made direct investments and supplied funding for ten additional private venture funds whose only guideline was to invest in technological ventures that were Israeli "or Israel related."[118] The program was an outstanding success, and by the mid-2000s Israel's VCS was the largest in the world in relative terms, investing a total of $15.2

Table 1. Summary of Changes to the R&D Law, 1984–2005.

	Crucial Junctions		
	Original Legislation (1984)	First Round of Amendments (1995)	Second Round of Amendments (2001–5)
Domestic manufacture of OCS-supported products	Blanket requirement	General requirement; OCS can authorize transfer of manufacturing in "special cases"; transfer of manufacturing requires payment of increased royalties, up to 300 percent of the original OCS grant	No longer blanket requirement; supported products must be manufactured in Israel in accordance with the share declared in the firm's application; OCS can permit offshoring of manufacturing in excess of the declared share, at its discretion (in such an event, the rate and size of royalties are increased as detailed below)*
Transfer of IP outside Israel	Unconditionally prohibited	Unconditionally prohibited	Prohibited, but OCS can authorize, at its discretion, transfer of IP, subject to payment of a fine calculated according to the formula below†
Key societal actors in support of law/ amendments	MATIMOP (coalition of state, business and labor)	Local electronics manufacturing firms	Local electronics manufacturing firms, organized within the Israeli Association of Electronic Industries
Key societal actors supporting changes to original law		Globally oriented technological firms represented by Manufacturers Association of Israel	Israeli Venture Association, Manufacturers Association of Israel

Source: Author's elaboration of provisions of Israel's R&D Law (1984), Amendment 1 (July 1995), Articles 18 and 19; R&D Law, Amendment 2 (November 2002), Article 19; R&D Law, Amendment 3 (April 2005), Article 19.

*If overseas manufacturing is performed by the company receiving the grant, royalties on sales increase by 1 percent; if manufacturing is performed by another entity, rate of royalties equals the grant amount divided by the firm's total investment in the research project. In addition, the ceiling on royalties (ordinarily 100 percent of grant amount) increases to 120–300 percent, depending on the share of overseas manufacturing. Alternatively, the R&D Law provides a mechanism whereby manufacturing rights may be transferred overseas in return for an exclusive license to manufacture in Israel.

†When IP is transferred overseas as part of a sale of grant recipient itself, recipient will pay the greater of the following: (i) the amount equal to the sales price of the grant recipient multiplied by a fraction whose numerator is the total of OCS grants received by recipient and whose denominator is the total monetary investment in the grant recipient (including OCS grants), after subtracting the amount of "net financial assets"; or (ii) the original OCS grants (with annual interest), subtracting royalties previously paid. Repayment derived from formulae above is reduced in accordance with the following depreciation formula: after three years from completion of the research project, repayment amount is gradually reduced, on a linear basis, over a seven-year period, to a minimum amount equal to the original grant amount plus interest, and after subtracting royalties paid.

billion between 1997 and 2005.[119] As a result, by the early 2000s, the sector amassed significant powers and influence over the industry, as it became the main source of capital for start-ups looking to scale up their operations and commercialize their products. The Israeli Venture Association (IVA), a new organization representing the interests of the budding VCS, led the charge in advocating for the end of the unconditional prohibition on transferring IP.

Why did the VCS oppose those limitations? The answer to this question requires understanding the business model by which venture capital funds normally function. Such funds seek extremely high return on investment (ROI) by investing in and nurturing firms in high-risk sectors such as software, IT, or biotechnology. Yet most venture capital funds function under a rather limited timeline, as they are typically structured as limited partnership funds with set end dates (usually five to seven years). This set time frame for ROI places an upper boundary on the patience of venture funds. Such ROI is incurred through one of two exit routes: either an initial public offering, usually on NASDAQ, or, more commonly, via a merger and acquisition with a large MNC.[120] Therein, however, lies the rub. Since Israel's R&D Law prohibited the transfer of IP, the likelihood of OCS-funded firms' being acquired by an MNC was greatly diminished.

Representatives of the Israeli VCS understood established multinationals would be deterred from acquiring firms whose IP they could not fully control. This fact, they argued, also hindered the ability of start-ups to attract foreign investment in the first place. These concerns were articulated by Chemi Peres, the managing general partner and cofounder of the venture capital fund Pitango. Speaking to the Knesset's Science and Technology Committee, he said,

> The R&D Law is an obstacle for foreign investors, and it hurts start-ups. . . . Any [foreign] firm that learns your company [cannot transfer its IP] will not want to deal with you. The only way to deal with this is to either [alter the law] or cease investing in firms supported by the OCS.[121]

Yoram Oron, then chairman of IVA and the founder and general partner of the Vertex Ventures fund, expressed a similar logic:

> In today's world, it is impossible to stop the transfer of knowledge. What the state of Israel has tried to do all these years by administratively prohibiting the sale of knowledge has caused great economic damage. If a negotiating partner fears that there are these kinds of obstacles—they will pass on the deal.[122]

Although the VCS wanted state-supported start-ups no longer to be constrained by the guidelines of the R&D Law and advocated fiercely against the existing limitation regarding the transfer of IP, they were not in favor of doing away with the R&D Law altogether. Israel's VCS was still dependent on the innovations and technologies developed through the OCS's various funding schemes. As Peres explained,

> Venture funds mostly invest at the stage where we can help firms become profitable. We do not want to bother too much with the development of the technology. There we cannot bring our investors the yield in the timeframe they expect it. We want to invest when a company already has a product and is about to penetrate the market.[123]

In other words, the VCS wanted the state to keep subsidizing high-risk R&D but to refrain from intervening in the later stages of commercialization.

It is interesting that for the first-time state managers also shifted their view on the issue. Largely representative was the support the proposed changes received from Ehud Olmert—then the minister of trade and industry and future prime minister. Olmert favored replacing the outright ban on the transfer of IP with a much more flexible clause and said so publicly on numerous occasions.[124] The logic behind his position was that amending the law was necessary to make Israeli start-ups and firms in need of scale-up funds more attractive to foreign investors, particularly foreign MNCs. In a speech to the Knesset introducing the proposed changes, Olmert outlined this position:

> Our desire is to attract foreign investment, which in the realm of R&D is usually made by large multinationals . . . and when they invest in a certain product, they obviously want to have as much flexibility as possible. . . . In all my meetings with business communities abroad, this is almost the only question I am asked, and when I say we intend to change the [R&D] law it usually encourages international firms to enter negotiations with Israeli companies. . . . I must admit that many large high-tech firms have encouraged us to take this route and, of course so have the venture capital funds.[125]

This change in the state's position toward the transfer of knowledge was no doubt influenced by the government's broader economic agenda in this period. Indeed, it was in these years when, on being appointed minister of finance, Benjamin Netanyahu shifted the government's liberalization reforms into high gear. The reforms included, among other things, budget cuts, privatization of government-owned companies, a decrease in public sector employment, financial liberalization, and implementation of "welfare-to-work" policies.[126] It is not surprising, therefore, that Netanyahu was himself an enthusiastic supporter of suggested reforms to Israel's R&D Law that were consistent with his larger liberalization program.[127]

Although the government largely sided with the position of the VCS, some policymakers worried that implementing the proposed changes would negatively affect Israel's high-tech sector. As one member of Knesset, Chemi Doron, remarked when the proposed legislation changes were being discussed,

> [Israel] has an advantage in R&D, but according to [the changes] being discussed here, we risk being turned into a research lab. Everyone will come and exploit our human capital to carry out research, but the manufacturing and the jobs will go to . . . places like Thailand, China, and others.[128]

As we will see in the final section, such concerns were not unwarranted.

Attempts to reform the law in this direction were also met with organized opposition from within the high-tech industry. This was led by the Israeli Association of Electronic Industries (IAEI), an organization representing the interests of fifty domestic manufacturing facilities that carried out most of the electronic manufacturing for the high-tech sector. Together, such firms directly employed 10,000 workers in the field of electronic manufacturing and supported another 20,000–50,000 workers

employed in complementary industries such as packaging, logistics, transportation, and services. The businesses this organization represented had an obvious stake in maintaining the existing restrictions. As in the previous round of debates, the logic of their position was that because the R&D of these high-tech firms was publicly financed in the goal of national economic development, they were obligated to continue operating locally. Testifying on behalf of these interests in the Finance Committee was the coordinator of the IAEI, Hanan Caspi, who explained,

> We are not ignoring the fact we operate in a global market. . . . Yet we say something simple: if this knowledge was created using taxpayer money, then it cannot go abroad. . . . The state invests in R&D and subsidizes Israeli firms . . . so that we can have R&D and production in Israel.[129]

The outcome of these debates was once again mixed, but it ultimately leaned in favor of the VCS. Trying to negotiate these conflicting interests, the chief scientist, with the help of the Finance Committee, proposed a compromise. On the one hand, more leeway would be provided to R&D firms, as the transfer of IP would no longer be prohibited outright. On the other hand, such transfer would require the approval of the OCS and require payment of a significant fine. As Carmel Vernia, then chief scientist, argued,

> We . . . are not interested in promoting the transfer of knowledge overseas. Our interest is that it remains in Israel. Yet we also do not want to completely tie the hands of industry. There are situations where there is no alternative and it is more logical to transfer abroad.[130]

Although the VCS accepted this compromise, it strongly opposed the formula the OCS originally proposed for calculating the fine to be imposed on firms wishing to transfer their IP. It called for an amount equal to the price offered for the IP, multiplied by a ratio that would correspond to the share of the government's original investment in the firm's R&D (for details see Table 1). The state had historically refrained from demanding an ownership stake in the firms it funded; this formula represented a shift in that approach, but only in cases where firms pursued an exit strategy. As Myron HaCohen, MOTI's legal counsel, explained, according to the changes,

> the state's equity [in the firms] will be dormant. It will manifest itself only if knowledge is transferred. As an investor, you always have the option to continue operating in Israel. If you do that, [the state] does not take part in profit-sharing.[131]

What concerned the VCS was that according to this method the cost of transferring IP would be based on its value at the time of sale. The fine not only would be rather significant but, more important, would remain unknown to investors until that point. What the VCS advocated instead was setting a predefined cap on any potential future fine, regardless of the final price of sale. That arrangement would keep the fine

relatively low; further, the fine would be known at the point of investment (rather than point of sale). Articulating this position in the committee debates was none other than Yigal Erlich, former chief scientist, now speaking on behalf of the VCS he had helped develop:

> This change is intended to deter firms from transferring knowledge because they will have to pay a large fee. . . . But a new startup does not know what its fate will be. . . . When [the future fine] is unclear at the outset . . . it could be that investors will be deterred from investing.[132]

The opposition to the proposed formula on the part of the VCS was so strong that these amendments took more than five years to legislate.[133] However, in 2005 the two sides finally agreed on the OCS's proposal after it offered to incorporate a depreciation mechanism that caused the fine imposed on firms to decrease over time. The logic behind this method was to reflect the loss in value of the innovative technology. Firms that wished to transfer their IP only a few years removed from the development of technology would be forced to pay a much larger fine than firms that waited a decade to do so, at which point the fee would diminish significantly. That idea helped bring the two sides together, and in April 2005 the changes were finally enacted. Although the historical ban on the transfer of knowledge was lifted, the agreed formula often resulted in a significant fine that worked, at least in some cases, to discourage firms from transferring their IP.[134] In 2012 the R&D Law was once more amended in favor of the VCS. For the first time the VCS's original demand to set a predetermined cap on the fine was adopted. From that point onward, firms that wished to transfer their IP were requested to pay 300–600 percent of the R&D grants they received, irrespective of the price of sale. Firms that committed to preserving the IP listed in Israel and maintain local R&D operations for at least three more years were charged at the lower end of this range (300 percent), whereas firms that wanted complete freedom regarding the future transfer of IP were charged at the higher end (600 percent).[135]

Assessing the Impact of Israel's Innovation Policy Reforms

Reforming the R&D Law in the manner described above not only marked a fundamental transformation of Israel's R&D policy but also had a decisive impact on developmental outcomes. Although assessing those outcomes in full is beyond the scope of this article, a few noteworthy points illuminate how the scaling back of R&D conditions resulted in significantly fewer social rewards.

One notable trend that began in 2005 was an increase in the rate of foreign investment in Israel's R&D, from 29 percent of all business R&D in 2005 to 49.2 percent in 2017. That figure represents the highest rate among all OECD members, strikingly higher than in comparable economies such as Ireland (18.6 percent), Sweden (7 percent), or Singapore (5.8 percent).[136] Much of the increase in foreign investment results from the presence of foreign MNCs, currently over 370 and growing. Although MNCs

were always a part of Israel's ecosystem, their rate of growth has skyrocketed. Between 1989 and 2004, multinationals opened R&D centers at the average of 3.6 per year. Starting in 2004, however, this rate grew exponentially to an average of 19.5 per year.[137] More research is needed to demonstrate a causal link between the scaling back of the R&D Law conditions and the stark increase in the presence of foreign MNCs, but the historical timing demonstrates a clear association between the two. Lending further support to this view is the fact that since 2014 almost 70 percent of the 117 R&D subsidiaries opened by MNCs were the result of the acquisition and conversion of Israeli start-ups—the exact process the former IP restrictions aimed to curtail.[138]

Why is the dominance of foreign R&D centers a problem for development? The central weakness of the existing model is that foreign MNCs that operate in Israel do not generate the positive spillovers that homegrown businesses do. One example is in the realm of job creation. When a growing local company turns into a research-based subsidiary of a foreign corporation, potential good jobs are lost. To highlight just one illuminating statistic: for each employee of an Israeli high-tech manufacturer, two more local jobs are created. For each R&D center employee, on the other hand, only one-third of another job is created.[139] As a result, more jobs are created in countries where weaker labor market and environmental regulations allow firms to pay lower wages, disregard workers' safety, and damage the environment. Because job growth in multinational R&D centers has been far more rapid than in local high-tech firms—a staggering 16 percent annual growth between 2004 and 2011 in the former compared to only 1 percent growth in the latter—the negative impact on the creation of additional jobs has been tremendous. Overall, although the number of people employed in high-tech has been growing steadily in absolute terms, their percentage share in the labor force since the mid-2000s has decreased or stagnated.[140] Considering the substantial increase of invested capital in the Israeli tech sector during this period, this trend highlights the lack of additional job creation outside of high-end R&D.

The rapid growth of foreign-owned R&D centers has also negatively affected potential IP revenues and tax revenue that independent local firms might have generated. One telling statistic in this regard is local versus foreign ownership of patents. The percentage of Israeli patents granted by the US Patent and Trademark Office that were owned by non-Israeli firms rose from 27 percent in 1990 to 52 percent in 2010. As one report on the topic concluded, this increase in foreign ownership of the fruits of Israel's knowledge is a direct result of the increased activities of foreign-owned companies in Israel in general and foreign R&D centers specifically.[141] Researchers will have to explore how these changes affect the future development of Israel's tech sector, but it is clear that subsidies without conditions negatively affected the state's ability to ensure that the economic rewards of innovation would not remain in private hands but, rather, be shared generally.

Conclusion

A wave of new literature on innovation-led growth has shown that states continue to play a prominent role in promoting economic transformation. Far from simply

facilitating or solving market failures, states set the direction of economic change, subsidize risky investment in R&D, invest in technological infrastructure and human capital, and coordinate between various private and public actors. However, even if state promotion fosters innovation, it does not automatically produce broad-based development. For that to occur, it is vital that the rewards of innovation be widely distributed. In this article, I argued that achieving such a goal requires specific institutional mechanisms that enable states to condition state assistance on domestic commercialization and to discipline firms that breach those stipulations. I also argued that implementing such mechanisms requires the political support of a broad social coalition committed to the state's upgrading agenda. I then illustrated these claims using the historical case study of Israel's transition from a traditional to a knowledge-based economy.

In the account offered here, the success of Israel's innovation policies was the achievement not of a uniquely powerful state but of a state with skillful policymaking capacities, whose innovation policies were supported by a broad upgrading coalition. How can we account for the existence of these two crucial factors? It is interesting that both have roots in the original industrialization campaign that took place in the decades following Israel's independence in 1948. Much as in postwar Korea, Taiwan, or Japan, Israel's industry was first established through "catch-up" industrial policies guided by a developmental state. As I and others have shown elsewhere, industrial planning in that period was effective in large part because of the robust policymaking capacities nurtured within Israel's leading developmental agency—MOTI.[142] In that regard, policymakers in their efforts to advance Israel's innovation economy not only established new agencies and policy instruments but also drew on the institutional legacies forged during Israel's first industrialization. Thus they were able to redeploy existing institutions in an original configuration that was more suited for the challenges of innovation-led development.

The upgrading coalition that supported MOTI's innovation-led strategy also emerged out of that earlier historical period. It included members of both private industries and those owned by the national trade union (Histadrut) as well as financial interests responsible for channeling investment capital. The fact that large business groups originating in Israel's first developmental era remained a central coalition partner in its push to become an innovation-based economy is not surprising.[143] Indeed, that has been the norm elsewhere; Korea, for example, included the chaebols as senior partners in its recent attempts to transform from fast follower to a leading innovator.[144] More surprising, and in many ways counter to leading theories of innovation, is the fact that labor also remained an influential partner in this more recent development coalition.[145] Yet the finding that powerful industrial unions were instrumental in the transition to high tech is not unique to Israel. In fact, organized labor has played a key role in the development of other innovation-led economies, such as Finland, Denmark, and Sweden.[146]

The discussion above in no way diminishes the importance of the institutional and political processes analyzed in this article. After all, the OCS and its numerous innovation policies did not exist before the mid-1970s. The same is true of political

organizations such as MATIMOP or the IVA. What it does suggest is that the conditions that allow these institutions to produce the desired developmental outcomes have links to the state's previous developmental experience. Although the literature on state-led development has tended to distinguish between different developmental eras and regimes, future studies will benefit from considering the ways in which the two are linked: in other words, how contemporary developmental efforts are affected by the nation's developmental past.

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65. Ibid., 430; Breznitz, "Industrial R&D as a National Policy"; Morris Teubal, "A Catalytic and Evolutionary Approach to Horizontal Technology Policies (HTPs)," *Research Policy* 25, no. 8 (1997): 1161–88.
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69. Meeting 507 of the Knesset Finance Committee, May 30, 1995. Unless otherwise indicated, Knesset documents are from the Israel Knesset Archives, Jerusalem.
70. "MOTI Director General Circular Regarding: The Technological Incubators Program," September 8, 1994, ISA/GAL/20594.8. Verified in author's interviews with Yossi Smoler, November 2018, and Ilan Peled, November 2018. The one OCS program excluded from the domestic manufacturing and IP requirements of the R&D Law was the Binational Industrial R&D (BIRD) Foundation, largely because of the nature of the program that funded R&D collaborations between Israeli and American firms.
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73. "Template of OCS R&D Agreement, Article 4, October 26, 1983, ISA/GAL/2273/7, 4. Verified in author's interview with Lydia Lazanes, May 2018.
74. R&D Law, Article 45(C2-4). Author's interviews with Yigal Erlich, February 2018; Shuki Gleitman, April 2018, and Orna Berry, May 2018, helped verify that such enforcement was indeed carried out when warranted.
75. R&D Law, Amendment 1 (1995), Article 16.
76. Author's interviews with Yigal Erlich, February 2018, and Ilan Peled, November 2018. Also see Erlich, *Yozma: Courage, Innovation*, 82. This method of discipline became an official part of the R&D Law only in 2002 but was implemented as early as the mid-1980s. See R&D Law, Amendment 2, Article 45(b).
77. "Letter from Chief Scientist Gleitman to Directors of the Investment Center and the Marketing Fund," March 26, 1995, ISA/GAL/20594.8.
78. Author's interviews with Yigal Erlich, February 2018, and Shuki Gleitman, April 2018.
79. Navit Zomer, "Shuki Development," *Yedioth Ahronoth* (October 18, 1994).
80. Navit Zomer, "The Chief Scientist Suspects TelRad Violated the R&D Law," *Yedioth Ahronoth* (March 6, 1995).
81. Navit Zomer, "The Chief Scientist Demands Payment of 100 Million NIS in Royalties from ECI," *Yedioth Ahronoth* (July 29, 2001).

82. Testimony of Hannan Caspi of the Israeli Association of Electronic Industries, Minutes of meeting no. 7 of the Knesset's Scientific and Technological R&D Committee, May 20, 2003. For more, see Daniel J. Isenberg, "Given Imaging Ltd.—First We Take Manhattan, Then We Take Berlin?," Case 9-808-033 (Cambridge, MA: Harvard Business Publishing, July 25, 2009).
83. This northern town was included in one of Israel's areas of national promotion where additional economic incentives were provided under the Law for the Encouragement of Investment.
84. Avi Shmul, "Given Imaging Is Erecting a New Plant for the Production of Video Capsules in Yokneam," *Ha'aretz* (November 15, 2001).
85. Author's interview with Rina Pridor, January 2018.
86. Breznitz, "Industrial R&D as a National Policy, 1468.
87. Yehoshua Porat, "A World Leading Microprocessor Manufacturing Facility Will Be Erected in Migdal Ha'emek," *Ma'ariv* (May 15, 1983); Tamar Guy, "Migdal Silicon Valley," *Ma'ariv* (October 3, 1986). This fabrication facility is still active, currently owned by TowerJazz (formally Tower Semiconductors).
88. Author's interviews with Yigal Erlich, February 2018; Elisha Yanay, February 2018; and Rami Guzman, May 2018.
89. Testimony by Rami Guzman in the Knesset Sub-Committee on Scientific R&D and High-Tech, protocol no. 3882, November 16, 2001. Confirmed in author's interview with Rami Guzman, May 2018.
90. Breznitz, *Innovation and the State*, 60. Unlike other similar-size economies, MNCs played a limited role in the development of Israel's high-tech sector. In 1987, foreign direct investment was estimated at an annual average of 1–1.5 percent of all industrial investment. Similarly, employment generated by MNCs was estimated at 1 percent of total employment. See Daniel Felsenstein, "The Making of a High Technology Node: Foreign-Owned Companies in Israeli High Technology," *Regional Studies* 31, no. 4 (1997): 371–72.
91. Saul Lach, "Do R&D Subsidies Stimulate or Displace Private R&D? Evidence from Israel," *Journal of Industrial Economics* 50, no. 4 (2002): 375–76.
92. Saul Lach, Daniel Wasserteil, and Shlomi Parizat, *The Impact of Government Industrial R&D on the Israeli Economy* (Tel Aviv: EGP Applied Economics Inc., 2008), 39–40.
93. Author's interviews with Yigal Erlich, February 2018, and Ed Mlavsky, March 2018.
94. Author's interview with Rina Pridor, January 2018.
95. "MATIMOP Members of the Board of Directors," n.d. (likely from 1976 or 1977), ISA/N/217/2.
96. Doner and Schneider, "The Middle-Income Trap," 12.
97. MATIMOP Charter and Guidelines, n.d. (likely from 1976 or 1977), ISA/N/217/2.
98. "Letter from Chief Scientist, Arie Lavie, to Minister of Trade and Industry, Gideon Patt," July 27, 1980, ISA/GAL/2189/10.
99. MATIMOP Board of Directors, Meeting Minutes, June 18, 1980, ISA/2189/10; MATIMOP: Summary of activities since the second meeting of national developers, January 16, 1979, ISA/GAL/2162/1.
100. "Chief Scientists in Civilian Government Ministries—Notes for Debate," November 2, 1983, ISA/GAL/21766.7. Verified in author's interview with Yigal Erlich, February 2018.
101. "Letter to Minister Gideon Patt from the Subcommittee of the Technological Council," May 3, 1981, ISA/GAL/2273/7. Verified in interview with Dan Tolkowsky, February 2018.

102. "Letter to Minister Patt from Subcommittee of the Technological Council," May 3, 1981, ISA/GAL/2273/7.
103. MATIMOP: Summary of activities since the second meeting of national developers.
104. "Comments by Israel's Industrial Employer Organizations on the draft of the R&D Law Proposal," October 8, 1982, ISA/GAL/2189/5.
105. Meeting 137 of the Knesset Economics Committee, July 11, 1983, ISA/K/269/11; Meeting 147 of the Knesset Economics Committee, November 14, 1983, ISA/K/274/1; Meeting 163 of the Knesset Economics Committee, January 1, 1984, ISA/K/274/2.
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107. Gary Gereffi, "The Global Economy: Organization, Governance, and Development," in N.J. Smelser and R. Swedberg, eds., *The Handbook of Economic Sociology* (Princeton, NJ: Princeton University Press and Russell Sage Foundation, 2005), 166–68. For a recent attempt to bridge the literature on "global value chains" and state-led development, see Jostein Hauge, "Industrial Policy in the Era of Global Value Chains: Towards a Developmentalist Framework Drawing on the Industrialisation Experiences of South Korea and Taiwan," *World Economy* (2020), https://doi.org/10.1111/twec.12922.
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112. Chibber, "Building a Developmental State," 312.
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115. Ibid.
116. R&D Law, Amendment 1 (1995), Article 19, Article 2.4.
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122. Minutes of Meeting no. 122 of the Knesset's Science and Technology Committee, March 15, 2005. Verified in interview with Yoram Oron, July 2018.
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130. Ibid.
131. Minutes of Meeting no. 1 of the Joint Finance and Science and Technology Committee on the R&D Law, November 15, 2001.
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Author Biography

Erez Maggor (erez.maggor@nyu.edu) is a PhD candidate at the Department of Sociology at New York University. His research interests include political economy, sociology of development, innovation policy, and comparative-historical sociology. His work has appeared in *Socio-Economic Review* and *Israeli Sociology*.