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Severing the Innovation-Inequality Link: Distribution Sensitive Science, Technology and Innovation Policies in Developed Nations

Abstract: Innovation is essential to economic growth. However, it appears that the ways in which we pursue innovation *policies* have aggravated inequality. Inequality is an increasingly contentious political issue in both wealthy and emerging economies. Yet, it is becoming clear that use of traditional state instruments to alleviate inequality by redistributive means, is no longer sufficient. For those reasons, in this paper we consider other state instruments that are rarely associated with distributive goals. Specifically, we inquire whether we can successfully devise and employ Distributive-Sensitive Science and Technology and Innovation Policies focused on disadvantaged groups of users and consumers of technology. Following an exploratory theoretical approach, the paper first develop four types of such programs, and then utilize a comparative approach to analyze existing programs that fit into these categories, first, in Israel, and then, in the United State, Germany, and Sweden. We conclude by arguing that although these programs are currently driven primarily by economic efficiency concerns and not by distributive ones, they show the promise of our approach of utilizing innovation policy to reach social policy goals.

Acknowledgments: the authors would like to thank Robert H. Cox, David Art, Mark Zachary Taylor, Petri Rouvinen, Michael Piore, Matthew J. Higgins, Marie Thursby, Henry Sauermann, and Julia Lane for detailed remarks on numerous versions of this paper. We would also like to thank Erica Juergensen, Shira Bergman, Noam Galili, Noa Gani and Adi Meiri for superb research assistant that went far being the call of duty. This research was supported by a gift from the Canadian Friends of Tel Aviv University, and a grant from the United States-Israel Binational Science Foundation (BSF grant # 2008305), Jerusalem, Israel, we are also extremely grateful for the generous intellectual and financial support of the Kauffman Foundation. The views presented in this paper are solely those of the authors, and so are all the mistakes

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Introduction

Inequality is an increasingly contentious political issue in both wealthy and emerging economies, and is becoming a defining area of socio-political-economic contention. Yet even when the political will exists – certainly not a given – it is becoming clear that use of traditional state instruments, primarily taxation and the welfare state, faces certain political and economic limits (Pierson 2001, Steinmo 2002). For this reason, it is important to consider other state instruments that are rarely associated with distributive goals.

Policies that contribute to growth are seen as an unquestionable good. Innovation is essential to economic growth. However, it appears that the ways in which we pursue innovation *policies* have aggravated inequality, whether through the mechanism of Skill Based Technological Change (SBTC), the crowding-out of workers by new technology, or through enabling greater global fragmentation of production. Indeed some, we argue mistakenly, see an inherent link between innovation and inequality, instead of asking whether there are different ways to excel in innovation that might induce more equality.

Accordingly in this article, we ask *whether and how Science and Technology and Innovation policies could be successfully employed as a social policy instrument that would help reduce inequality and specifically support economically disadvantaged groups.*[1] More specifically, we explore what policy programs are likely to achieve this goal and which disadvantaged groups do they benefit. In addition, we also study the motivational and political underpinnings of such policies.

This paper is consciously explorative, and our scope is modest. We aim to show that theoretically there are at least four ways in which Distribution Sensitive S&T and Innovation

[1] S&T and innovation policy, as we use the term here, is government policy primarily aimed at inducing domestic technological innovation (R&D), facilitation of domestic and local absorption of new technologies, and increasing the size and improving the quality of the S&T labor force.

Policies (hereafter DSSTIP) can induce equality. The list we develop is certainly not exhaustive. Nonetheless, it suffices to demonstrate the merit of this endeavor and draw some basic theoretical principles, around which a public debate could prosper. Accordingly, after our theoretical exploration, we take a case study approach. First, we examine different examples of DSSTIPs in a single country– Israel – that is widely considered a current leader in innovation as well as the prime case of how success in innovation leads to rapid growth of severe inequality. Then we demonstrate the generalizability of our finding by a more limited study of three countries that were selected to maximize the generalizability of our findings within the OECD: the United States, Germany, and Sweden. In all three S&T and innovation policies plays a significant role in economic growth, but they have widely divergent levels of inequality and economic exclusion, as well as significant difference in views with respect to the role state intervention should play in the economy.

The main objective of this article is to focus attention on the social role that growth-creation policies could play in addressing economic disadvantage, and to introduce what we believe to be a potentially important example of this in DSSTIP. In similar vein, we call for a change of thinking away from a narrow redistributive welfare state paradigm, into a distributive sensitive *welfare regime*.[2]

In this paper we utilize an approach that focuses on how different innovation policies affect specific disadvantaged groups either as producers or as consumers of technology. The producer-consumer distinction, we believe, is fundamental to understanding the distributive impact of technology, and is implicitly used by all scholars who analyze the issues of SBTC, globalization, and the financing of innovation. Using this approach we contend that there are at least four types

[2] Esping-Andersen defines a welfare regime "as the combined interdependent way in which welfare is produced and allocated between state, market and family." This definition allows for a broader focus on welfare and distribution than captured by the narrower term of the 'welfare state' (Esping-Andersen 1999).

of DSSTIP programs that could reduce inequalities and specifically better the lot of disadvantaged groups. Moreover, as we show in the empirical section, there are numerous real world examples of such programs across the developed world. Nevertheless, the distributive rationale for these programs is often not acknowledged and, relatedly, we lack information about their scope, modes of operation, and effect.

In what follows, we first explain how innovation and S&T policies, on the one hand, and inequality and economic disadvantage, on the other, are connected. We then theoretically discuss four different types of DSSTIP: support for traditional industries, geographical-economic periphery, ascriptive minorities (that is groups a person belongs to by birth, such as women or ethnic), and the disabled. To illustrate the motivation for establishing such programs and their operation, we turn to a review of such DSSTIP programs in Israel before briefly discussing Sweden, Germany and the US. We also present some evidence of the success of these programs. However, given the fact that governments do not systematically gather data concerning the distributive aspects of these programs – something we view as a major policy problem –this evidence is employed to suggest the distributive promise of the programs, and in no way should be construed as an attempt at policy evaluation.

Innovation, Inequality, Welfare Regimes and DSSTIP

Economic research on the effects of innovation uncovers a troubling state of affairs. Although for developed economies technological innovation has become the main source of sustained economic growth, it also tends to increase income inequalities. First, SBTC has widened the economic gap between highly-skilled and less-skilled workers (Krueger 1993, Acemoglu 2002, Hornstein and Krusell 2003, He and Liu 2008).Innovation, it is argued, increases the productivity of high-skilled workers considerably more than workers that possess a

more limited skill set, and this explains the rising wage gap between the technology haves and have-nots. Application of new industrial R&D and its related innovations contribute to growing inequality. Conversely, as noted in recent work, accelerated technological innovation also worsens the lot of many types of workers as certain occupations are rendered irrelevant by new technology that substitutes human labor (Brynjolfsson and McAfee 2012). Finally, the growing global fragmentation of production – made possible through innovations in information and communication technologies (ICT) and transportation – aggravates in-country inequality by enabling the reorganization of production and the transfer of increasing numbers of jobs away from the centers of R&D, into lower-wage regions (Gereffi, Humphrey et al. 2005, Breznitz 2007, Breznitz and Murphree 2011).[3] Thus, new technologies have been weakening the *localized* economic benefits, specifically the creation of new quality jobs for mid and low-skilled workers, which used to occur within the close spatial proximity of innovation centers. Global fragmentation of production has significantly decreased the "all boats rising" in-country economic impacts of novel-product innovation.

The standard response to inequality is unrelated to S&T and Innovation policy, instead it aims at redistribution by making taxes more progressive then they currently are and increase welfare effort to support the economically disadvantaged and socially excluded. These responses are vital but researchers in the social policy field often recognize the political and economic limits to increasing taxation rates and growing the welfare state. High marginal tax rates can hamper economic growth in different ways and, perhaps even more importantly, powerful

[3] A recent approach applied to the relationship between innovation and inequality is related to the financialization theory. Focusing on financial markets and regulation it tracks the changes financial deregulation brought to the distribution of risk and rewards associated with innovation. While not part of the focus of this proposed research, financial regulations have had significant impact on the distributions of wealth (Lazonick and Mazzucato 2013, Lazonick 2014).

interests mobilize effective opposition to such redistributive measures (Pierson 2001, Steinmo 2002).

Accordingly, we argue, governments that wish to reduce inequality should also adopt measures that directly affect the market's allocation of incomes in addition to post-market redistribution.[4] In this paper, we concentrate on one such measure: DSSTIP. Given the critical role that technological innovation plays in economic growth and in increasing economic inequality, it stands to reason that S&T and Innovation *policy* could be employed to influence inequality. Admittedly, S&T and Innovation policy is almost exclusively geared towards the overarching goals of increasing domestic firms' international competitiveness and economic growth as well as enhancing national security, but this does not mean that what is usually perceived as an economic and security policy could not be employed as a *social policy* as well. Indeed, we argue that S&T and innovation policy can and should be viewed as a component of the *welfare regime.*

Critically, however, the distributive aspects of S&T and Innovation *policy* receive precious little attention. Currently, only a small body of work has emerged that speaks to the distributive aspects of innovation and policies (Cozzens, Bobb et al. 2002, Oughton, Landabaso et al. 2002, Cozzens, Bobb et al. 2005, Woodhouse and Sarewitz 2007, Bozeman, Slade et al. 2011, Cozzens and Thakur 2014) This literature argues that the inequality arising from innovation is to a great degree the result of S&T policy. This literature affirms that innovation is good, but policies formulated without concern for distributive outcomes can enhance inequality. For example, public medical R&D funding in developed countries is rarely invested in 'poor people's diseases' such as malaria, but tilted towards high-end medical technology targeted for diseases common

[4] Education seems to be the one area in which such arguments have gain credence, however, one should be cautious not to overemphasize what schools can do and underestimate barriers other than formal education to economic advancement (Jencks 1979, Labaree 2012)

among wealthy patients such as heart disease (Bozeman et al., 2011). Existing works also set out to establish a conceptual framework by which innovation policy and equity could be evaluated. Cozzens and Thakur call attention to the types of jobs stimulated by different innovation policy packages: some are likely to increase inequality by creating only skilled, high-end jobs, others create more inclusive employment opportunities that could also benefit low to mid-skilled workers (Cozzens and Thakur 2014). This literature contributes by focusing attention on the 'equity' deficit in innovation policy and outlining mechanisms through which innovation policy is associated with distribution. Nevertheless, the literature suffers from some deficits.

First, the existing work on the relationship between innovation policy and distribution is mostly focused on studies of the U.S., despite the fact that extrapolation from the U.S. experience to other countries is problematic at best. Second, the literature presents little more than a *rudimentary outline of the distributive aspects* of innovation policies. Lastly, these publications, important as they are, did not systematically present and discuss different types of DSSTIP. Moreover, discussions of DSSTIP tend to be highly abstract with relatively little reliance on investigation of actual programs: investigations that could shed light not only on the potential impact of such programs, but also on the motivation for their establishment, their operation, political context, and actual impact. In what follows, we aim to close this important gap.

Theory Development: Four DSSTIP Programs

We propose that a fruitful approach to show the validity of DSSTIP would be to focus on how different innovation policies affect a particular set of target groups either as producers or as consumers of technology. The producer-consumer distinction, we believe, is fundamental to understanding the distributive impact of technology. Producers of technology are those who carry out research work or implement technologies to improve their output. Consumers of technology

are those who utilize the goods or services produced as a result of S&T and Innovation policy. For instance, on the producers' side, by enabling production activities to move overseas, manufacturing jobs for new products tend to be generated abroad from the start. Consequently, while profits accrue to the innovator, the societal broad-based benefits through job creation no longer occur in the same locale. On the consumer side, research products could have a differential effect on the economic status and quality of life for different income groups. Research on more cost-effective public transportation, for example, would disproportionally benefit individuals who cannot afford private means of transportation.

Using this novel producer-consumer approach, on the producers side we pay special attention to the effects of policy on three target groups: low-skilled workers, disadvantaged ascriptive groups, and individuals from disadvantaged regions within countries. On the consumer side, there are many different groupings of disadvantaged individuals that could benefit from the development of specific technological products, but we especially concentrate on the disabled due to their relatively high share (10-20%) in the adult population (WHO 2011. Table 2.1.: Disability Prevalence Rates.) In general, we argue that addressing economic hardship in these four target groups through DSSTIP would involve the following four program types.

First, policy could support technological innovation in directions that would create productivity gains for less-skilled workers. Productivity gains, in turn, lead to higher incomes. This is also important since given global competition from developing countries, the only way for developed countries, with relatively high labor costs, to retain workplaces for low and medium skilled employees is to lead the pack through innovation. Government programs that focus on support of innovation in industries with a high share of low- and medium-skilled workers, should, therefore, have significant positive outcomes in terms of overall economic equality. Traditional

industries tend to have a high share of low- to medium-skilled workers and are therefore plausible targets for government support intended to upgrade their innovative capacities.

Second, there are considerable inequalities between regions within a single country and these are largely determined by differences in technological development. Hence, governments that care about reducing inequality should reduce the inter-regional technological divide. Government programs could accordingly concentrate on supporting innovation in relatively disadvantaged regions of the country assuming that they are indeed technologically backward.

Third, economically disadvantaged ascriptive groups are severely underrepresented in S&T occupations and high-tech industries: occupations and industries that tend to be high income. DSSTIP, in this context, would seek ways to increase the share of ascriptive groups in technology-intensive industries either as workers or entrepreneurs. Such action, it is hoped, would not only directly advance those involved, but will also create important spillover effects for other members of the group.

Finally, all of the above groups, and numerous others, could be the target of DSSTIPs intended to improve their lot as consumers. In some cases, such innovations would involve a monetary gain. For example, the production of less expensive vision aids for the near blind. In other cases, new technological products might lead to non-monetary utility gains (e.g., development of musical instruments for the use of the physically disabled). In this paper we specifically focused on the disabled.

While the main emphasis in this study is on understanding the substantive form that DSSTIP take, we also seek to understand the factors that shape such programs. The limited literature on this topic suggests that DSSTIP is not a concern for policymakers, at least in the U.S, which is often the only country discussed in these works. If this is indeed the case, then we should expect to find few examples of DSSTIP. Even programs that could be described as

DSSTIP are expected to be established for non-distribution related reasons. At the extreme, policymakers are unlikely to see the distributive aspects of these programs as a valid metric of their success, because they refuse to relate innovation policies to social policy goals.

DSSTIPs in Practice? An Exploratory Case Study

In this section, we illustrate how DSSTIPs can be employed to address inequality alongside more traditional policy instruments. We then discuss motivation and limitations to such policies by comprehensively analyzing one case study – Israel – before complementing our analysis with brief examples from the U.S., Germany, and Sweden, which were chosen in order to maximize the generalizability of our finding with OECD countries.

A series of successful innovation policies helped Israel transform from one of the lowest R&D intensity in the Western world in the 1970s to a world-leader in R&D intensity with an economy highly dependent on new product-based ICT (Avnimelech and Teubal 2006, Breznitz 2007). More alarmingly is that fact that concurrently Israel moved from being the second most egalitarian western society, to the second most unequal. Currently one of five Israeli households falls beneath the OECD-defined poverty rate (Brandolini and Smeeding 2008, OECD 2013). Furthermore, certain demographics were markedly left behind by this growth: most notably the Israeli Arab community, which suffers from social exclusion and economic marginalization (Reiter 2009).

S&T and innovation also plays an important role in Sweden, Germany, and the United States, all of which together with Israel are in the top eight in the world in terms of R&D intensity. Indeed, since World War II, there has not been one new technology that became the basis for new industries that did not originate from the U.S. (Weiss 2014). Germany, with its network of Fraunhofer Institutes is now widely viewed as a global leader in industrial R&D, and

Sweden has the third highest R&D intensity, but unlike Israel, stands as a paragon of egalitarian society. The three countries have varying degrees of economic inequality and economic exclusion, and represent different paradigms of state intervention in the economy. However, they all face issues of minorities' exclusion and political concerns about growing inequality.

In order to describe the DSSTIP programs, understand the environment in which they were established and operate, and assess their success and limitations, we employed a range of qualitative methods. We analyzed government documents, followed newspaper coverage, and made extensive use of semi-structured interviews. Document analysis traced back program evolution since 2000 (i.e., fourteen years), although in some cases the period investigated was slightly longer. The interviews were conducted with policymakers (politicians and bureaucrats), program leaders, different stakeholders, members of target groups that participated in the different programs, and policy experts from academia. In total we conducted seventy-two interviews in the period 2010-15, of which forty four were in Israel, eleven in the U.S., nine in Sweden, and eight in Germany. The interviews and document research provided three solid secondary case studies that were then compared to the Israeli case and to each other.

Supporting R&D in traditional industries

Traditional industries face challenges across the developed world; not least competition from relatively low labor cost countries. In Israeli such competitive pressures led major traditional industries, most prominently the textile industry, to decline considerably. In the 1990s, this contraction process was overshadowed by a positive development in the Israeli economy: the rapid growth of the Israeli high technology sector.

However, while Israel enjoyed its rapid high-tech growth, the productivity figures for the rest of the business sector were either stagnant or negative (Trajtenberg 2000, Trajtenberg

2005).In the early 2000s senior economists together with officials at the Office of the Chief Scientist in the Ministry of the Economy (hereafter OCS), Israel's main innovation policy agency, started to fear that current policies are creating over-reliance on one economic sector – ICT. The danger of over-reliance on the high technology industry was made clear in the dot.com crisis of 2000s (Authors' Interviews). As a way to correct this imbalance, discussions within the OCS were initiated to generate ideas to enhance innovation and R&D in the traditional industries.

In 2005, a new fund earmarked for the support of R&D in the traditional industries was established within the OCS. The motivation, as was described to us in several interviews, and later articulated in a public committee report, was macroeconomic stability and growth: Israeli industry was in urgent need of diversification and R&D support for the traditional industries was critical in this regard (Committee 2007). The problem was conceived as one of economic inefficiency, *not* inequality. Although the traditional industries still accounted for 60 percent of all industrial employment, the overall trend of decline was clear. The 2007 Makov committee appointed to investigate the state of the traditional industries found that worker productivity in the Israeli traditional industries was more than forty percent lower than in the U.S. or Europe – a much worse ratio than in more technology intensive industries – and that the main reason for this was comparatively very low Israeli investment in R&D in these industries (Committee 2007). As a result of the committee's recommendation the budget of the fund for traditional industries increased threefold from 71 to 236 million shekels between 2006 to 2010 (dropping to 184 million shekel in 2011) (Office of the Chief Scientist 2012). In addition, the OCS subsidizes 200 consulting hours per company, at a 75 percent rate, for companies that wish to apply for grants but are unsure how to proceed.

This last measure addresses the problem of insufficient demand for R&D. As the officer in charge of the traditional industry program explained, while a typical high technology start-up

often applies to the OCS the moment it is formed, traditional industry companies are likely to underestimate the value of R&D for their company's development, are unaware of the possibility of receiving support from the OCS, or are unsure about how to put together a viable grant proposal. Indeed, one of the main objectives of the program is to raise awareness among traditional industries of the value of R&D and the role of the OCS in securing funding for this purpose (Authors' Interviews).

The Traditional Industries program is considered a high priority activity for the OCS. The former Minister of the Economy, Naftali Benet, in a conference dedicated to encouragement of R&D in traditional industries, stressed that funds for traditional industries grants are not capped due to the program's importance: all good proposals will be approved.

Interestingly, in the same conference, the Minister presented a distribution-based reason for the program quite different from the dominant competitiveness/economic growth justification. Stating that inequality is Israel's biggest problem and that more than half of workers earn less than 6,000 shekel per month, he argued that infusing R&D into traditional industries was a means for addressing this problem (Benet 2014). In similar vein, the head of the Traditional Industries program explained in an interview his motivation for heading the program:

> "You see a different world, different people. Real people that work hard, long hours, long shifts, otherwise the pay is not enough – so they work 12 hours a shift. Nobody is really interested in them – that's what I felt. This really moved me in contrast to others [at the OCS] who care more about the technology side of things. This is "real" to me, and I think it is important that the Chief Scientist is involved in this." (Authors' Interviews)

Accordingly, although distributive concerns were not the driving force behind the program, it appears that they do play some role.

The program is now operating for close to ten years and some "success stories" suggest that the program has some positive effects. For example, *Rav Bariach,* a longstanding manufacturer of security doors utilizing this program to move from being on the verge of

bankruptcy in 2008 to renewed international success in 2014. Revenues increased from 90 to 300 million shekels between 2009 and 2014. The number of workers increased from 170 to 440, and productivity increased. According to the company's CEO, the main reason for this dramatic turnaround was the injection of much needed R&D and the changes this created in the company's manufacturing process and products. In 2008, the company employed just a single engineer. By 2014, 44 engineers were on its payroll. The OCS was instrumental in bringing about this change extending six R&D grants to the company (Orpaz 2014).

In five interviews with other traditional industry companies that received grants from the OCS, similar stories about technology breakthroughs were told. An increase in the number of engineers occurred in these companies, but what was more interesting, from a distribution perspective, was that the number of production workers related to the OCS supported project grew and plans were in process to further increase their numbers. This is far from a trivial during a period of global recession in a sector in which the overall number of workers is in decline. While the OCS's effect on employment trends among the supported companies was generally positive, the wage effect for production workers was unclear: either interviewees were unsure or did not wish to share wage-related information.

S&T in the Periphery

The problem of inequalities between the periphery and the core, persist in all OECD countries. In Israel, the center of the country, especially the Tel Aviv metro area, is relatively affluent. However, the Galilee region in the north and the Negev in the South are characterized by low incomes and high unemployment. Starting at independence an important pillar of government economic policy was to promote economic growth in the periphery by use of a range of policy

instruments, such as incentivizing private firms to establish plants in the periphery, tax deductions and subsidies for periphery based firms, and the opening of State-Owned Enterprises.

S&T and innovation policy, in this geographical context, has two central manifestations. First, utilizing an existing law used to incentivize foreign direct investment toward opening plants in the periphery, as early as 1974 the OCS won approval to grant "approved factory status" to all science-based firms in the periphery. Second, since the early 1990s, the OCS technological incubator program intentionally situated most of its incubators in the periphery. Support for established technology intensive firms is, in effect, a continuation of the aforementioned periphery-targeted industrial policy.

It is important to note that not all activities of technology intensive firms are technology intensive. Hence, government must take into account that, in effect, it might be supporting the low-skills activities of high technology firms (e.g., assembly lines). Although this is likely to boost employment it does not necessarily create quality workplaces or induce productivity gains. Indeed, these concerns motivated the OCS to change some of the conditions attached to branch opening in the periphery. For example in an interview, the officer in charge of these programs recounted that in 2010, when the OCS launched a program to incentivize telecommunication firms to relocate to the periphery, the program was devised specifically to attract engineers to work and live in the South, not simply to boost employment. Under the conditions of this program firms are guaranteed significant subsidies (tens of millions of shekels per annum) for three years, on condition that not only they relocate their operations to the South, but that their workers do so as well. This requirement is motivated by the supposition that such quality worker relocation would ensure the creation of high quality jobs as well as exerting a positive effect on local consumption, education, and civic involvement (Authors' Interviews). However, many within the OCS, including several former Chief Scientists, view the emphasis on the periphery as

more of a politicians' concern that should not truly be a core concern of the Office (Authors' Interviews).

In general, the expenditure share of the OCS R&D fund dedicated to companies in the periphery grew from four to thirty two percent of the OCS's budget between 2001 and 2011. This extraordinary growth is explained by the establishment of both the OCS traditional industry program (most traditional industries are located in the periphery) and the special fund (around 100 million shekel per annum) for large firms in the periphery (Office of the Chief Scientist 2012). In addition, OCS grants are 10 percent higher for firms in the periphery (e.g., 60 percent of a project's R&D costs instead of 50 percent).

The second major component in R&D policy associated with the periphery is the OCS's technological incubator program. Technological incubators offer start-up firms financial support, administrative services, a location to open shop, consulting services (e.g., marketing), and networking possibilities. The Israeli technology incubator model, launched in 1990, is widely considered a success story (Frenkel, Shefer et al. 2008).

While the contribution of technology incubators to the success of the Israeli high-technology sector is often highlighted, the social role that the incubators play is not as well-known. The majority of the incubators are situated in the periphery (15 out of 24) and this is no coincidence. When the OCS established the incubator program, beyond its general contribution to Israel's economy, the program was specifically designed to encourage economic growth in the periphery and to help absorb the large numbers of high-skilled immigrants from the former Soviet Union (Breznitz 2007). Nevertheless, whatever the initial motivation there is little doubt that the incubator program diminishes – somewhat – the inequality gap between center and periphery (Avnimelech, Schwartz et al. 2007). On the other hand, the same study also found that the incubator program's success in permanently (that is ensuring that firms stays in the periphery

after graduating from the incubator instead of relocating to the center) attracting technology-based economic activities to the periphery is admittedly low. With regards to incentivizing large high-tech firms to invest in the periphery, a study looking at Intel's Karyat Gat plant (by far the biggest investment subsidy given to any company in Israel since independence) suggests that government support for Intel benefited the region in terms of income, employment and other spillovers, such as bolstering the local education system (Shachar, Gradus et al. 2005).

S&T Policy for Disadvantaged Minorities

Ascriptive groups that are economically disadvantaged are also severely underrepresented in S&T occupations and high-tech industries. In Israel this situation is no different. In 2008, 8.3 percent of Israeli Arab citizens were unemployed compared to 5.8 percent of their Jewish compatriots and their average monthly income was thirty percent lower (Ministry of Industry Trade and Labor 2010). If anything, Arab participation as producers in R&D and high technology sectors is even more marginal. The share of Arabs in high tech sector employment in 2003 was only 1.3 percent (Central Bureau of Statistics communication to authors) compared to their twenty percent share in the general population. Up until ten years ago, Arab technology intensive firms were essentially non-existent.

Policies aimed at rectifying this situation can be divided to those that focus on labor market participation and others that aim at stimulating entrepreneurship. An important example of a program intended to bolster Arab employment is government wages subsidies for Arab employees in firms that employ five or more Arab workers. The subsidy is for thirty months at about twenty-five percent of the employee's wage (MoITL 2012). The number of employees enrolled in this program expanded considerably from 266 in 2010 to 2,252 in 2013 (Ministry communication to authors). Although the program is not exclusively tailored for technologically-

oriented employment, according to the Director of the Authority for the Economic Development of the Minorities Sector at the Israeli Prime Minister's Office, it plays an important role in promoting Arab employment in the knowledge industries. For example, a major reason that Amdocs (Israel's biggest software company) opened a development plant in Nazareth in 2013, employing about 200 (mostly Arab) workers, was to take advantage of the aforementioned wage subsidies (2014).

Another such program that targets future labor market participation is a 300 million shekel fund (to be spent over six years) created by the Israeli Council of Higher Education intended to support Arabs in academia. One of the main programs sponsored by the fund involves scholarships for Arab students who enroll in 'high priority" courses: S&T programs are especially welcome given the future labor needs of the Israeli economy and the high likelihood of finding a high income position as an engineer (Vatat Professional Committee 2013).

Government also is involved in aiding Arab placement in technology intensive industries. While government actively partners with such programs, and contributes to their funding, program operation is left exclusively to nonprofits (most prominently *Tsofen*, *Maantech*, and *Kav Mashve*). The focus is mostly on: job training in computer engineering; gathering and disseminating information on job openings; and helping applicants prepare their CVs and coaching them ahead of job interviews. In addition, to their activity on the supply side, these organizations also interface with high-tech firms in order to raise awareness regarding the benefits involved in employing Arab engineers and the cultural adaptations required for successful absorption.[5]

[5] For example, by making company interviewers aware that Arab interviewees' tendency to avoid eye-contact with the interviewer is a sign of respect, and is not due to lack of social skills.

On the side of high tech entrepreneurship, government support began in 2000 with a decision to establish a technological incubator in the largest Arab town of Nazareth. The incubator was operated by a private company headed by an Arab CEO, but grants for the incubator's member firms are funded by the State at the rate of eighty-five percent. From the very start, the incubator was criticized from within the OCS for its alleged ethnic orientation. Critics argued that ethnicity should not factor in to grant decisions. Indeed, the Nazareth incubator does not use ethnic origin as a selection criterion to screen applicants and, accordingly, many of its companies are managed by Jews. Nevertheless, due to its location many of its member firms are Arab-owned and managed. Moreover, the incubator's focus is on pharma and medical devices, an unsurprising choice given that compared to other knowledge fields, Arabs tend to concentrate professionally in medicine (Authors' Interviews). Since its establishment, the Nazareth incubator hosted 27 different firms.

In addition, the OCS has recently launched a new program dedicated to the support of Arab high-tech entrepreneurship that is intended to cover eighty-five percent of costs for early stage projects. However, even with the incubator and the new OCS program, policy is lagging in the area of entrepreneurship in comparison to labor market participation.

In terms of motivation, the growing government interest in Arab high-tech employment and entrepreneurship is predominantly explained by the economic imperative. In countless public statements senior civil servants, ministers and even Prime Ministers have emphasized that Arab employment and entrepreneurship in knowledge industries not only benefits Arabs, but also the economy that is short of qualified manpower in technological professions.

In terms of outcomes, DSSTIP programs targeting the Arab population are in their early stages and therefore difficult to assess. Some programs have been studied and show promise.[6] Overall, while Arabs still constitute a small minority of high tech workers, the share of Arab workers in the high tech industry is constantly increasing: it doubled from 1.3 to 2.6 of all workers between 2003 and 2011 (Central Bureau of Statistics communication to authors). Moreover, most of our Arab interviewees appeared to feel that the general trajectory was positive and significant.

DSSTIP for the disabled

In Israel, as is true of basically all other developed nations, the physically disabled are a prominent "special needs" group that is the subject of numerous government programs.[7] However, up until 2011 the OCS was not involved.

In 2011, the OCS established a program dedicated to the support of technological innovation that would aid disabled individuals to achieve daily functionality (Office of the Chief Scientist 2012). The program's budget was fixed at six million shekels per annum in which – unlike other OCS programs – nonprofits are encouraged to apply for funds. Grants for commercial firms comprise sixty-five percent of R&D costs while nonprofits receive eighty-five percent. OCS grants are extended to the development of instruments that are likely to improve the quality of life of disabled individuals as well as help integrate them into the community. For example, Milbat, a nonprofit, received 600,000 Shekels to develop a "smart" walker with electronic sensors that transmit data tracking an individual's movement. This data is to be used to

[6] For example, a recent government evaluation study found that in a program focused on training and placement of Arabs in technology intensive sectors over 80 percent of participants viewed the program as helpful and more than 60 percent of them managed to find a job through the program ((Lis-Ginsburg and Porat 2014)
[7] In 2013, there were approximately 800,000 people in Israel with disabilities severe enough to impair their everyday functioning.

inform future walker practice sessions for the monitored individual in the hope of accelerating the rehabilitation process (Authors' Interviews).

Interestingly, the bar for OCS funding in this program is noticeably lower than for firms that apply to the general R&D fund. First, as explained to us by the OCS officer who established and managed the program, the technology supported did not necessarily have to be new – only its application to the problems faced by the disabled had to be novel. Second, while the applicant was required to demonstrate both technical feasibility and that the prospective technology would benefit the disabled, the OCS does not require proof of market viability. Indeed, economic concerns are subordinated to social ones in the management of this program. Even if the OCS estimates that the likelihood that the firm will turn a profit is non-existent, it could still extend funding so long as several disabled individuals stand to benefit from the product's development (Authors' Interviews).

The program was entirely the initiative of officials in the OCS (and approved by the Ministry of Finance) and is conceived as a social program – not an economic one. However, the program's non-economic rationale could also explain its marginality. Not only is its budget extremely limited, but funding uptake is even lower. Demand for program grants is so low that, to date, OCS annual spending has yet to reach even the six million shekel mark. It appears that very few Israeli organizations innovate in this field and the market is not sufficiently lucrative to attract new entrants.

DSSTIP in other Countries

The Israeli case study is highly informative because distribution sensitive innovation policies are very relevant in a relatively unequal economy driven forward by the high tech industry. In this sub-section, we briefly describe DSSTIP in other countries to demonstrate that such programs

can hardly be considered unique to Israel, as well as to point out a couple of interesting differences and similarities across countries.

Traditional industries tend to be less technologically intensive than high tech industries. However, without technological innovation these industries are doomed in developed countries unable to compete with the cheap labor of developing economies. This insight is not lost on central actors in the policy field. For example, in several interviews in Sweden, we found that the joint industrial committee, which includes both employer and union representation, plays a critical role in shaping S&T and innovation policy. This is important because it offers a policy venue in which the entrenched interests of traditional industries (interests that in Sweden are highly organized and powerful) lobby intensively for public R&D support. In an interview, the chief economist of the metal union specifically stated the Swedish unions understand that the future of their industries depends on continuous innovation (Authors' Interviews). In contrast, based on interviews with American policymakers and innovation policy experts in Washington, it appears that until very recently traditional industries are mostly an afterthought in American federal innovation policy formulation. Very differently from Sweden, American unions are generally quite weak and are not involved in the shaping of S&T and innovation policy (Authors' Interviews). The Swedish and American cases, when compared, suggest that, in Albert Hirschman terminology, who has 'voice' is a critical factor in shaping DSSTIP (Hirschman 1970).

In contrast, the Israeli case offers a different rationale for public support for innovation in traditional industries: the economic imperative of keeping the economy diversified. Indeed, in the United State, as part of policy re-orientation after the financial crisis of 2007, innovation-based manufacturing policy is gaining prominence as a critical component of American long-term economic competitiveness. Thus, both "voice" and different conceptualizations of economic

imperatives are primary motivators of such policies. However, distribution concerns were rarely voiced as motivation in any of the four countries.

Unlike DSSTIP in traditional industries, support based on economic-geographic criteria is associated with well-established industrial policy practices in different countries. The EU has been a leading organization in linking distribution, industrial and innovation policies, with respect to regions, even if actual implementation of these ideas is lagging (Braczyk, Cooke et al. 1998, Morgan and Nauwelaers 1999, Oughton, Landabaso et al. 2002, Garretsen, McCann et al. 2013). Nonetheless, interviews in Washington and Stockholm revealed that policymakers in the innovation field either claim that in general innovation policy is unconcerned with narrowing region-based inequalities (U.S.) or acknowledge such considerations but view them as an external imposition foreign to the world of innovation policy (Sweden). However, German interviews, in similar vein to Israel, revealed a different picture. Public support for S&T innovation in relatively backward Länder was viewed as a high priority by government, especially on the backdrop of German unification and the political imperative of closing the gap between East and West (Authors' Interviews). In sum, perhaps as an extension of longstanding general economic policy legacies, innovation policy is at times explicitly distribution-sensitive with respect to regional-based inequalities. Nevertheless, such an egalitarian orientation is far from universal (e.g., the U.S.) or welcome among many policymakers even where it is practiced (e.g., in Sweden and Israel).

From a producer point of view, DSSTIP could also be employed, in different countries, to promote disadvantaged ascriptive groups. However, unlike Israel, in a survey of the U.S., Germany and Sweden we failed to find evidence of a concentrated government effort to integrate disadvantaged minorities in the high-tech sector and/or to promote technological entrepreneurship specifically among such populations. However, in Germany, a central federal

policy prioritization is women's employment in R&D activities. An important institution in this respect is the Center of Excellence Women and Science (CEWS). CEWS was established in 2000 and its goals are to increase the share of women in leadership position at universities and research facilities, to increase the efficiency of gender equality programs and to raise gender awareness in all fields of science and research (BMBF 2011). Our interviewees in Germany all agreed that government efforts to advance women's employment in S&T fields in academia and in business are both persistent and intensive. These efforts are generally driven by the under-representation of women in these fields and a more general socio-political interest in Germany in gender equality. Interestingly, no equivalent effort exists to integrate disadvantaged minorities (e.g., Germans of Turkish decent). Thus while in Israel considerable effort is concentrated on promoting minorities in S&T, but not women, the opposite is the case in Germany.

Government support for the technological development of products that would aid specific disadvantaged populations is mostly haphazard. For instance, governments fund research that is likely to help address healthcare concerns that are over-represented in disadvantage populations. In the U.S., for example, government effort to developing treatment of type-2 diabetes will disproportionately benefit African American women, who suffer from the disease at far higher rates than the population at large. However, the support of African-American women is coincidental in this case.

Nevertheless, there are cases in which government programs are explicitly dedicated to the development of technologies that would assist specific disadvantaged groups. One example of this is the Swedish Institute of Assistive Technology that for several decades has sponsored the development of new assistive technologies for disabled and elderly populations. The motivation, as is true of Israel's, is not economic, but socially-based: the disabled suffer from unequal

opportunities in society and tailor-made technologies help to narrow the gap (Hjälpmedelsinstitut 2014)

Discussion

At the very least, our case studies demonstrate that DSSTIP are viable in a broad range of political environments. Accordingly, we view DSSTIP as a rich field for policy action and future research. Moreover, the empirical section offers several insights concerning the motivation for such policies, political system context, and their effect.

First, in terms of *motivation*, there are definitely instances in which the development of such programs was motivated by social, perhaps even egalitarian, concerns. This is clearly the case with government sponsored technological innovation for disabled populations. However, interestingly, disproportionate support of disadvantaged groups is often a byproduct of attempts to achieve national economic goals. In fact, we found that policymakers are often oblivious to the distributive implications of policy. This is clearly the case for the programs that support Arab minority integration into S&T firms in Israel: these programs are motivated by a desire to make a large highly-educated population more economically productive and by so doing strengthen the *general* economy. Similarly, programs that promote innovation in traditional industries were designed with diversification of the economy as the main goal and only later, once the social impact became clear, inequality became an issue.

Regional policy occupies a gray area in this respect. Egalitarian objectives are sometimes expressed in the context of inter-regional DSSTIP. In such instances, DSSTIP constitutes an extension of traditional industrial policy that often aimed to reduce inter-regional differences. However, in other instances motivation for these programs is framed in economic growth

terminology: public S&T support for relatively backward regions is justified with reference to the economic benefits that will materialize due to the technological upgrading of these regions.

A comparison of Israeli programs with counterparts in other countries highlights the significance of *political-economic context* for the development of a distribution-sensitive orientation. First, the U.S. stands out as a DSSTIP laggard. One major reason for this is that American policymakers are less concerned about redistribution than their counterparts in most other places. In general, in the U.S., egalitarian considerations are of lower priority than in most other developed nations (Sachweh and Olafsdottir 2012). However, a U.S. comparison with Sweden regarding DSSTIP for traditional industries highlights a different factor: in the American political economy the room for union-driven policymaking is very limited. While in Sweden (and Germany) unions are integrated into the decision-making process as part of the neo-corporatist governance arrangement. Given that unions in traditional industries are relatively well-organized, union participation in decision-making in the neo-corporatist countries implies a high likelihood that traditional industries would be seen as part of the innovation policy agenda.

In Israel, however, the support for traditional industries derives not from union power/intervention, but from government concern with economic diversification. Further, the renewed interest in manufacturing in the U.S. demonstrates that voice and a seat at the table might not be the only decisive factor. Nonetheless, it is clear that interest group power is relevant for understanding the scope of DSSTIP. Finally, it is worthwhile to stress that in *none of the four cases* was redistribution a primary motivational factor.

Policy is not only shaped by political actors, but also by professional debates within the community of policy experts. First, as mentioned above, distributive concerns are often not part of the policy discourse. Yet even when they are, we have come across instances of policy experts that question whether egalitarian purposes are either desirable or practical in the S&T and

innovation policy field. For some experts, innovation policy is exclusively about economic growth and competitiveness. Redistribution, they argue, might be appropriate in the education and welfare fields, but not in S&T.[8] Others fear that DSSTIP innovation policy will simply fail. The reason is that it is viewed as an example of "bad old industrial policy" in which the state takes upon itself to support *specific* industries/groups/regions without the knowledge required to do so successfully. Instead, the argument goes, governments should stick to 'horizontal' policies that provide infrastructure and do not prefer one type of actor/sector over another (Teubal 1997, Rodrik 2008, Wade 2012). The degree to which these policy experts have the upper hand in policy debates depends on the more general inclination of government, in a specific country, to engage in industrial policy.

Finally, while there is qualitative evidence that DSSTIP is successful, we still know relatively little about the *effect* of DSSTIP programs for two reasons. First, most of these programs have a relatively short track record and the effects of innovation policies are in the medium and long run. Second, and more importantly, governments do not systematically gather the kind of data that would allow for a systematic evaluation of these programs. The main reason for this is that when these policies are conceived they are not seen as having distributive/social goals – even if they are highly likely to have a distributive impact – and as a consequence relevant measurement variables are neither formulated nor collected.[9]

[8] It is certainly possible that there is a tradeoff between distributive and economic growth objectives in the design of policy. However, such a tradeoff does not imply that economic efficiency concerns should always trump distributive ones. As is true of other policy fields, how to manage tradeoffs should be the subject of informed public debate. Moreover, in many instances, distributive and growth objectives might actually be associated with one and the same policy. As argued above, Israeli DSSTIP for traditional industries and the Arab minorities are first and foremost driven by economic concerns.

[9] For example, government's that wish to assess the distributive impact of traditional industries DSSTIP should gather longitudinal data on low skill labor employment and income in firms that receive public support.

Conclusion

The main objective of this study was to introduce DSSTIP as a relevant and important component of the new welfare regimes approach to inequality. Programs of this type have the potential of leveling the playing field where it is most tilted: Science and Technology.

In this article we focused on the effects of innovation on specific groups of producers and users of technology and discussed four different archetypes of DSSTIP programs: innovation in traditional industries, geographical-economic peripheries, disadvantaged ascriptive groups, and the advancement of disadvantaged consumers of technology. Utilizing a case study approach we presented empirical examples of each program type.

If one eschews any state intervention for redistributive purposes, DSSTIP quite obviously is a negative development. However, even for egalitarians, DSSTIP is not necessarily positive. Some commentators are skeptical about government's use of growth-creation policies to advance egalitarian purposes. This, as we mentioned above, is related to a general critique of industrial policy. The argument is tied to the view that government is unable to successfully pick winners. However, as many point out, this rationale equally applies to other policy fields – education, healthcare, etc. – where there are far less reservations about government intervention (Rodrick 2008). The question is, in truth, *how* to intervene. Answers to this question could only be arrived at following intensive engagement with the question of what constitutes good DSSTIP practice and such engagement largely depends on large-scale longitudinal policy experimentation coupled with systematic policy evaluations.

Those who will view the emergence of DSSTIP in a positive light typically view growing social inequality as a concern and are favorably inclined towards adding new policy instruments to the traditional arsenal of the egalitarian policymaker. It is worth pointing out, however, that DSSTIP are in no sense well-established as such. As discussed above, the push for DSSTIP is

often – probably in most instances – driven by non-distributive concerns. This matters because programs established for reasons other than distributive purposes could be designed in ways that do not optimally advance distributive objectives. Moreover, insofar as these programs are not recognized as DSSTIP they are unlikely to attract support from actors interested in advancing such purposes. As a result, their funding is likely to be lower than it otherwise would have been and, in some cases, DSSTIP program would be terminated, or not established in the first place, due to lack of support.

For these reasons, we argue that it is vital for those who care about inequality – whether policymakers, academics, industry stakeholders or the informed public – to seriously consider DSSTIP as a new tool within an effective welfare regime. Well-designed DSSTIP programs could prove to be an important component of future efforts. However, if we do not recognize them as such and allow for full policy experimentation, their promise will never be fulfilled.

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