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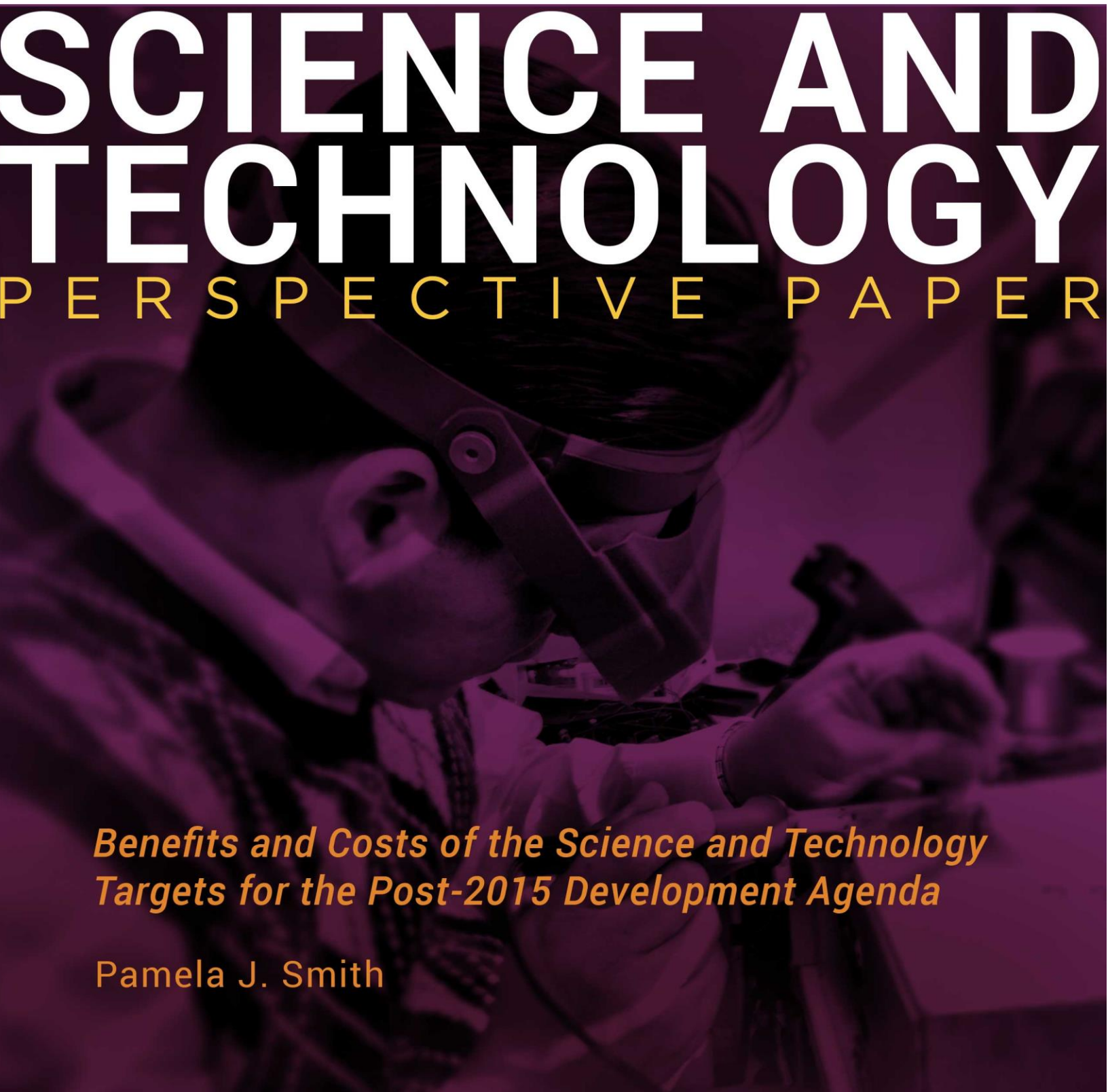

Benefits and Costs of the Science and Technology Targets for the Post-2015 Development Agenda

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POST-2015 CONSENSUS

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Introduction

In 2015, the United Nations will select a list of "Sustainable Development Goals" for the world to meet by the year 2030. Since aid for development is limited, this process of goal setting requires establishing global priorities. The need to identify priorities is not new. The current task follows a similar process whereby the United Nations (UN) set "Millennium Development Goals" in 2000 to be achieved by 2015. The goals for 2000-15 covered issues in eight areas focusing on poverty and hunger, education, gender equality, child mortality, maternal health, disease, environmental sustainability, and global partnerships for development. Substantial strides have been made in achieving those goals. To develop the new agenda for 2015-2030, an Open Working Group has convened for roughly two years to identify a list of "challenge areas" and "target goals" within each area. Many have argued that this list needs to be short, objective, and achievable for aid to be effective. However, the list under development has been influenced by pressure groups and is currently quite long with 200 plus target goals.

To help prioritize the list of development goals, the Copenhagen Consensus Center (an international think tank) has assembled leading economist to undertake research. The purpose of the research is to identify the goals that yield the largest returns for economic and social development, and to support a focused prioritizing of goals within the UN and other development aid bodies. To this end, the research will provide benefit-cost analyses of the goals under consideration and then rank them by their cost effectiveness. This approach seeks to clarify the likely effectiveness of each dollar spent on aid. Ultimately the goal is to help the UN determine the direction of more than $700 billion in aid.

For this purpose, the Center has commissioned economists from a range of disciplines to write "Assessment Papers" analyzing the costs and benefits of specific goals in their fields of expertize and in the areas identified by the UN as "challenge areas." The Center has also commissioned economists to write "Perspective Papers" that review and/or extend these analyzes and provide a broader context for the research. The results of this research will be reviewed by an expert panel of economists and will be disseminated in discussions and workshops conducted by the Center with UN missions, UN agencies, governments and aid agencies, and to the general public. The commissioned papers for this project cover topics in 13 "challenge areas" which roughly overlap with the areas identified in the UN Open Working Group (2014) report.

These challenge areas include: "Strengthen and enhance the means of implementation and global partnership for sustainable development." This area focuses on international movements including International Technology Transfers. Examples of general technology transfer goals under consideration include:

> Promote regional and international collaboration on and access to science, technology, innovation, research and knowledge sharing, including through North-South, South-South and triangular cooperation (17.26).

> Enhance international cooperation with developed countries taking the lead in implementing sustainable consumption and production patterns, including through strengthening developing countries' scientific and technological capacities to move towards more sustainable patterns of consumption and production (17.38).

The UN goals also include proposals in specific technology sectors. Examples include:

> Support research and development of vaccines and medicines for the communicable diseases that primarily affect developing countries in cooperation with pharmaceutical companies, provide access to affordable essential medicines in developing countries, and support developing countries' use of TRIPS flexibilities (17.11).

> By 2030, expand international cooperation and support in water and sanitation related technologies, including water harvesting technologies and wastewater treatment, recycling and reuse technologies (17.18).

> Enhance international cooperation to facilitate developing countries' access to clean energy technologies, including through appropriate partnerships (17.19).

> Promote transfer and dissemination of clean and environmentally sound technologies to developing countries, including through the possible implementation of a UN global technology facilitation mechanism, and encourage the full use of TRIPs flexibilities (17.31).

> Build science, technology and innovation capacity in developing countries, including to undertake technology assessment and research, development and adaptation of clean and environmentally sound technologies (17.33).

> Increase scientific knowledge, and develop research infrastructure and capacities to enhance the contribution of marine biodiversity to the development of developing countries, in particular of SIDS and LDCs (17.41).

The UN goals also include those that can be thought of as foundational to technology transfers that occur through trade and foreign direct investment such as:

> Facilitate investments in developing countries in infrastructure such as roads, railways, ports, water supply and treatment, and ICT (17.29).

These examples illustrate the range of goals that relate to technology transfers. These goals tend to be cross-cutting in that they have implications in multiple challenge areas. What they have in common is that they seek to address market failures by improving the conditions that support the higher socially optimal levels of technology transfers into developing countries. In other words, the goals in their current form can be thought of as supporting the prerequisite conditions that advance technology transfers and ultimately

sustainable economic development.

This paper is a "Perspective Paper." The purpose of this paper is twofold. The first purpose is to assess the policy proposals presented in the "Assessment Paper" by Keith E. Maskus (2014). These proposals are in the spirit of the UN's target goals 17.26 and 17.38 (above). Maskus analyzes two specific policies that have the potential for increasing technology transfers to developing countries. These are R&D subsidies that support the ability of developing countries to absorb foreign technologies; and innovation zones that support technology transfers via temporary labor movements between participating countries. The second purpose is to provide a broader perspective on policy options in the area of technology transfers. To this end, I discuss the channels for technology transfers, the economic conditions that support technology transfers, the role of government, and policies suited for countries at different levels of development. I then consider how the Maskus proposal fits into this broader literature and range of policy options.

The remainder of this paper is organized as follows: Section 2 provides an assessment of the Maskus proposals. Section 3 provides perspectives from the broader literature. Section 4 provides concluding remarks and comments on prioritization for the UN's 2015-30 Sustainable Development Goals.

Costs and Benefits of Technology Transfer Policies

Maskus (2014) focuses on two potential policy targets for inclusion in the UN's 2015-30 Sustainable Development Goals—R&D subsidies and innovation zones. Maskus chose these targets because of their potential to facilitate technology diffusion, improve access to knowledge, and promote growth of domestic technological capacities in developing countries. Below I review each of these in turn.

R&D Spending

The first objective is to increase the ratio of R&D spending as a percentage of GDP (above historical rates) in developing countries. Maskus considers two national policies to achieve this goal: (a) R&D tax credits to create an incentive for increases in R&D spending by the private sector; and (b) increases in direct government expenditures as the public sector counterpart.

Maskus's analysis of these policies is well grounded in the literature. In brief, the argument is that R&D investments support productivity spillovers and growth. In the absence of government intervention, the private sector will under invest in R&D because firms do not take into account the full social benefits arising from their investments (e.g., the external spillovers). This is the classic market failure argument for government intervention. If the knowledge spillovers are national in scope, then national government intervention to subsidize R&D is justified to support a socially optional level of investment nationally. If the spillovers extend beyond borders, then international support or coordination is justified to support a socially optional level of investment globally.

The question then is what form of intervention? As Maskus notes, there are numerous policy instruments that can be used to support R&D investment. National policies include R&D tax credits and direct government spending (those analyzed by Maskus), among others. The existing literature provides some evidence on the effectiveness of R&D tax credits in stimulating private investments in developed countries; however the literature is more limited on the subsequent impact of this policy on knowledge spillovers and growth (the ultimate goals). The existing literature focuses primarily on developed countries, with few studies of developing and emerging countries. The Maskus paper provides a contribution to this literature gap.

The analysis presented by Maskus is well motivated by existing observations. As a starting point, Maskus evaluates the R&D/GDP ratios of emerging, developing, and more developed countries. He shows that the ratio has been trending upward for each group. Thus, he takes as a given that these historical trends will continue through the 2015-2030 period. His analysis focuses on policies that raise the ratio above the historical trends. He establishes a range of target growth rates in R&D/GDP from modest to ambitious. He focuses his analysis on developing and emerging countries, and excludes countries that will likely exceed the targets without new policy intervention.

Maskus uses a variation of a partial-equilibrium model from Lester (2012). Maskus computes a target level of R&D expenditures required to raise the R&D/GDP ratio above the historical trends to the targets selected for the period 2015-2030 for both developing and emerging countries. This R&D expenditure is split 50/50 between the private and public sectors, based on current data on R&D spending. The specific policies to achieve these expenditures are R&D tax credits and government grants to R&D. Maskus assumes that these policies are equally effective within the countries of each group and that there are no spillovers in the effects of the policies across countries. The model is then used to assess the welfare impact of the two policies by calculating the net of benefits minus costs. Benefits include: (1) productivity gains from private and public spillovers, and (2) induced innovation from these spillovers. Costs include: (3) efficiency loses, (4) financing costs, (5) fixed costs to firms, and (6) administration costs to government. This calculation requires that assumptions be made about parameter values in the model. Maskus selects values based on current research in the literature; and in the cases where the literature is limited Maskus considers a range of values. This approach is reasonable and consistent with the literature.

The results of the analysis include benefit-cost ratios for developing and emerging countries, with a range of results corresponding with modest and ambitious scenarios. For developing countries, the modest target is growth in the R&D ratio to 0.50 percent of GDP by 2030. The results of this case show a benefit-cost ratio that ranges from 0.88 to 1.42. The ambitious target is growth in the R&D ratio to 0.75 percent of GDP by 2030. The results of this case show a ratio that ranges from 0.90 to 1.44. The ranges in each case reflect variation in underlying parameter values and length of policy effects. In comparison, for emerging countries the benefits and costs are larger. However, since the benefits and costs increase proportionately, the ratios are similar for emerging countries as those of the developing countries. Given the conservative assumptions underlying the

analysis, one can conclude that benefits exceed the costs by a ratio of 1.4 under likely conditions. Maskus concludes that the benefits of the R&D policies do not sufficiently exceed the costs, and thus these policy targets do not qualify as "strong or phenomenal." In other words, developing countries would benefit more from investing in policies that yield a higher benefit-cost ratio. I agree with this assessment.

Innovation Zones

The second objective is to establish 10-year visas permitting free mobility of skilled labor among participants in "innovation zones."

The theory literature in economics provides well established support for policies that relax barriers to labor movements. To illustrate the classic findings, Maskus uses the Specific Factors model originating from Bhagwati (1984). He shows that even partial labor mobility across countries results in an increase in wages in the (low wage) source country and a decrease in wages in the (high wage) recipient country. In terms of country welfare, labor mobility results in an increase the welfare of labor in the source country, and capital and land owners in the destination country; and an increase the welfare of the migrant labor. These welfare gains are partially offset by decreases in the welfare of capital and land owners in the source countries, and labor in the destination countries. From a national perspective, the source country loses in net while the destination country gains in net. From a global perspective, the combined welfare of the countries unambiguously increases.

Maskus offers several caveats to these established results that are also well documented in the literature. The first is that it is possible for the source country to experience a net welfare gain if the migrant labor remits some of their wages back to their country of origin. Second, if the productivity of migrant labor is lower than that of labor in the destination, then the gains in wages would be more modest. Third, the source country may experience other types of losses due to outmigration of labor including the loss of positive externalities associated with knowledge spillovers and a decrease in the tax base. Finally, the magnitude of the welfare changes from migration depends on the extent to which barriers are relaxed, with more complete relaxation generating larger gains.

In the analysis, Maskus accounts for the core finding in the literature and most of these caveats. He also adds additional features. He considers the migration of skilled labor which is more closely associated with knowledge spillovers, and he considers the effects of temporary migration that occurs within a group of cooperating countries. These features match the proposed innovation zone scenario and make the proposed policy distinct from existing policies.

The analysis is well motivated by existing data and trends. Maskus begins by calculating the bilateral stocks of skilled migrants. Data for constructing these stocks are quite limited. Maskus uses the dataset of Docquier, Lohest and Marfouk (2007) as a starting point, and augments these data in a number of ways. The resulting data set is for a sub-set of countries and regions in the Americas for 2000 and 2010.

For policy instruments, Maskus considers innovation zones which would allow skilled workers with visas to circulate within all of the countries participating in the innovation zone. He examines two types of visas and two types of innovation zones. For visa, he examines: (1) a one-time five percent increase (over the initial level) that is implemented immediately, with economic effects sustained from the initial year through 2030; and (2) a twenty percent increase phased in over five years. For innovation zones, he examines: (a) a North-South zone and a South-South zone (both within the Americas). As Maskus rightly notes, these zones are "suggestive" in that the policies proposed do not currently exist. The regions of the Americas provide a benchmark reflecting current arrangements on labor mobility.

Maskus uses a partial equilibrium model, where the costs and benefits vary depending on whether countries are the source or destination of migrating skilled labor. In this analysis, developed and developing countries can be both the source and destination of labor flows, although flows from the South to North are dominant. The benefits/costs include: (1) wage changes in source and destination countries, (2) income gains to migrant labor minus their bilateral remittances back to their source country, (3) efficiency changes in source and destination countries, (4) fiscal externalities in source and destination countries (changes in tax revenues), and (5) spillovers (that raise total factor productivity) into destination countries within the zones.

The results correspond with three policy scenarios. The first scenario is a North-South zone that results in a 5 percent increase in bilateral labor flows. Overwhelmingly the largest effects of this policy are the income gains to the migrant labor and remittances back to their countries of origin. In comparison, the other benefits and costs are relatively small. The benefit-cost ratio for this scenarios ranges from approximately 3 to 68. This ratio assumes that the benefits experienced by the migrant labor are attributed to their country of origin. This assumption results in high ratios for developing countries that are primarily the source of migrant labor. When the income gains of migrant labor are removed from the calculations for the source country, the results show smaller ratios now ranging from roughly 1 to 14. In terms of the global welfare effects, the ratio is 13.5 (including the welfare of migrant labor) and 3 (excluding migrant labor). These results indicate that the welfare effects of the fiscal and technological externalities are economically significant, even though they are dwarfed by the wage gains to migrants. These are the findings generated using the most conservative parameter values. When the parameters are adjusted to a more moderate case, the resulting ratios are higher as one would expect. In terms of the global welfare effects, the ratio is 30.3 (including the welfare of migrant workers) and 4.1 (excluding this welfare component).

The results for the second scenario correspond with a South-South zone. In this case, benefit-cost ratios decrease to 7.1 (including the welfare of migrants) and increase to 5.1 (excluding the welfare of migrants). These results are consistent with expectations since the income gains to migrants are smaller in a South-to-South zone where wage differences are smaller across countries. Further, destination countries experience smaller tax gains on lower wages in South-to-South migration. Alternatively, the increase in the ratio that

excludes the migrant labor welfare suggests that the fiscal and technological externalities generated within a South-South zone are economically significant.

A third scenario is a 20 percent increase in bilateral labor flows phased in over 5 years for the North-South zone. This case is more ambitious as it allows for a much larger movement of skilled labor. The results of this aggressive policy are similar to those of the conservative program. This is because the welfare benefits and costs increase in roughly the same proportion. The value of this last exercise is to provide a sense for the magnitude of the potential effects of spillovers on total factor productivity. Assuming a 3 percent discount rate, these gains are 4.4 billion in additional real GDP. These gains would be attributed most to the countries experiencing the largest circulation of skilled labor and thus benefiting most from the associated spillovers.

In summary, the results show that global benefits exceed costs by a ratio of approximately 13 for a North-South agreement and 7 for a South-South agreement under the most conservative conditions. These results are "suggestive" in that they provide a benchmark under existing regional agreements in the Americas, rather than a pluri-lateral zone in the full form proposed. I agree with Maskus that these ratios place the program nearly in the "phenomenal" range.

Summary and Comparison

One can compare the two proposals in terms of their goal to stimulate technology transfers and thus raise welfare (the ultimate goal). In this regard, the R&D policy raises benefits and costs in roughly the same proportion such that the benefit-cost ratio is only slightly larger than 1. Even so, there are economically substantial benefits in terms of domestic knowledge externalities. In comparison, the innovation zone policy generates welfare benefits that substantially outweigh the associated costs. The corresponding ratios are as large as 30 under conservative conditions. This figure reflects the "global" effectiveness of the policy. However, the benefits and cost vary across source and destination countries. Destination countries experience an unambiguous increase in welfare, as does the innovation region in aggregate. However, source countries experience a potential net loss in welfare. This loss can be offset by remittances from labor that has out-migrated. The largest gains are to migrants in the form of wage increases. Under this policy, the benefits associated with spillovers are economically significant, even though they are a relatively small proportion of the net gains. In both analyzes, the results are conservative estimates suggesting that the gains under both policies are likely larger than reported.

Assumptions and Omissions

Maskus's benefit-cost methodologies are solidly grounded in economic theory, empirical evidence, and real world behavior. However, numerous assumptions are required to implement the model, adapt it to the policy scenarios, and generate parameter values when desired data are not available. Maskus does bump up against data limitations and finds reasonable solutions. He does a meticulous and admirable job in this regard. He relies on findings in the literature, and when the literature is scarce, he allows for a range of parameter values in the accounting process. His approach is intentionally conservative so

as not to overestimate the effects of the policies examined.

One has to look hard for omissions in the analysis. If one were to insist upon noting omissions, there are only two that are noteworthy. The first is the omission of "international spillovers" in the analysis of the R&D spending policy. This omission is a conscious one that Maskus discusses. The potential effect of this omission is to under estimate the magnitude of the benefit-cost ratio. That is, if one included international spillovers, the ratio could be larger than those reported. Even so, I expect that the magnitude of change would be modest and there would be no change in the basic conclusion that the R&D policy results in modest benefit-cost ratios suggesting that there are alternative targets that are more worthy of investment.

The second is the omission of human capital (and the associated externalities) in the welfare analysis of innovation zones. Again, the omission is a conscious choice which Maskus discusses. The potential effects of this omission are to overestimate the benefit-cost ratio for source countries and under estimate the ratio for destination countries. That is, if such human capital transfers (and their externalities) where accounted for, I expect that the costs would be higher in source countries and the benefits would be higher in destination countries. However, I don't expect that inclusion of this component would change the basic conclusion that this policy falls nearly in the phenomenal range.

Perspectives

The section considers a broader perspective on policies that support economic development through technology transfers. I focus on areas of consensus in the literature.

Channels for Technology Transfers

How is technology transferred internationally? The literature focuses on four prominent channels by which international technology transfers occur: (1) trade, (2) foreign direct investment, (3) licensing, and (4) labor movements. In each case, developed countries tend to be relatively abundant in knowledge resources and are thus the source of the knowledge; and developing countries tend to be relatively scarce in knowledge resources and are thus the recipients (see Coe and Helpman, 1995; Jaffe and Trajtenberg, 2002; Keller, 2004 and1996).

The first and most studied channel is international trade (see Coe, Helpman, and Hoffmaister, 1997; Eaton and Kortum, 1996, 1999 and 2002; Evenson and Westphal, 1995; Grossman and Helpman, 1991; Keller, 1998, 2002; Maskus, 2000; Parente and Prescott, 1994; Schifff, Wang, and Olarreaga, 2002; Tybout, 2000). The intuition emerging from this literature is that knowledge flows across borders embodied in goods and services. For importers, this results in access to new and improved factor inputs (from imports of intermediates) as well as the opportunity to extract the knowledge via reverse engineering (from imports of intermediates and final goods). This trade can have a positive effect on the total factor productivity of the importing countries, thus supporting economic development (Klenow and Rodriguez-Clare, 2005).

The second channel is foreign direct investment (FDI) (see Aitken and Harrison, 1999; Blalock, 2001; Blomstrom and Kokko, 1997; Gorg and Greenway, 2004; Javorcik, 2004; Kokko, Tansini and Zejan, 1997; Larrain, Lopez-Calva, and Rodriguez-Clare, 2000; Markusen, 2002; Moran, 1998, 2001, 2004; OECD 2002; Saggi, 2002). The intuition emerging from this literature is that the activities of multinational enterprises (MNEs) can have both positive and negative effects on the recipient host countries. The positive effects include improved access by domestic firms to efficient foreign technologies, knowledge spillovers to domestic firms through labor movements, and knowledge spillovers through vertical linkages between subsidiaries and the sourcing networks of the parent firm. These positive effects tend to be associated with vertical FDI, where the foreign affiliates engage in production activities that are distinct from the home firm's activities. In contrast, the negative effects occur when the MNE draws domestic skilled labor away from domestic firms or satisfies local demand for goods that were previously supplied by domestic firms. Negative effects also include an adverse effect on local R&D. These negative effects tend to be associated with horizontal FDI, where a foreign affiliate replicates the parent firm's product for sale in the foreign market. The net effects tend to be positive when vertical FDI is more prominent than horizontal FDI. In such cases, local firms benefit from technology transfers.

The third channel is licensing (see Correa, forthcoming; Fauli-Oller and Sandonis, 2002; Gallini and Wright, 1990; Glass and Saggi, 2002; Maskus, 2000; Mukherjee and Pennings, 2004; Smith, 2001; Yang and Maskus, 2001). The literature on licensing and technology transfers is much smaller, but does suggest that knowledge flows via licensing are an important source of technology transfers for developing countries. Licensing tends to be more prominent in markets that are large and have transparent policy environments. Licensing also tends to be more prominent in countries where the enforcement of intellectual property rights is stronger. The intuition is that such environments provide greater confidence to the licensor that the licensee will not violate their intellectual property.

The fourth channel is labor movements. The literature on the role of labor movements in promoting technology transfers is also relatively modest (see Maskus, 2014; Mattoo and Carzaniga, 2003; Rhee, 1990). This literature considers labor movements that occur via multinational enterprises. The intuition is that technology transfers from the multinational to domestic firms as labor circulates over time. Domestic firms that benefit most tend to have the capacity to absorb the circulating knowledge. The literature also considers labor movements that occur when people migrate internationally on a temporary basis to study or work abroad, or on a more permanent basis. The ability of local firms to benefit depends on the extent to which the skills of those who migrate can be adapted to the local environment. Generally, labor movements via multinationals tend to be North-to-South, whereas the other forms of migration tend to be from South-to-North. The former provides direct knowledge spillovers into developing countries. In the latter case, the developing country can benefit if migrants return to their country of origin and/or remit income gains back to their country of origin.

The literature on these alternative channels for technology transfers does not provide clear guidance on which of the channels provides the largest social benefits. However, the literature does suggest that the magnitude of the social benefits from knowledge spillovers depends on: (1) the scope of the spillovers (e.g., whether they are occur within countries or across countries; and whether they occur within industries or across industries), (2) the characteristics of the source and destination countries of the spillovers (e.g., such as ability to absorb and adapt technologies); and (3) the characteristics of government policies that influence spillovers (e.g., such as the strength of intellectual property rights).

Developing Country Conditions

What economic conditions in developing countries support technology transfers? The literature suggests that the ability of developing countries to benefit from technology transfers depends on characteristics of the countries (see Arora et al., 2001; Blyde and Acea, 2002; Eaton and Kortum, 1996; Hausmann and Rodrik, 2003; McCalman, 2001; Peri, 2003; Smith, 2001; World Bank, 2004). The most basic conditions are the ability to absorb technologies and adapt them to meet domestic needs. The literature is wide ranging in terms of the domestic characteristics that support absorption and adaptation. Characteristics include the quality of the domestic infrastructure, the transparency and stability of local government, and the abundance of skilled labor. These characteristics influence all of the channels for technology transfer, but particularly FDI which is especially responsive to the local business environment. The literature suggests that a business environment that attracts vertical MNE activities as well as skilled labor movements can be particularly important in supporting technology transfers in developing countries.

The literature also suggests that the intellectual property rights (IPRs) of countries are an important feature affecting inward technology flows via the alternative channels (Fink and Maskus, eds., 2005). Generally, the least developed countries are less likely to benefit from stronger IPRs because such rights result in monopoly pricing of intermediate goods (which are technological inputs in domestic production) and final goods (for which there may be few domestic substitutes). However, stronger IPRs can have a positive effect on technology transfers into middle income and large developing countries. Stronger IPRs in these more advanced developing countries can also support investment in domestic R&D.

Finally, the literature suggests that countries with fewer barriers to trade, FDI, licensing and labor movements benefit more from inward technology transfers.

Government Intervention

When should governments intervene to support technology transfers? The classic economic argument is that governments should intervene when there is a market failure. Market failures are prominent in the case of knowledge because of its public goods characteristics (e.g., non-rival and non-excludable). The consequence of these characteristics is that socially optimal levels of technology transfers are not naturally achieved by private actors who do not account for knowledge externalities in their decision making. Thus, the role of government is to create incentives for private actors to generate the socially optimal levels of technology transfers. It is important to note that one can

think of socially optimal levels of technology transfers from many perspectives including the sub-national, national, regional, or global levels. The relevant scope depends on the scope of the knowledge externalities. This is important in that the most efficient policies that generate the fewest new distortions (e.g., first-best policies) have a scope that matches the scope of the knowledge externalities.

The literature on technology transfers touches on three prominent types of market failures (see Hoekman, Maskus and Saggi, 2005). The first is associated with information asymmetries between the source and recipients of knowledge transfers. Developing countries may not have sufficient information to accurately value the knowledge assets from foreign firms. This can increase transactions costs and thus limit inward technology flows. Second, there can be inefficiencies associated with the market structure. Specifically, developing countries may face high monopoly prices for knowledge assets. This is particularly relevant when the source of the knowledge has strong IPRs or other means of making their knowledge assets excludable. This can result in sub-optimal levels of technology transfers. Third, private actors in developed and developing countries may undervalue the externalities associated with knowledge transfers because they are external to the firm. This can result in an underinvestment in R&D (e.g., knowledge production) and the under use of the products of R&D (e.g., knowledge consumption). These market failures suggest a role for government to improve information between buyers and sellers of knowledge, reduce prices/costs of acquiring knowledge, and increase investments in R&D in developing countries.

Appropriate Policies

What are the appropriate policies to support technology transfers? To answer this question, one needs to rely on the empirical literature and historical evidence, as the theory literature in economics does not provide clear guidance. It is also useful to consider a "customized approach" where the appropriate policies depend on the particular context. Hoekman, Maskus and Saggi (2005) provide an extensive summary of policy options that could be used to influence technology transfers into developing countries. I refer the reader to this article, and briefly summarize the main points here (see also Maskus, 2003; Saggi, 2004).

Hoekman, et. al. (2005) and others suggest that there is an evolution in conditions for technology transfers that roughly corresponds with the level of development of countries. This evolution is referred to as a "technology ladder." The poorest least developed countries are on the lowest rung of the ladder. For these countries, the prominent condition that limits their ability to benefit from inward technology transfers is their weak ability to absorb foreign technologies. For such countries, appropriate domestic policies would target improvements in the conditions that support absorptive capacity (see Section 3.2). Examples include policies to improve the local business environment and related institutions, policies that create incentives for education, and policies that encourage inward technology flows via trade, FDI, and labor movements. There are also policies that are not yet appropriate for the poorest least developed countries. Examples include domestic policies that encourage local R&D (such as strong IPRs) and policies that

encourage technology licensing (by domestic firms from MNEs). Such policies are viewed as not appropriate for the poorest countries because they do not yet have the capacity to benefit from them and may be adversely affected.

For developing countries at higher income levels, the conditions for benefiting from technology transfers are stronger. This rung on the ladder includes two steps—duplicative imitation and creative imitation. Duplicative imitation refers to the ability to reproduce or replicate a technology, whereas creative imitation refers to the ability to adapt the technology to fit the domestic environment and needs. As countries advance in their ability to absorb foreign technologies, they move from duplicative imitation to creative imitation. Appropriate domestic policies for these countries include stronger IPRs. For these higher income countries, stronger IPRs encourage domestic R&D and innovation, and encourage technology inflows via multiple channels including licensing of technologies from foreign to domestic firms.

Finally, developed countries that are the source of the knowledge transfers can adopt policies that support technology transfers to developing countries. For source countries, appropriate policies include those that provide an incentive for outward technology flows and those that seek to improve the absorptive, adaptive, and innovative capacities of recipient countries. Examples include a wide range of financial and technical supports (e.g., fiscal incentives for R&D performed in developing countries, subsidies for developing country students, and technical assistance) among others (see Hoekman, Maskus and Saggi 2005, pg. 1598). Most noteworthy are policies that allow for differential pricing that would give the poorest countries access to technology inflows at lower prices/costs, particularly for critical technologies (such as medicines) that are subject to high monopoly pricing.

Concluding Remarks

This last section provides remarks on how the R&D and innovation zone proposals (in Section 2) compare, how they fit into the broader literature perspective (from Section 3), and the implication of the findings for the UN's prioritizing of technology transfer goals.

Maskus (2014) proposed two specific policies for promoting technology transfers—fiscal supports for R&D in developing countries and international innovation zones. These two policies are quite distinct from one another. The R&D supports would augment existing "national" R&D programs in developing countries. The intuition is that current levels of R&D in developing countries are below the socially optimal levels and government intervention would create incentives for increased activities. This policy is "general" in that it does not target a specific sector, but rather targets a basic condition in developing countries needed to absorb and adapt inward flows of technology—the local R&D infrastructure. This policy is likely to be most effective in middle-income developing countries that have an existing R&D sector and that are on the second rung of the technology ladder at the duplicative imitation or creative imitation stage.

In contrast, the innovation zones policy would be new since such a policy does not

currently exist. This policy would be "international" in that it requires coordination between the visa granting authorities of participating countries. The intuition for this proposal is that current levels of technology transfers via labor movements is below the socially optimal level and the relaxation of barriers to labor movements would allow for increased transfers. This policy is "general" in that it does not target a specific sector, but rather supports the circulation of high- skilled labor in all technology areas. Since labor would circulate within all countries participating in the zone, the technology transfer benefits would depend on the size of the zone and its participants. The policy is likely to be most effective for middle-income developing countries that would experience inflows of skilled labor (such as through vertical MNE activities) and for low-income developing countries that would receive remittances from skilled labor that has out-migrated or where the migrants seek skills training and then return to their countries of origin.

The two policies are similar in one prominent way. They support technology transfers generally rather than sector-specific transfers. The economics literature provides strong support for such general policies, and is more mixed on the effectiveness of sector-specific policies (Noland and Pack, 2003). The effectiveness of sector-specific policies depends on the ability of governments to target industries with the largest market failures, where intervention is economically justified to promote socially optimal levels of activity. The effectiveness also depends on the ability of government to target firms that can become competitive over time (i.e., to learn by doing) such that supports are eventually no longer needed. The economics literature provides weak support for such technology targeting of "infant industries." This point is relevant since the target goals articulated in the UN (2014) report include both general proposals as well as sector-specific proposals (see Section 1).

What then would a global enabling environment look like that supports technology transfers? I circle back to this question as the majority of the technology transfer goals summarized in the UN (2014) report are listed under the challenge area: "Strengthen and enhance the means of implementation and global partnership for sustainable development." The literature suggests that there needs to be a balance between national policy freedom and policy coordination through international agreements (Finger, 2002; Helleniner, 2000; Hoekman, 2005; Sabel and Reddy, 2002). Some have suggested that multilateral monitoring and exchange of information and policy assessments through international institutions can be more effective than international policy harmonization through regional or multilateral agreements. Hoekman, Maskus and Saggi (2005) further suggest that technology transfer policies could be linked to the special and differential treatment of developing countries within the WTO. This approach would allow for latitude in policy variation for developing countries. Or alternatively, technology transfer policies could be integrated into existing or new WTO agreements. As these authors suggest, R&D subsidies relate most closely to the WTO Agreement on Subsidies and Countervailing Measures which allows for non-actionable subsidies under certain conditions; and the innovation zones relate most closely to provisions under the General Agreement on Trade in Services for temporary international movement of people providing services.

Finally, how do the Maskus (2014) proposals stack up in the context of the long list of goals being considered by the UN for 2015-2030? Are R&D subsidies and innovation zones a high priority for development assistance? The two policies are quite different in terms of their cost effectiveness. The R&D policies result in a benefit-to-cost ratio of roughly 1.4 suggesting that for every dollar spent there is a $1.40 benefit. In contrast, the North-South innovation zone results in a benefit-to-cost ratio that ranges from 13 to 30 suggesting that for every dollar spent there is a $13 to $30 benefit within the zone. And, a South-South zone results in a benefit-to-cost ratio of roughly 7 suggesting that for every dollar spent there is a $7 benefit within the zone. For the innovation zones, the caveat is that the benefits and costs at the country level depend on whether the country is predominantly a source or destination for the labor movements and whether migrants remit income back to their country of origin. This analysis suggests that the R&D proposal does not qualify as a strong or phenomenal investment, whereas the innovation zone policy does fall in the strong-to-phenomenal range. In other words, the innovation zone policy is cost effective and can be considered a sound investment for promoting technology transfers that support economic development.

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This paper was written by Pamela J. Smith, Associate Professor at University of Minnesota. The project brings together more than 50 top economists, NGOs, international agencies and businesses to identify the goals with the greatest benefit-to-cost ratio for the next set of UN development goals.

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