

# Skill, Innovation and Wage Inequality: Can Immigrants be the Trump Card?

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## **Impressum:**

CESifo Working Papers

ISSN 2364-1428 (electronic version)

Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH

The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute

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# Skill, Innovation and Wage Inequality: Can Immigrants be the Trump Card?

## Abstract

With the ensuing immigration reform in the US, the paper shows that targeted skilled immigration into the R&D sector that helps low-skilled labor is conducive for controlling inequality and raising wage. Skilled talent-led innovation could have spillover benefits for the unskilled sector while immigration into the production sector will always reduce wage, aggravating wage inequality. In essence, we infer: (i) if R&D inputs contributes *only* to skilled sector, wage inequality increases in general; (ii) for wage gap to decrease, R&D sector must produce inputs that goes into unskilled manufacturing sector; (iii) even with two types of specific R&D inputs entering into the skilled and unskilled sectors separately, unskilled labor is *not always* benefited by high skilled migrants into R&D-sector. Rather, it depends on the importance of migrants' skill in R&D activities and intensity of inputs. Inclusive immigration policy requires inter-sectoral diffusion of ideas embedded in talented immigrants targeted for innovation.

JEL-Codes: F220, J310, O150.

Keywords: HIB, immigration, innovation, wage gap, skill, R&D, policy, RAISE Act.

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## Skill, Innovation and Wage Inequality: Can Immigrants be the Trump Card?<sup>1</sup>

*“How educated immigrants are matters because, although the economic gains for low-skilled migrants of moving to America are great, the benefits to the American economy are not clear. Highly skilled immigrants, by contrast, offer a lot to their adopted country. Education seems to matter much more than where people come from.”—pg. 25, The Economist, August 12<sup>th</sup>, 2017<sup>2</sup>*

### 1. Introduction:

No other issue has received so much attention in recent policy debates as the issue of role of immigrants for economic growth and development of the US economy, and it has raised controversies in different camps, either supporting or opposing it.<sup>3</sup> Recent presidential debates, since the time of President Barack Obama, have focused on the high-profile H-1B program among other specific policies. Also, European refugee crisis from war-ravaged zones has spawned the conflict for assimilation of migrants with frictions. Current uproar about migration and assimilation of foreigners, frequently heard arguments resonate with the discussion on domestic impact on labor market, especially with respect to wage dispersion between skilled and unskilled workers in the aftermath of influx of immigrants. As both types of labor immigrate into the developed nations with the prospect of better income and socio-economic conditions, the heated debate about repercussions on rich host’s domestic economy is replete with controversies. As skilled immigrants contribute to the rich nations by dint of their talents and knowledge (for example, in high tech industry and Silicon Valley)<sup>4</sup>, while unskilled workers displace the native low-skilled one (e.g., high school dropouts or those with non-tertiary education level), the debate essentially hinges on the issue of benefits and costs of curbing skilled vis-à-vis unskilled migrants. Gordon (2016) has offered a detailed study on the U.S economic growth and what is in store for her unless some appropriate measures are taken for nurturing innovation by exploiting ingenuity of workers.

Recent U.S. election thanks to President Trump’s policy of curbing immigration has attracted academic interests on role of immigrants—especially skilled talents—in

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<sup>1</sup> With whatsoever no intention, use of the word ‘trump’ here is based on Merriam Webster definition where trumping up means ‘overriding’ or ‘winning over’ or ‘a decisive overriding factor or final resource, or a dependable and exemplary person.’ See <https://www.merriam-webster.com/dictionary/trump>

<sup>2</sup> Attitudes to immigration. Still Yearning. The Economist, pp. 25—26. August 12<sup>th</sup>, 2017.

<sup>3</sup> The most recent is the one announcing the repeal of DACA program on September 5<sup>th</sup>, 2017.

<sup>4</sup> Economist article (ibid.).

contributing to the U.S. economic growth. The introduction of Reforming American Immigration for Strong Employment (RAISE) Act in the US senate in February 2017 (revised in August 2017) aims to reduce over 10 years the legal immigration by 50%, as well as restrictions on green card, cap on refugees, and termination of visa diversity lottery. This will affect both skilled and unskilled workers.<sup>5</sup> Deferred Action for Childhood Arrivals (DACA) is another in the pipeline to be ended in March 2018.

Not only in the U.S., recent Brexit phenomenon or elections agenda of France for the nationalist party, or for that matter the dissonance or antipathy towards the EU (and hence, moving out of EU) are also pointer to the fact that ‘immigration’ is a major agenda to cure domestic economic malaise in the labor market. But, ironically EU Horizon 2020 or Talent Mobility Program under FP 7 (Seventh Framework Plan) are opening doors of ‘global pool of talents’ via research and brain pool initiative. So does South Korea in a non-English speaking environment to harness global talents to research, innovate and do cutting-edge research to enhance the frontier of technology.

Many economists have raised concern about such anti-immigration (or, anti-globalization) forces and their potentially grave impacts in future (Stiglitz, Krugman in Project Syndicate). Without assigning malice or being suspicious, can immigration turn into opportunity? This paper throws light in that direction where skilled migration-led innovation can have spillover benefits for the unskilled under certain plausible conditions.

Tension between skilled native versus skilled immigrant talents cannot be overlooked. Thus, it is pertinent to study the impacts of skilled immigration on innovation of such developed economies and how does it cause ‘tension’ in the developed destination economies’ labor market internally. Similarly, as technologies are not confined and rather percolate or diffuse across sectors/firms, the “labor-linking” nature of such aspects can no way be underestimated for welfare of skilled vis-à-vis unskilled. Otherwise, backlash will follow from both camps of the labor with adverse consequences. Restricting immigration could be counter-productive via contraction of

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<sup>5</sup> [https://en.wikipedia.org/wiki/RAISE\\_Act](https://en.wikipedia.org/wiki/RAISE_Act) and [https://www.aier.org/research/unskilled-immigrants-do-not-harm-americans?utm\\_source=Web+Articles+08202017+Prospects+&utm\\_campaign=Web+Articles+08202017+Prospects+&utm\\_medium=email](https://www.aier.org/research/unskilled-immigrants-do-not-harm-americans?utm_source=Web+Articles+08202017+Prospects+&utm_campaign=Web+Articles+08202017+Prospects+&utm_medium=email)

innovative sector/s producing R&D output used as inputs into manufacturing sectors. Thus, it would affect productivity of innovation-user sectors in the industries. Skilled migrant differs in terms of productivity from native skilled, hence, wage differentials exist. This paper adds value by exploring the role skilled immigrants in innovation in countries like the US, and how does that affect the wage gap. In other words, we analyze under what conditions the adverse wage impact could be arrested so as to make immigration policy inclusive.<sup>6</sup> As Kerr (2016) has mentioned: “These discussions naturally lead to a key objective that research should address over the next decade, namely, to trace out how high-skilled migration impacts inequality within and across countries. ... Second, to understand the impact of high-skilled migration for inequality, we need to understand the real distribution of returns. This task is again quite complex and requires extensive micro-data work.” Supporting high-skilled immigration to a limited extent, Borjas (August 2017) has argued that: “Exceptional high-skill immigrants will introduce knowledge and abilities that we will learn from, making us more productive, and expanding the frontier of what is economically possible in our country. And high-skill immigration, unlike low-skill immigration, will reduce, rather than increase, income inequality.” But unskilled immigration is thought to be harmful.

In order to analyze this complex interplay of factors, repercussion across sectors and labor types, a general equilibrium mixed-specific factor model in trade based on Jones (1965, 1971) is employed. A stylized specific factor model and its variants with three sectors--skilled and unskilled sectors, and an R&D (innovative) sector, and three primary inputs, viz., capital, two skilled labor types, and unskilled worker ---is developed. R&D innovation—produced via specialized talent/skill and capital—is used in both the final goods sectors. Depending on skill and/or, R&D-intensity in the sectors, the direction of wage inequality will evolve. In effect, knowledge embodied in high-skilled talents diffuse to other sectors. For an inclusive immigration policy absorbing unskilled labor in the diaspora, we see that innovation should be having spillover effects across sectors and therefore, as opposed to opposition immigration could turn into

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<sup>6</sup> Inclusive growth and development agenda focuses on assimilation of diaspora, not discrimination or curb of global talent flows. As globalization is in full swing, restricting labor migration is impossible thanks to, inter alia, labor-linking technology (Basu, 2017 JPM).

opportunity. As will be furnished below, this has ramifications for distributional consequences across the economy.

Section 2 offers stylized facts/background evidences which motivates the theoretical model in section 3. Section 4 derives some comparative static results with intuitive discussion on policy implications. Section 5 concludes.

## **2. Literature and Stylized Facts**

Recently, in an excellent survey Abramitzky and Boustan (2017) has documented the historical and current flows of immigrants into the US economy and its impact on the labor market and attributed higher immigration to higher rates of trade, innovation, and economic growth. Regarding the impact on employment and wages in the US economy, the study concludes that: there are skill heterogeneities (and hence, earning differences) among immigrants across ‘sending countries’ vis-à-vis the destination and immigration takes place for taking advantage of high returns to skill in the US; also, most importantly immigrants not having ‘net’ negative effects on the economy. Furthermore, it surveys the trajectory of researches showing that even within skill categories natives and immigrants are not perfect substitutes in production, patenting rates, and thus immigration increases total factor productivity via task-specialization. <sup>7</sup> Impact of high-skilled immigration on invention and innovation has been studied in the economics literature—see Hunt and Gauthier-Loiselle (2010), Kerr et al. (2016a&b), Akcigit et al. (2017a&B)—to document their positive contribution in the US economy via creation of ideas, knowledge diffusion, and positive externalities. In the context of Thai manufacturing, it has been shown that unlike developed countries with educated migrants enabling R&D, unskilled immigration from neighboring countries like Myanmar or Cambodia is more like ‘labor-saving technology without facilitating R&D investments, innovation and sustainable growth in the long run (Pholphirul and Rukumnuayakit 2016). According to the World Bank (2016) study, in 2010 28 million high skilled immigrants resided in OECD registering 130% escalation since 1990. Four countries in the world—Australia, Canada, UK, and US—account for 70% of these 28 million, with US hosting 41% (11.5 million) of OECD by herself. The report identifies that policy for attracting talents and positive spillovers through skill agglomeration and education apart from decline in trade and transport cost

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<sup>7</sup> In fact, it finds that ‘new arrivals created winners and losers in the native population and among the existing immigrant workers’ (p. 1312)

account for this sharp rise. In 2013, the share of foreign-born people in total population was 13.1% with total 41 million immigrants in total (Kim and Lim 2017).

Talented Immigrant workers usually occupy employment mainly in Science, Technology, Engineering and Mathematics (STEM) jobs related to R&D, innovative sectors spurring productivity growth and better economic performance. Role of foreign-born worker—talented inventors, workers with diverse skill spectrum from high, to medium, and low—in contributing to economic development of the host recipient nations has spawned debates and spurred researches which documented positive contribution of high-skilled immigrants for invention and innovation. There are some evidences of displacement of native skills in sciences and mathematics, and small positive externalities in the US following largest influx of Russian scientists and their ideas during post-1992 Soviet collapse (Borjas and Dorn 2012 and 2014). By studying contribution of doctoral students for innovation for 2300 US science and engineering schools for 1973-1988, Stuen et al. (2012) has found that: “Both US and international students contribute significantly to the production of knowledge at scientific laboratories, and their contributions are statistically comparable, consistent with an optimizing department. Visa restrictions limiting entry of high-quality students are found to be particularly costly for academic innovation.” Kerr and Lincoln (2010) and Kerr et al. (2016) find that H1B immigrants, foreign doctoral students, and college-educated talents increase patent rates, and positively impact on scientific contributions in the academia in the US (and other developed nations). Using a 1940-2000 panel data, Hunt and Gauthier-Loiselle (2010) has shown that ‘a 1 percentage point increase in immigrant college graduates’ population share increases patents per capita by 9—18 percent’ and ‘immigrants patent at double the native rate, due to their disproportionately holding science and engineering degree’; even they provide complementary skills, such as entrepreneurship, to natives to be more inventive (p.31-32, *ibid.*). they also find that talented immigrants account for 24% of patents and hence, diaspora networks facilitate knowledge diffusion across migrants and natives with different skill spectrum. Using publication citations of Web of Science data, Ganguli (2014) has shown that Russian scientists’ publications in post-1992 when Russian scholars emigrated to the US. Freeman (2014) has provided evidence that increase in foreign-born scientists and engineers in US universities and in the labor



market is facilitated by globalization of scientific and technological knowledge as it spawned collaborative works via aligning immigration policies with educational attainment.

Although frictions exist, from the established evidences, immigrants facilitate innovation in the US economy and other countries in Europe. Nathan (2014) has discussed the “wider” impacts of high-skilled migrants in the context of U.S, Europe and other countries to offer the empirical evidence supporting such direct-indirect effects throughout the economies via thoroughfares of such R&D-intensive inputs. In case of US, using Federal Censuses and patent records for 1880-1940, Akcigit, Grigsby and Nicholas (2017b) has offered an historical account of role of migrant inventors (especially European) behind the emergence of fundamental technologies influencing not only the US, but other countries as well. As per their study, immigrants had 16% of patents in areas such as chemicals, electricity, and medical, mechanical-to name a few. Akcigit, Grigsby and Nicholas (2017a) reports that the share of immigrants in all inventors is 30%.<sup>8</sup> Kerr and Lincoln (2010) has found that: ruling out displacement effects, Higher H1B admissions increase patenting and science and engineering employment by inventors of either Indian and Chinese names.<sup>9</sup>

According to Kerr (2013), average skilled immigrants with better quality accounts for about one-fourth of workers in innovation and entrepreneurship sectors and help in technology exchanges and business expansion in other countries including their home. Mostly, these occur in the field of Science, Technology, Engineering and Mathematics (STEM) fields and occupations. Thus, apart from direct benefits there are scopes for spillover or indirect transmission of benefits to other sectors using such innovations. Kerr et al (2016) discusses possibilities of such benefits via talented migrants and calls for a framework analyzing such effects. By constructing a measurement of foreign-born expertise based on share of origin country’s patents in a given technology class and the number of migrants to US, Akcigit, Grigsby and Nicholas (2017a) found that immigrant

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<sup>8</sup> <http://voxeu.org/article/immigrants-and-innovation-us-history>

<sup>9</sup> Beladi et al. (2012) discusses the case of impact of outsourcing on the R&D in the home country and shows that the former reduces the latter as outsourcing emerges as a substitute, but it is complementary elements of product development as home country engages in both kind of R&D. In our model, immigrants enter to contribute for innovation and its diffusion across natives as well as, for reverse technology flows to the source wherefrom immigrants come.

inventors contribute not only to their own activities by generating ideas, but also in the other areas with positive externalities or spillovers via augmenting skills and productivity of domestic inventors; typically, they estimate that ‘1 standard deviation increase in foreign-born expertise is associated with increase in patents that is 40.8% of its standard deviation, similar to 30% increase in innovation (ibid.).’ Breschi et al. (2015) discusses the cases of knowledge spillover or diffusion to host as well as homeland via diasporic network and knowledge remittances for countries such as, South Korea, China, Russia and to a lesser extent, for India.

Using TFP as a proxy for innovation, Fassio, Kalantaryan and Venturini (2015) has shown for the period 1994-2007—in the context of UK, France and Germany—that migrants with their ‘foreign’ human capital are important in all sectors. They show that high-skilled migrants have positive effects on high-tech sectors while, the medium and low-skill contribute for manufacturing. Not only that, inter-sectoral complementarities also foster such innovation transmission. They highlight the necessity of a migration policy ‘focusing on the skill-specific needs of the productive system, strongly connected with the actual demand of firms (sectors).<sup>10</sup> Using patent citation as a proxy for knowledge in the context of Europe to USA migration, Douglas (2015) has offered evidence that correlation between international migration and trans-border knowledge flows from source/s to host, viz., US. For example, emigration of 41,000 people from UK to the US between 2001—2005 resulted in 1.23% increase forward citations with British inventors in 2006.<sup>11</sup> Although there are mixed evidences, such as, Canadian evidence showing modest impact on innovations, however, that is attributed to idiosyncrasy of employment policy and information frictions about credentials (Blit, Zhang and Skuterud 2017). Recently for fostering innovation-led development, the Canadian government is encouraging cross-border talent movement. According to Kerr et al. (2016b): “Canada has been very active in targeting skilled migrants who are denied or frustrated by the H-1B visa system in the United States, even taking out ads on billboards in the United

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<sup>10</sup> Demand-driven migration policy where tertiary educated migrants specific to sectors with more knowledge content as well as non-tertiary educated migrant workers is emphasized.

<sup>11</sup> Even return or reverse migration entails knowledge flows as well.

States to attract such migrants.”<sup>12</sup> Horton et al (May 2017) has shown that expansion of digitally connected labor markets facilitate flows of talent across the globe by connecting companies and contractors. Not only that, Basso et al (October 2017) has given evidence computerization led technological change and automation has decimated the routine-tasks, task-specialization, increasing the role of analytical task so as to fuel demand for skilled talent migration as well as that of unskilled immigrants for doing manual tasks and services.

Also, there are evidences of firm heterogeneity in demand for different skill (Deming and Kahn 2016). However, most of the innovations are primarily geared towards the skilled sector where it enhances productivity and does not benefit directly the unskilled sector. One important finding is that high-skilled immigration contribution to innovation and entrepreneurship has wider impact on non-routine biased technical change experienced in rich nations. As high-skilled migration changes occupational distribution, it has effects on labor market via changes in wage gap. In particular, Jaimovich and Sui (2017) have shown that such talent migration has in fact contributed to narrowing of wage inequality since 1980s. Akcigit et al. (2017a) finds wage gap between immigrant inventors and those with comparable native skilled workers and ‘potentially marginalized groups’ thanks to discrimination. As immigrant inventors through foreign-born expertise affect domestic inventions, ‘labor-linking’ aspects of innovations binding both kinds of labor is important.<sup>13</sup> Hence, myopic immigration policy should not pose barriers to unskilled labor and allow skilled migration for inclusive globalization.

As per Kerr (2013, 2016) and Nathan (2014), amongst others, there are substantial gaps in understanding the impact of high-skilled migration across sectors, economies and distributional consequences which needs better theorizing alongside empirical evidences. In what follows, we offer a theoretical framework for tracing general equilibrium impacts to show under what conditions such high-skilled talent migration led innovation could

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<sup>12</sup> Thum (2004) has discussed that instead of ‘direct immigration policy’ for a common labor market altering the composition of government expenditures by controlling goods and services provision can control migration.

<sup>13</sup> As opposed to trade, in the endogenous growth literature, skill-biased technological change (SBTC) is a prime suspect for wage inequality. However, recently Parro (2013) has identified the role of skill-biased trade—attributed to fall in trade costs causing decline in capital goods prices—for skill premium via capital-skill complementarity. This is not the subject of our paper. In this paper, ‘place premium’ is more pertinent as driving force underlying inflows of foreign-born workers into rich hosts.

improve wage inequality. Competitive trade models could capture such effects (Jones and Marjit 2009, Chaudhuri and Marjit 2017, Chaudhuri and Yabuchi 2011-to quote a few).<sup>14</sup>

### 3. Core Model

Consider two final goods sectors without any intersectoral mobility of labor types in the context of host country like the US: Skilled (X) and Unskilled manufacturing (Y). Another sector (M) produces specialized R&D inputs (i.e., R&D-intensive intermediate input embodying innovation) using specialized skilled labor with research talent ( $S^*$ ) (i.e., those with acumen for research and innovation potential) and capital (K). Unlike Jones (1971), here M is mobile R&D input used in both X and Y sectors along with heterogeneous immobile specific factors skilled labor (S) and unskilled labor (L). ‘M’ is innovative sectors while X and Y are innovation-user sectors. Thus, two different skill categories (viz., S and L) have access to produced R&D-input (M). In the basic model, S,  $S^*$ , L, and K are not mobile intersectorally.<sup>15</sup> We assume perfect competition in product and factor markets. The production setup is generally represented as:

$$\left. \begin{aligned} X &= X(S, M) \\ Y &= Y(L, M) \\ M &= M(S^*, K) \end{aligned} \right) \quad (E1)$$

Production functions in (E1) are assumed to exhibit linear homogeneity and diminishing returns (DMR) to respective inputs. Following notations are used to describe the model:

X: Skilled sector

Y: Unskilled sector

M: R&D sector for specialized inputs catering to X and Y.

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<sup>14</sup> These kinds of models are plenty, such as, Marjit and Kar (2013) showing role of capital flows causing two-sided wage gaps between skill types as some industries disappear due to factor price changes; Beladi et al. (2011, 2013) has considered trade and skill premium in the context of skill formation and finite changes; Mandal and Marjit (2010) has considered the role of engagements in corruption by skill and unskilled workers resulting in wage inequality; Kar and Beladi (2017), on a different note, modeled the case of illegal immigrant trafficking, and smuggling of unskilled workers and impacts on illegal wages of unemployment benefits. All these models demonstrated the elegance of a general equilibrium mechanism to arrest the effects of contemporary real world issues. However, the phenomena of H1B restrictions is as recent a policy shock that its ripple effects could only be analyzed within such an eclectic framework. This is our value-addition.

<sup>15</sup> Subsequently, to explore the implications under different scenarios, variant of the basic model will be discussed in the paper. Beladi, Marjit, and Weiher (2011) is an important contribution for analyzing skill demand in the context of emerging economies like India and China. Current paper is in the context of developed US economy and for mobility of high skilled talents from sending to receiving nations.

$P_j$ : exogenously given prices for  $j^{\text{th}}$  final good,  $\forall j \in \{X, Y\}$  and  $P_m$  is price of M

$w$ : Unskilled labor's wage in the host country

$w_s$ : Skilled labor's wage in the host. Assume originally,  $w_s > w$ .<sup>16</sup>

$w_s^*$ : Specialized Skilled labor's wage (or, return to innovation talent).

$r$ : Return to homogeneous capital.<sup>17</sup>

$a_i^j = i^{\text{th}}$  input required to produce 1 unit of  $j^{\text{th}}$  good,  $i = L, S, S^*, K, M$ ; and  $j \in \{M, X, Y\}$ .

$\theta_{lj} = w_l a_l^j / P_j$  is the distributive share of  $l^{\text{th}}$  labor-types in the production of  $j \in \{M, X, Y\}$ ,

$\forall l \in \{S, S^*, L\}$ ;

$\theta_{kj} = r_k a_k^j / P_j$  is the distributive share of owner of capital K for M;

$\theta_{mj} = P_m a_m^j / P_j$  is the distributive share of M for  $j \in \{X, Y\}$ ;

$\lambda_{ij} = \frac{a_i^j Z_j}{f_i} = j^{\text{th}}$  commodity's input share in  $i^{\text{th}}$  factor's endowment, where Z is generic output and

$f$  is generic endowment;  $\sigma_j, \forall j \in \{M, X, Y\}$  is the elasticity of substitution in production.

$\bar{K}, \bar{S}, \bar{L}$ , and  $\bar{S}^*$  are factor endowments of respective primary inputs.<sup>18</sup>

“ $\wedge$ ” = proportional changes for a variable, say  $V$ , such that generically  $V = \frac{dV}{V}$ .

Note that we have two types of skilled labor—S, for general skill-based sectors, and  $S^*$  with R&D talents—as specific with  $w_s \neq w_s^*$ . Supply of ‘M’ requires specialized skill (talent or research skills) and capital (K)<sup>19</sup>. Perfect international capital mobility ensures that with no binding constraints,  $r = \bar{r}$ . However,  $S^*$ —specific to ‘M’ sector—is affected by global talent flows or skilled migrants (as well as native talents).

Following (E1), competitive equilibrium with zero pure profit condition implies that:

<sup>16</sup> Even in developing economies skilled labor attracts considerable higher wage than their unskilled counterpart, although levels are *lower than* the rich nations. Income gap is persistent in these nations with incidence of poverty.

<sup>17</sup> K is domestic capital or could be conceived as composite capital made of foreign and domestic types. Given the primary focus of the paper, we *do not distinguish* capital by origin. However, the model could be extended to incorporate foreign capital with higher premium and could study the impact of differences in relative premium between domestic and foreign capital on income gap and output response. In this model, *implicit presumption* is: being naturally capital-abundant, foreign capital inflow is already internalized in the economy via composite K.

<sup>18</sup> In these countries, “Immigration” is more common due to host economy's better conditions and hence, remittances are source of foreign capital for the source country. As there is no skill shortage, innovation or technical progress is important via knowledge diffusion, diasporic networks, spillovers to native skilled workers, as well as low-skilled labors.

<sup>19</sup> ‘K’ could be conceived as composite financial capital and/or, capital goods embodying superior blue-print of technology.

$$a_s^X w_s + a_m^X P_m = P_X \quad (1)$$

$$a_L^Y w + a_m^Y P_m = P_Y \quad (2)$$

$$a_{S^*}^M w_s^* + a_K^M r = P_m \quad (3)$$

$$a_s^X X = \bar{S} \quad (4)$$

$$\text{Full employment ensures:} \quad a_L^Y Y = \bar{L} \quad (5)$$

$$a_{S^*}^M M = \bar{S}^* \quad (6)$$

$$a_k^M .M = \bar{K}, \text{ with } r = \bar{r}$$

As innovation is occurring in R&D-intensive sectors which is used in X and Y, derived demand for 'M' is via increase in final goods production. Better input quality of 'M' improves quality of X and Y as per the variations in these coefficients.<sup>20</sup> The final demand for R&D output is given by:

$$a_m^X .X + a_m^Y .Y = M_d \quad (7)$$

where  $a_m^j, \forall j \in \{X, Y\}$  are R&D input-output coefficients.

Given  $P_m$  and CRS with DMR,  $a_s^X(w_s / P_m)$ ,  $a_L^Y(w / P_m)$ , and  $a_{S^*}^M(w_s^* / r)$  are the technological coefficients. Thus, given  $P_m$  and full-employment conditions, using (1) and (2), (4) and (6), we determine X and Y (note with 4 equations, given  $P_X$ ,  $P_Y$ , and  $P_m$  we determine X, Y,  $w_s$ , and  $w$ ). Given  $P_m$ , as  $w_s$  and  $w$  are determined factor proportions are also determined. From (1) and (2) as  $P_m$  rises, given prices of X and Y, wages have to fall. With DMR, as  $w_s$  and  $w$  fall,  $a_s^X$  and  $a_L^Y$  have to increase. Via (1) and (2), therefore, given  $P_X$  and  $P_Y$ ,  $a_m^X$  and  $a_m^Y$  have to fall, causing reduction in output of both X and Y, giving  $M_d = M_d(P_m), M_d' < 0$ . Rise in  $P_m$  will cause  $w_s / P_m$  and  $w / P_m$  to fall.

As  $a_s^{X'}(w_s / P_m) < 0$  and  $a_L^{Y'}(w / P_m) < 0$ , both  $a_s^X(w_s / P_m)$  and  $a_L^Y(w / P_m)$  increase. Thus, rise in  $P_m$  results in use of more of skilled and unskilled labor in respective sectors, and will cause  $a_m^j$  to fall across the board triggering fall in final goods production. Given equations (3) and (6), with DMR, and via envelope condition (Jones 1965), we can infer

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<sup>20</sup> Of course, better engineer, scientists and talents will improve quality of X and Y; however, here we do not model quality ladder or, variety of R&D inputs.

that as  $P_m$  rises (given  $r$  and  $a_K^M$ )  $w_s^*$  must go up,  $a_{S^*}^M$  falls, supply of M ( $M_s$ ) increases such that  $M_s = M_s(P_m), M_s' > 0$ .

$$M_d = M_s \Rightarrow a_m^X \cdot X + a_m^Y \cdot Y = M_s \quad (7')$$

(7') intrinsically corresponds to the full-employment of produced means of production (M). With  $M_d = M_s, P_m$  is determined.

As a whole, we have 7 equations (4 full-employment conditions, and 3 price equations for  $P=AC=MC$ ) and given exogenous world prices  $P_X$  and  $P_Y$ , we determine 7 variables, viz., outputs of X, Y, and M; and input prices  $w_s, w_s^*, w, P_m$ .

## 4. Equations of Change: Analysis of Results

### 4.1 Basic Model

Following discussions in preceding sections, for tracing the effects of talent immigration on innovation, we consider first the case that  $S^*$  is affected by talent immigration *targeted for innovative sector* only.<sup>21</sup> We consider comparative statics parametric changes to focus on ensuing policy changes. For enumerating proportional changes for the equation system (1) to (3), employing envelope theorem (Jones 1965), we derive, following [Sec 3](#), the factor-return shares— $\theta_{SX}, \theta_{mX}, \theta_{mY}, \theta_{S^*M}$ —to obtain:

$$\theta_{LY} w + \theta_{mY} P_m = P_Y \quad (9)$$

$$\theta_{S^*M} w_{S^*} + \theta_{Km} \hat{r} = P_m \quad (10)$$

**Proposition 1.** *Following high skilled immigration into the innovative R&D-sector, the wage inequality will improve iff  $\theta_{mY} > \theta_{mX}$ .*

**Proof:** Given  $r = \bar{r} \Rightarrow \hat{r} = 0$ , and from (10)  $\theta_{S^*M} w_{S^*} = P_m$ .  $\hat{P}_X = \hat{P}_Y = 0, \hat{P}_m \neq 0$ . With

immigration targeted to M-sector ( $\Delta S^* > 0$ ),  $w_{S^*}$  falls, and  $P_m$  falls too. Via (8) and (9),

both  $\hat{w}_S > 0, \hat{w} > 0$ . Using (8), (9) and (10), given shares and wage changes

$$\hat{w}_{S^*} = -\frac{\theta_{SX}}{\theta_{S^*M} \theta_{MX}} \hat{w}_S = -\frac{\theta_{LY}}{\theta_{S^*M} \theta_{MY}} \hat{w} \Rightarrow \hat{w}_{S^*} < 0$$

<sup>21</sup> Donald Trump's recent policy announcement favors post-graduate migrants for granting H1B visas (more to follow on this in Section 4.3).

X and Y production rise causing increase in demand for ‘M’ concomitant with its supply

to match.  $\hat{P}_X = \hat{P}_Y = 0, \hat{P}_m \neq 0$ . Using (8) and (9),  
 $\hat{w}_s = -\frac{\theta_{mX}}{\theta_{SX}} \cdot \hat{P}_m$  and  $\hat{w} = -\frac{\theta_{mY}}{\theta_{LY}} \cdot \hat{P}_m \Rightarrow \frac{\hat{w}_s}{\hat{w}} = \frac{\theta_{mX} \theta_{LY}}{\theta_{SX} \theta_{mY}}$ . Thus, using

$\theta_{LY} = 1 - \theta_{mY}$  and  $\theta_{SX} = 1 - \theta_{mX}$  we show that  $\frac{\hat{w}_s}{\hat{w}} > 1$  iff  $\theta_{mX} > \theta_{mY}$ . (QED.) As  $P_m$  falls,

$w_s$  and  $w$  both increase but degree of wage inequality will increase (i.e.,  $\hat{w}_s > \hat{w}$ ) if

skilled sector is more R&D-input intensive, or if share of unskilled labor in the

production cost of Y is higher than the share of skilled labor in X’s cost (i.e.,

$\theta_{mX} > \theta_{mY} \Leftrightarrow \theta_{LY} > \theta_{SX}$ ). In other words, for inequality to improve (i.e.,  $\hat{w}_s < \hat{w}$ )

innovative sector should be contributing more for the unskilled sector (i.e.,

$\theta_{mY} > \theta_{mX} \Leftrightarrow \theta_{LY} < \theta_{SX}$ ). Thus, a restriction on migration could have pernicious effect on

existing inequality. The intuition is clear: *ex post* with increase in supply of R&D inputs,

if R&D’s share is more to aid unskilled sector’s production, low-skilled worker becomes

more productive, registering in higher wage ( $w$ ) to reduce the prevalent wage gap.

$$\text{From (7) and (7'), we get: } \lambda_{mX} \hat{X} + \lambda_{mY} \hat{Y} = \hat{M}_S \quad (11)$$

where  $\lambda_{mj}$  is the share of the economy’s R&D supply used in the production of

$j \in \{X, Y\}$ . Let  $M_X + M_Y = M$  where  $a_m^X \cdot X = M_X$  and  $a_m^Y \cdot Y = M_Y$ .

Following (4), (5), and (6), we derive:

$$\hat{X} = \hat{S} - \hat{a}_S^X, \hat{Y} = \hat{L} - \hat{a}_L^Y, \text{ and } M = \hat{S}^* - \hat{a}_{S^*}^M \quad (12)$$

Now, *ex post* skilled immigration we infer that  $\hat{S}^* > 0$ . However, embodied talent or skill-

biased technical change (SBTC) latent in the high skilled migrants implies:

$$\hat{a}_{S^*}^M < 0 \Rightarrow \hat{a}_{S^*}^M = -\alpha, \alpha > 0. \quad (13)$$

Thus, using (12) and (13), we get  $\hat{M} = \hat{S}^* + \alpha$  (14)

It signifies that talent immigration with knowledge embodiment augments supply of

R&D innovations via SBTC. Via (7) and/or, (7') and (14), then we argue that

$\hat{S}^* > 0$  and  $\alpha > 0 \Rightarrow \hat{M}_S > 0, \hat{M}_X > 0, \hat{M}_Y > 0$  and given  $a_m^X$  and  $a_m^Y, \hat{X} > 0, \hat{Y} > 0$ .



Suppose, there is rise in immigration directed to X sector (or, increase in native high skilled pool of talents) so that  $\hat{S} > 0$ , and following earlier presumption about skill-embodiment or skill-upgrading,  $\hat{a}_S^X = -\beta, \beta > 0$ .

$$\text{Then, analogously } \hat{X} = \hat{S} + \beta \Rightarrow \hat{X} > 0. \quad (15)$$

Considering the ‘relative effect’ of both types of immigration (i.e.,  $\hat{S}^* > 0$  vis-a-vis  $\hat{S} > 0$ ), we observe that effective talent of high skilled migrant adjusted for quality ( via 14 and 15) augments output in R&D as well as skilled sector while innovation sector contributes to both skilled as well as unskilled labor. From (14) and (15),  $\hat{X} > \hat{M}$  iff  $\hat{S} + \beta > \hat{S}^* + \alpha \Rightarrow (\hat{S} - \hat{S}^*) > (\alpha - \beta)$ . With  $\beta = \alpha$ , it all depends on  $(\hat{S} - \hat{S}^*)$ . Thus, differentials between growth in skilled migrants going to X vis-à-vis that in M should be exceeding the differences in rate of technical changes in these sectors. This implies that in order to have higher output in skilled sector, it requires inflows of more foreign-born expertise, with skill-migrant biased technical change for the hi-tech R&D sector being higher than that in the skilled manufacturing sector. In case of unskilled sector, assuming low skilled migration *without* any superior technical skill upgrading ( $\hat{a}_L^Y = 0, \hat{L} > 0$ ), we see that for output of Y-sector, it all depends on relative magnitude of  $\hat{S}^* + \alpha$  and  $\hat{L}$ .

## 4.2 General setting

From the previous case, we see that sectoral R&D-intensity matters for direction of movement of wage gap. However, it is quite plausible that unskilled and skilled sector might not use the same generic R&D (i.e., M). In other words, in a fairly realistic setting *general framework* would be to consider that two different R&D varieties—say,  $M_1$  and  $M_2$  produced with  $S^*$  and K as in Heckscher-Ohlin setup—are used in X and Y sectors respectively (i.e.,  $X = X(S, M_1), Y = Y(L, M_2)$ ). Also, it is pertinent to assume that the nature of the R&D sector depends on the differences in factor intensities of  $S^*$  and K in  $M_1$  and  $M_2$  production. How inequality is affected in this set up and when targeting immigration to X as well as M-sectors? We will see that nature of R&D sector and share of R&D inputs in respective sectors matter. Consider the additional competitive equilibrium with zero pure-profit conditions now: -

$$a_{m1}^X \cdot P_{m1} + a_{S^*}^X \cdot w_{S^*} = P_X \quad (16)$$

$$a_{m2}^Y \cdot P_{m2} + a_L^Y \cdot w = P_Y \quad (17)$$

$$a_K^{M1} \cdot r + a_{S^*}^{M1} \cdot w_{S^*} = P_{m1} \quad (18)$$

$$a_K^{M2} \cdot r + a_{S^*}^{M2} \cdot w_{S^*} = P_{m2} \quad (19)$$

As before, demand curves for M-types are negatively sloping and equating with respective supplies, prices of each M-varieties are determined. Using envelope condition

$$\theta_{m1X} \cdot \hat{P}_{m1} + \theta_{SX} \cdot \hat{w}_S = \hat{P}_X \quad (20)$$

$$\theta_{m2Y} \cdot \hat{P}_{m2} + \theta_{LY} \cdot \hat{w} = \hat{P}_Y \quad (21)$$

$$\theta_{S^*m1} \cdot \hat{w}_{S^*} + \theta_{Km1} \cdot \hat{r} = \hat{P}_{m1} \quad (22)$$

$$\theta_{S^*m2} \cdot \hat{w}_{S^*} + \theta_{Km2} \cdot \hat{r} = \hat{P}_{m2} \quad (23)$$

$$\text{From (22) and (23), with } \hat{r} = 0 \Rightarrow \quad (24)$$

$$\theta_{S^*m2} \cdot \hat{w}_{S^*} = \hat{P}_{m2} \quad (25)$$

**Proposition 2.** *In a fairly general setting with two different R&D-inputs, with immigration of skilled labor targeted to the R&D input used in the skilled sector, wage inequality will aggravate iff that R&D sector is relatively more immigrants' skill intensive; otherwise, the wage inequality will improve iff it is relatively capital intensive.*

**Proof.** With exogenous prices,  $P_X = P_Y = 0$ . As immigration is targeted to M<sub>1</sub> and M<sub>2</sub>

sectors,  $w_{S^*}$  has to fall ( $\hat{w}_{S^*} < 0$ ) so that (via equations 24 and 25),  $\hat{P}_{m1} < 0, \hat{P}_{m2} < 0$ . From

equations (20) and (21), therefore,  $\hat{w}_S > 0, \hat{w} > 0$ . By manipulating (20), (21), (24) and

$$(25), \text{ we get as below: } \frac{\theta_{m1X}}{\theta_{SX}} \cdot \theta_{S^*m1} \cdot \hat{w}_{S^*} \text{ and } \hat{w} = -\frac{\theta_{m2Y}}{\theta_{LY}} \cdot \hat{P}_{m2} = \frac{\theta_{m2Y}}{\theta_{LY}} \cdot \theta_{S^*m2} \cdot \hat{w}_{S^*} \Rightarrow$$

$$\frac{\hat{w}_S}{\hat{w}} = \frac{\theta_{S^*m1}}{\theta_{S^*m2}} \cdot \frac{\theta_{m1X} \theta_{LY}}{\theta_{SX} \theta_{m2Y}} \quad (27)$$

Hence, given the shares of respective inputs in X and Y, viz.,  $\theta_{m1X}, \theta_{SX}, \theta_{m2Y}, \theta_{LY}$ ,

$\frac{\hat{w}_S}{\hat{w}} > 1$  iff  $\theta_{S^*m1} > \theta_{S^*m2}$  (or, equivalently,  $\theta_{Km1} < \theta_{Km2}$ ), resulting in worsening of wage

inequality. When M<sub>1</sub> is S\* intensive (relatively) than M<sub>2</sub> and M<sub>2</sub> is relatively K-intensive, with skilled migration, M<sub>1</sub> expands more than M<sub>2</sub> because S\* needs more K to work with, which is released from M<sub>2</sub>, causing contraction of its output. X production expands.

Consequently, production of Y falls as  $M_2$  does not expand, making unskilled labor (L) surplus so that her wage ( $w$ ) does not increase as compared to that of  $w_s$ .

Conversely,  $\hat{w}_s < \hat{w}$  iff  $\theta_{S^*m1} < \theta_{S^*m2} \Leftrightarrow \theta_{Km1} > \theta_{Km2}$ , resulting in improvement in wage inequality. In this case, as  $M_1$  is relatively K-intensive, increase in high skilled migration does not increase its production much; instead,  $M_2$ —more skilled migrants intensive—inflates, causing expansion of output of Y-sector using unskilled labor (L) and  $M_2$ ; hence, registering relatively more pronounced increase in her wage by fueling demand for L, so that  $\hat{w}_s < \hat{w}$ .

In another general setting where  $M_2$  used in unskilled sector (Y) is low-quality R&D-input produced with L and K (i.e., not using  $S^*$ ), here *targeted* high skilled migration ( $S^*$ ) will cause expansion of output of X via increase in  $M_1$  production, causing  $\hat{w}_s > 0, \hat{w}_{S^*} < 0$ . With rise in production of X and  $M_1$ , more Capital will flow out of  $M_2$  to  $M_1$ , aggravating wage inequality, that is,  $\hat{w}_s > 0, \hat{w} < 0$ .

In essence, we can infer: (i) if R&D inputs contributes *only* to skilled sector, wage inequality increases in general; (ii) for wage gap to decrease, R&D sector must produce inputs that goes into unskilled manufacturing sector (*helping the low-skilled*); (iii) even with two types of specific R&D inputs entering into the skilled and unskilled sectors separately, unskilled labor is *not always* benefited by talented or high skilled migrants entering into R&D-sector. Hence, it depends on importance of migrants' skill in R&D activities and intensity of inputs used.

Thus, how critical is the R&D inputs for the skilled and unskilled manufacturing sectors and nature of each of the R&D-sector (i.e., importance of skilled labor vis-à-vis capital for the R&D innovation) are crucial in driving the direction of movement of wage inequality. Facilitated by talent flows, wage gap could go either way, contingent on the contribution of R&D inputs (share in production)—produced by dint of high skilled labors' innovativeness and capital—entering the production of unskilled sector. Thus, nurturing high skilled talents from abroad could make immigration '*inclusive*' via provisioning of innovative input (better technology or knowledge inputs) into other sectors. This could improve productivity of the workers lacking access to technology absorption.

Given this backdrop of analysis, it's pertinent to explore the aspects of targeting skilled immigration—either into skilled manufacturing sector or, innovation or, both—for turning immigration policy— into best opportunity for the diaspora network as well as for the native workers in host country.

### 4.3 Immigration Targeting, Wage impact and H1B Visa Case:

We consider how wage inequality is affected in the following cases as below:

- (a) *Two different* skill types (S and S<sup>\*</sup>) going into X and M sectors, so that they are specific factors in each sectors
- (b) *Same skill types* contribute equally to both X and M sectors and targeting immigration into X-sector (skilled production) only.
- (c) *Same skill types* contribute equally to both X and M sectors and targeting immigration into R&D (M-sector) only.

Considering (a), it is very much identical as dealt in Sections 4.1 and 4.2.

In case of (b), unlike previous analysis, we now have:

$$\Rightarrow a_S^M M + a_S^X X = S \quad (28a)$$

$$a_S^M \cdot w_S + a_K^M \cdot r = P_m \quad (29)$$

The last one generates supply function for M, so that, as before,  $M_s = M_d$  gives  $P_m$ .

However, here  $M_d = a_m^X \cdot X + a_m^Y \cdot Y$  and equation (28a) implies that  $M_s, M_d$  now depend on  $S_M, S_X$ .

**Proposition 3:** *Skilled migration targeted into skilled manufacturing will have spillover effect on unskilled wage, both wages will fall, and inequality can go either way.*

**Proof.** Consider the following equations, by employing envelope condition for (29)

$$\theta_{Sm} \hat{w}_S + \theta_{Km} \hat{r} = \hat{P}_m \quad (30)$$

and the equations (8) and (9) as before (used in Proposition1). From (8) and (9), Using them,  $\hat{w}_S < 0, \hat{w} > 0$ , and further,

$$\frac{\hat{w}_S}{\hat{w}} = \frac{\theta_{mX} \theta_{LY}}{\theta_{SX} \theta_{mY}} \quad (31)$$

Thus, using  $\theta_{LY} = 1 - \theta_{mY}$  and  $\theta_{SX} = 1 - \theta_{mX}$  from (31), we derive, as before, that:

$$\frac{\hat{w}_s}{\hat{w}} > 1 \text{ iff } \theta_{mX} > \theta_{mY} \text{ and the opposite is true (QED.)}$$

With increase in skill migration targeted towards X-sector, demand for M will go up as migrants need more R&D-inputs to work with; however, this triggers rise in  $P_m$ ,  $S_M$ , and  $M_s$ , and fall in  $S_X$ . Substitution effect, induced by rise in  $P_m$ , will lead to rise in  $a_s^X$ , decline in X, while  $S_X$  goes down, resulting in fall in  $w_s$  and  $w$ . If Y is more M-intensive ( $\theta_{mY} > \theta_{mX}$ ), 'w' will fall by more; or the other way round. Here, 'w' does not fall as much as 'w<sub>s</sub>' declines because the targeted immigration to skilled manufacturing sector yields more derived demand and hence production of R&D, used more intensively without reducing demand for unskilled worker, and therefore, improving productivity. Thus, as before, thanks to the high-skilled migrants, spillover benefits to unskilled sector results in improvement in wage inequality.

As mentioned in case (c), if talent migrants are targeted to R&D-sector only, different mechanism comes into play because now wage impact will move in opposite direction (i.e., rise) as there will be two reinforcing channels—via both skilled and innovative sectors along with unskilled usage of innovative inputs—working on wages.

**Proposition 4:** *Skilled migration targeted into R&D-sector will have spillover effect on unskilled wage, and both wages will rise and inequality can go either way.*

**Proof.** Consider same sets of equations as in cases of Proofs for 2<sup>nd</sup> and 3<sup>rd</sup> propositions. However, here talent flows into innovative sector will cause its price to fall ( $P_m$  falls) as  $M_s$  rises causing downward pressure on its price.  $S_M$  rises. As X and Y both use it for their production along with Skilled and Unskilled labor, both wages rise, i.e.,  $\hat{w}_s > 0, \hat{w} > 0$ . However, iff X uses M more in its production than Y (i.e.,  $\theta_{sX} > \theta_{sM}$  and  $\theta_{mX} > \theta_{mY}$ ), and as more L is required in the Y-sector with 'M', wage inequality worsens,  $\hat{w}_s > \hat{w} > 0$ . On the contrary, wage inequality improves ( $\hat{w}_s < \hat{w}$ ), iff  $\theta_{mY} > \theta_{mX}$ . This supports our conjecture that even if same skill types could contribute to skilled manufacturing and/or, innovative R&D sectors, targeting immigration to the latter helps through induced spillover to the unskilled sector using the innovative input relatively intensively in its production. Furthermore, this helps improving wage inequality via reduction of existing wage gap.

All the foregoing analytical exercises in the basic model and its variants or extensions are capable of handling the recently passed bill in the US congress for H1B and L1 visa holders with skill and specialty talents, under which US Citizenship and Immigrations Service (USCIS) issues 65,000 H1B visas and 20,000 for those with advanced degrees in STEM subjects are granted visa annually (H-1B visas to several categories like those in academic and research institutes is exempted from the Congressional mandated limit).<sup>22</sup>

As mentioned before, under the Trump administration to protect jobs for low-skilled and unskilled American jobs and to avert the ‘sharp decline in wages’ for Americans recently passed legislation Cotton-Perdue bill (RAISE Act) aims to restrict legal immigration by 50% so as to fix immigration at ‘historically normal level’. At the same time, the emphasis is on higher wages for the workers.<sup>23</sup> Under the ‘Protect and Grow American Jobs Act (HR 170)’, replacement of American workers with skilled H1B employees are prohibited. This will impact the IT professionals’ migration from India. However, the Act ‘dramatically increases the salary requirements for H1B workers’, with an inflation-adjusted minimum salary of US\$ 90,000 raised from 60,000 and the maximum of US\$130,000.<sup>24</sup> As per news report quoting Pew Research Center, ‘for eight of the top 10 India-centric IT companies, the average salary for workers on H-1B visas was higher than the median salary for US citizens in computer and mathematical jobs.’<sup>25</sup> There are disagreements and rooms for conflicts of interests about the legislation as many doubts it is driven by myths. Not only that, there are shortage of skilled talents in the US for such employment and 20 million job losses every year are not linked to H1Bs, rather it’s a different issue. Except a study by Borjas (2017), most studies find the argument flawed.<sup>26</sup>

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<sup>22</sup> <https://economictimes.indiatimes.com/nri/visa-and-immigration/us-resumes-premium-processing-of-all-h-1b-visa-categories/articleshow/60935385.cms>

<sup>23</sup> <http://www.hindustantimes.com/india-news/bill-to-halve-the-number-of-legal-immigrants-can-hit-indians-working-in-the-us/story-W6pi6DjtMy1ZlqWHEan1bP.html>

<sup>24</sup> <https://economictimes.indiatimes.com/nri/visa-and-immigration/congressional-committee-votes-to-increase-minimum-salary-of-h1b-visa/articleshow/61665673.cms>

<sup>25</sup> <https://economictimes.indiatimes.com/nri/visa-and-immigration/congressional-committee-votes-to-increase-minimum-salary-of-h1b-visa/articleshow/61665673.cms>

<sup>26</sup> <https://www.politico.com/magazine/story/2017/08/04/why-trumps-new-immigration-bill-makes-sense-215457>

Given the above legislation, *our basic model*—with minor modifications as per the case—is capable of offering cogent insights from a general equilibrium perspective. We consider the cases of no-restriction on H1B visa in both innovation and skilled production sectors, and policy reversals in the current US administration. Consider the following scenarios: -

- a) *Case of R&D-sector*: in this scenario, without visa restrictions R&D talents/professionals come at a cheaper price, so that  $w_{s^*}$  falls to internationally low level (or, say at the lower level as that in emerging economies like India or China). With  $r = \bar{r}$ , and lower wage level, we determine  $\theta_{s^*m} w_{s^*} = P_m$  i.e., it translates into lower price of R&D input ( $P_m$ ) with flat  $M_d$ . Supply of  $M$  increases. Both skilled and unskilled production sector expands with capital and labor moving freely. As discussed before, both  $w_s, w$  rises as they expand their production with more innovative inputs along with labor types. Low initial  $P_m$  implies (from basic model equations) that  $w_s$  was high while  $w_{s^*}$  was low. Therefore, we see possibilities of *inter-skill* groups as well as *intra-skill* groups movement of inequality. *With policy reversals*, where restrictions are in place with high salary going to the cream of H1Bs, now  $w_{s^*}$  will rise reflecting on higher  $P_m$ , and raising demand for innovation sector output. Then, from the basic model we can see innovative sector contracts along with both skilled and unskilled production sectors resulting in  $\hat{w}_s < 0, \hat{w} < 0$ . Following propositions 1 and 4 above, wage inequality can go either way depending on the relative input-intensity (i.e., intermediate R&D input vis-à-vis skill labor types).
- b) *Case of Skilled Production Sector*: in this scenario, without visa restrictions H1B workers come at a lower international price level (as from India, Korea or China) to be absorbed into the skilled production sector ( $X$  in the basic model). This implies adjustment of  $w_s$  to a lower level, and as before,  $P_m$  is determined with flat demand curve for  $M$ -sector. Supply of  $M$  determines its actual use. However, with low wage in production sector demand for R&D input goes up via  $X$ -sector and  $P_m$  inflates causing  $\hat{w}_{s^*} > 0$ . Substitution effect (and DMR) will lead to fall in

$a_m^X, a_m^Y$  and rise in  $a_s^X, a_s^Y$ , and  $\hat{X} < 0, \hat{Y} < 0$ . Increase in supply of innovative input and fall in its demand will lead to exports of R&D-input (kind of reverse outsourcing R&D) at the world price of  $P_m$ . This makes it exogenous like  $w_s$ . Inequality between two kinds of labor—R&D professionals and skilled production workers—will rise; however, as we saw before, between skilled and unskilled it can go either way depending on use of innovative input intensity in use. With policy reversal, restrictions on H1B and higher wage,  $w_s$  will increase and so will  $w$ . Also,  $P_m$  falls, export of M contracts, and hence  $w_{s^*}$  is reduced.

Thus, both the cases illustrate that whether it's win-win depends on H1B policy effectiveness in respective skill-specific sectors. In fact, Khanna and Morales (July 2017) has discussed in a general equilibrium simulation model doing counterfactual analysis in the context of India that the IT exuberance and US immigration policy are mutually conducive; in other words, they showed that high-skilled immigration is mutually beneficial for both the countries as it enabled India to move up the occupation ladder while for US, the benefits occurred via innovation and spillover to natives. Koppel and Plunnecke (2017) has shown that in the context of even Germany and Europe qualified immigrants with skill have played major role in STEM employment, esp. from India rising to the top (in Germany, for example, Indian STEM employment has doubled pushing China in third rank), thanks to the diasporic network effects as well as skill factors.

### **5. Discussion and Remarks:**

The analytical model—based on background stylized evidences and current spate of debate about restrictions on immigrations—shows that apprehension about adverse impacts on wage gap in the rich host economies (either in EU or USA) is not well founded. Under alternative scenarios about migration of high skilled talents into skilled and innovative sectors, we argue that policy debates about migration-induced wage inequality should consider the contribution of innovative sector in cost-share of different sectors of the economy. The results corroborate the fact that relative shares of R&D inputs and skilled vis-à-vis unskilled workers matter for direction of movement of wage inequality between skilled and low-skilled workers; in other words, the apprehension and hence, the policy debates in the US that wage inequality will worsen following high



skilled migration ignore the important aspects of how innovative sectors could benefit the low skilled manufacturing with a conducive spillover effect on the unskilled wage. In particular, the results point out that if R&D-input—innovated via talent migrants in the innovative sectors—is important in production (i.e., higher relative cost-share than that in the skilled sector) for the unskilled manufacturing sector, wage inequality decimates. Even with homogenous skill types used in both innovative and skilled sectors, skilled immigration in R&D sector will lower wage inequality in fairly general setups, irrespective of different R&D-input types and immigrant skill types.

For immigration to be inclusive, contributions of high skilled talent for innovation should have induced spillover effects. In other words, the share of output of innovative sector is critical for unskilled to benefit. Via R&D done by talented migrants' innovativeness, the unskilled productivity improvement results in increases in their wages, resulting in reduction of the existing wage gap. Therefore, unanimous across the board ban on immigration might be counter-productive unless direct and indirect spillover potentials are neglected. It is prudent to use the foreign talents for productivity-enhancing sectors by dint of their innovation potentials. Under the aegis of globalization, the policy resilience in the economy could be built by channelizing the pool of foreign human capital in high value-added sectors that, without disruption, help the unskilled to make immigration inclusive. In keeping with the background facts and literature (vide section 2), this result confirms our conjecture. Although our analysis is predominantly focusing on US case, role of skill composition of immigration and its effects on innovation is significant in Europe as well as in other advanced nations. For example, Ozgen et al. (2017) presents evidences that for a panel of 170 regions in Europe (NUTS 2 level), average skill levels of the migrants affect patent applications significantly. Same for New Zealand (McLeod et al. 2014).

In essence, this implies that without eviction or blocking of skilled vis-à-vis unskilled workers, the rigid immigration policy could be made inclusive by utilizing high skilled immigrants in STEM employment and using the outcomes for other sectors that employ low skilled labor and immigrants. If the employment of foreign-born skilled workers translates into enhanced innovation and growth without crowding-out of native workers (skilled and unskilled), host country welfare will certainly improve. This

research has a wider connotation for policy dialogues on migration, innovation and productivity.

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