Skilled Immigration, Offshoring, and Trade*

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Abstract

We develop a dynamic general equilibrium model with skilled immigration, offshore labor hiring, and intermediate input trade to study the impact of skilled immigration policy changes in the US. Consistent with the data, the model accounts for a small subset of large firms that adjust offshore labor hiring in response to skilled immigration policy changes. Our calibrated model that matches the US economy shows that if we ignore the offshoring channel, we would overstate welfare gains to skilled domestic wage earners by approximately 20 percent following a 10 percent immigration cap reduction. The paper highlights the importance of considering the interactions between immigration, offshoring, and trade when studying the impacts of skilled immigration policy on domestic labor markets and trade.

JEL Classification: F16, F22, J61, J68.
Keywords: Immigration policy, Intermediate input trade, Offshoring, Skilled immigration.

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1 Introduction

There has been a significant increase in skilled migration to the US in recent years. According to the Current Population Survey, skilled foreign-born workers now constitute more than 17% of the US skilled labor force.[1] This phenomenon has led to growing debates on immigration policy and increasing concerns about wages and employment of domestic workers. One of the key arguments for a stricter skilled immigration policy is that it would lead to higher wages and employment gains for native skilled workers.

What is often overlooked is that skilled immigration policy affects not only the skilled labor market but also firms' employment decisions on various dimensions, for instance, (a) domestic vs foreign, (b) skilled vs unskilled, and c) domestically vs offshore. Immigration policy discussions need to take into account firms' optimal responses and feedback effects on labor markets. This paper mainly focuses on one such important channel. Multiple surveys have documented that the cap on the entry of skilled foreign-born workers via the H1-B program and associated administrative procedures impose frictions.[2] These incentivize firms to increase their offshoring activities by sending foreign workers to offshore affiliates and/or hiring foreign skilled labor in these affiliates.[3] Therefore, the design of US skilled immigration policy requires models with systemic links between skilled immigrants and offshore workers. However, most of the debates and literature surrounding the impacts of skilled immigration policy changes ignore this offshoring channel, even though it is potentially important for how skilled immigration policy changes affect wages, employment, and domestic households' welfare.

This study aims to highlight this important caveat — policies that restrict skilled immigration may not affect wages as much as one would expect. Instead, firms can respond through hiring skilled labor at offshore locations or through importing skill-intensive intermediate inputs. Motivated by this, we build a dynamic general equilibrium model that is consistent with key trends in the data and includes a channel where firms can adjust their offshore labor hiring following immigration policy changes. Our main goal is to quantify the relevance of the offshoring channel when evaluating the welfare impacts of skilled immigration policy changes on skilled and unskilled domestic workers. Our results indicate that it is important to account for this channel. We also aim to shed more light on the channels that link skilled immigration, offshore labor hiring, and intermediate input trade.

We first document some trends related to firm hiring of foreign-born skilled labor using data from the

[1]Among all foreign-born individuals, those with at least a bachelor's degree witnessed the sharpest increase (42%) during the 2004–2016 period. The corresponding increase for the native-born in the same skill group was 26% in the US. According to Kerr et al. (2016), skilled and low-skilled workers' global immigration increased nearly 130 and 40%, respectively, from 1990 to 2010.

[2]In the US, the H1-B visa is the dominant entry route for foreign skilled workers. The cap on H1-B visas was reduced from 195,000 to 85,000 in 2004, and has been binding since. See Appendix B for an overview of the H1-B policy and the quota.

[3]According to a survey by Anderson (2012), for the National Venture Capital Association, 43% of the companies said that the lack of H-1B visas influenced the company's decisions to place or hire more personnel in facilities located outside the United States. In another survey (Slaughter 2016), 77% of firms responded that "skilled positions unfilled for more than 30 days harm their operations and 71% thus say that if it became too difficult to find qualified talent in America, they would consider relocating". According to GAO (2011)'s report, in years when firms did not receive approvals for their H-1B petitions, most of the large, multinational firms reported that they were generally able to hire their preferred candidates by sending the candidate to work in an overseas office, but they had to incur additional costs to do this.

Bureau of Economic Analysis (BEA), Labor Condition Applications (LCA), and Compustat. The bulk of the demand for immigrant skilled labor in the US is accounted for by the Professional. Scientific, and Technical services sector. Since 2004, this sector has witnessed an increase in offshore labor employment in foreign affiliates located in the Asia Pacific region, particularly in India. There has also been an increase in the sector's output that is traded. Consistent with the increase in offshore labor hiring by domestic firms, the share of domestic imports from foreign affiliated firms has increased.[4]

Since we focus on firms' responses to immigration policy changes, we also highlight some firm-level trends related to hiring of immigrant skilled workers. First, approximately 46% of firms in our sample do not hire foreign skilled workers, i.e., have not submitted any applications for foreign workers during our sample period (2012–18). These are the smallest in terms of total average sales and 98% of these are not Multinational Enterprises (MNEs). Second, approximately 45% of firms hire immigrant skilled labor, and are also not MNEs. These account for around 18% of the total demand for immigrant skilled labor. Finally, only 9.2% of the firms are MNEs that hire immigrant skilled labor. However, these account for more than 80% of the total demand for these workers. These firms are also the largest in terms of average sales. We also highlight that there is notable persistence across firm types in the data. Firms that do transition between hiring and not hiring immigrant workers across years only account for less than 2% of the total demand for immigrant skilled workers.

Motivated by the above trends, we build a two-country (Home and Foreign), two-sector (skilled and unskilled), dynamic general equilibrium model with offshoring, skilled immigration, and intermediate input trade. The skill-intensive sector at Home includes heterogeneous upstream firms that differ in relative productivity and produce differentiated inputs. A representative downstream firm combines inputs from these domestic intermediate firms with imported intermediate inputs to produce the final skill-intensive good. A representative outside sector hires unskilled labor to produce the unskilled good. Output from both sectors are consumed by the final consumers at Home, which include domestic skilled households, domestic unskilled households, and immigrant skilled households.

Consistent with the data, firms in the upstream sector at Home include a subset of firms (type d) that hire only domestic workers, a subset of firms that hire imperfectly substitutable skilled domestic and immigrant workers but are not MNEs (type f), and a subset of firms that hire imperfectly substitutable skilled domestic and immigrant workers and are also MNEs (type m). Only type-m firms have operations in Foreign and can hire labor in offshore affiliates. Type-d firms are below an exogenously-set cutoff in the Pareto distribution and are therefore less productive than type-f firms, which are in turn below another exogenously-set cutoff that separates type-f from type-m firms. Therefore, consistent with the data, MNEs that hire immigrant workers are larger than non MNEs that hire these workers and both these firms are larger than firms that do not hire any foreign workers.

Types-f and -m firms are forward looking and optimally choose the amount of immigrant skilled labor to hire, subject to an immigration policy-imposed cap, a hiring cost for each worker, and an exogenous

[4] If more labor is hired in offshore affiliates to produce output as part of a vertical production chain, this would be reflected in an increase in imports from foreign affiliated firms.

probability of return to Foreign. The immigration cap is binding in the model, and firms are allocated a fraction of their immigrant worker demand.[5] These immigration policies impose hiring frictions and only the larger type-m firm can choose to hire skilled foreign labor in existing affiliate firms located in Foreign. In equilibrium, the marginal cost of hiring skilled workers domestically is equal to the marginal cost of hiring workers in the offshore affiliates. The model features an increase in offshoring at the intensive margin (increase in labor hired in existing affiliates) rather than an increase in the number of foreign offshore affiliates (extensive margin).

To solve the model numerically, we calibrate the main parameters in the Home country that pertain to immigration policy, labor markets, hiring traits, trade, and offshoring at Home to match the US economy during the 2012–2018 period. We also calibrate parameters related to the Foreign economy's labor markets to match data from India. We show that the distribution of immigrant worker demand in the model for type-f and type-m firms is close to the corresponding distribution in the data.

Our main counterfactual exercise quantifies the impact of a 10% immigration cap reduction. The more restrictive skilled immigration policy leads to a reduction in output in all three upstream firms at Home. Lower availability of skilled labor at home increases the marginal cost of hiring workers domestically relative to offshore. Type-m firms partially compensate for the decrease in domestically available skilled labor by increasing offshore labor hiring. However, iceberg offshoring costs and relatively lower productivity in Foreign prevent a full substitution of offshore labor for immigrant labor. Output at type-f firms that do not have offshore affiliates also falls, while output at type-d firms falls as domestic skilled labor shifts from type-d to more productive type-f and type-m firms following the increase in demand for skilled labor in these firms. Firm profits at all three firm types falls. Additionally, Home unskilled wages fall because of lower demand for unskilled labor output, which causes unskilled wages to fall. Overall, a more restrictive skilled immigration policy leads to lower welfare of unskilled workers and profit earners and higher welfare for skilled domestic workers via a wage increase.

Our results indicate that most of the impacts of immigration policy changes are felt over time as the stock of immigrant workers changes slowly. We show that it is important to account for transitional dynamics when evaluating impacts of immigration policy changes. The results also emphasize the importance of accounting for the offshoring activities of domestic firms after an immigration policy change. When we do not account for the adjustment in offshore labor hiring after the immigration cap decline, wages of domestic skilled workers rise by more compared to the case where we account for the adjustment in offshore labor hiring. Since firms can partly substitute immigrant skilled labor with offshore workers (that are now relatively cheaper because of more skilled labor available in Foreign), the wages of skilled workers increase by less at Home. This is important for welfare calculations. The welfare gain to domestic skilled workers because of a wage increase following a 10% immigration cap reduction is approximately 19.56% higher when we ignore the offshoring channel.

Finally, the offshoring channel is important for how changes in immigration impact trade, particularly

[5]This mimics the current H1-B policy as when the cap binds, firms are allocated workers according to a lottery.

imports. Our framework with skilled immigration, offshore labor hiring, and trade in intermediate inputs includes two channels of imports from the Foreign economy. First, part of the domestic intermediate firm's output is produced offshore and is imported back to the Home country. Second, the domestic downstream firm also imports intermediate goods from non-affiliated foreign intermediate firms. A decrease in skilled immigration has two opposing effects on imports. On the one hand, there is an increase in offshore labor hiring, which increases output produced in the offshore affiliates, and therefore imports from affiliated firms increase. On the other hand, a lower immigrant stock in the domestic economy tends to decrease the import of intermediate inputs from non-affiliated firms.[6] We show that it is important to account for the endogenous adjustment in offshoring following immigration policy changes to better understand the effects on imports from affiliated vs non-affiliated firms.

Our framework highlights that firms' adjustment in offshore labor hiring following an immigration policy change matters for the quantitative and qualitative impacts in the domestic economy. Elements of our model that include hiring dynamics of immigrant skilled workers, ability to adjust offshore labor hiring by a small subset of large firms, and intermediate input trade between affiliated and non-affiliated firms, are key for understanding the relationships between skilled immigration, offshoring, and trade.

This paper is organized as follows. In the next section, we discuss the related literature. Section 3 documents some trends that motivate our focus on skilled immigration and offshoring in the skilled services sector and also documents some firm-level trends. Section 4 introduces our baseline model. Section 5 describes some relationships obtained from the model's analytical solution. In Section 6, we present the calibration for the numerical solution. Section 7 then presents the model dynamics, welfare results, and underlying mechanisms. Section 8 provides further discussions and implications of our results. The last section concludes.

2 Related Literature

We contribute to studies that measure the welfare gains from lowering barriers to labor mobility.[7] The existing literature has identified several important channels for welfare gains — cross-country productivity differences, access to product varieties, housing prices, the role of imperfect substitutabilities, among others. In particular, Caliendo et al. (2021) document the importance of trade, migration, and their interaction channels in quantifying the welfare impacts of immigration policies. They, however, focus on goods trade in the EU and ignore offshoring channels. Recently, Piyapromdee (2021) studies welfare impacts of immigration across US cities using a spatial-equilibrium model and shows that these welfare effects depend on workers' responses to immigration.

Our paper complements the above literature by highlighting the role of firms' adjustment in offshoring

[6]These opposing effects are consistent with contrasting impacts of immigration on imports documented by empirical literature, as discussed in Section 2.

[7]See Urrutia (1998); Klein and Ventura (2009); Iranzo and Peri (2009); di Giovanni et al. (2015); Docquier et al. (2014); Ehrlich and Kim (2015) among many others.

activities that is one important but often overlooked channel that affects the welfare impacts of immigration.

The empirical literature has documented a strong impact of immigration on offshoring.[8] In contrast to our paper, much of this literature focuses on offshoring in the manufacturing sector and on low-skilled immigration. Olney (2013) finds that an increase in immigration reduces both the extensive and intensive margins of offshoring. Ottaviano et al. (2013) also give evidence of substitutability between immigrant and offshore workers. Olney and Pozzoli (2021) study the relationship between immigration and offshoring by exploring whether an influx of foreign workers reduces the need for firms to locate production activities abroad. Their paper shows that an exogenous increase in immigration reduces firm-level offshoring at both the intensive and extensive margins. There is also literature that finds a positive relationship between immigration and FDI (e.g., Buch et al. 2006; Javorcik et al. 2011; De Simone and Manchin 2012).[9]

The recent empirical literature has started to focus on skilled immigration and documented substitutability between skilled immigration and offshoring in the skilled services sector. Ottaviano et al. (2018a) explore the impact of immigrants on the imports, exports, and productivity of service-producing firms in the UK. Immigrants substitute for imported intermediate inputs (offshore production) and lead to a re-assignment of tasks among offshore and immigrant workers. They find a negative correlation between bilateral immigration and offshoring in the services sector (primarily concentrated in the professional, scientific, and technical activities). Glennon (2020) is another recent paper that empirically links skilled immigration restrictions and foreign affiliate activity. Using matched firm-level data, she finds H1-B visa restrictions caused an increased foreign affiliate activity at both the intensive and extensive margin. 0.3 jobs were offshored for every unfilled H1-B position. This is consistent with our calibrated model — a decline in the immigration cap leads to higher offshore labor hiring, but this increase is less than the immigration cap's decline.

Our paper also relates to the extensive literature that studies the impact of immigration on trade. The empirical literature has documented that immigrants may demand goods and services from their home countries, leading to an increase in imports (Gould 1994; Head and Ries 1998). On the other hand, as mentioned above, the literature has also documented that immigrants and imported intermediate inputs may be substitutes when a good is part of a production chain. Our framework is consistent with both these effects — an increase in skilled immigrants would increase intermediate imports (from non-affiliated firms in our framework) but would decrease intermediate imports from affiliated firms (because of substitutability between immigrant and offshore labor).

To the best of our knowledge, our paper is the first to incorporate skilled immigration, offshore labor hiring, and intermediate input trade in a two-country general equilibrium framework with immigration policy frictions that mimic the US and endogenous firm responses to policy changes. This allows us to find the welfare impacts of immigration policy changes in the US and to explicitly account for the role of offshoring and transitional dynamics in influencing these welfare impacts. We also gain some notable insights on the impact of immigration on intermediate input imports (from affiliated and non-affiliated firms) and the role

[8]See Hummels et al. (2018) for the literature review on the impacts of offshoring on labor markets.

[9]Kugler and Rapoport (2007); Tomohara (2017) document contemporaneous substitutability and dynamic/long-run complementarity between migration and FDI.

of offshoring in influencing this. This would not be possible in models that separately study the impact of skilled immigration on imported intermediate trade or on offshoring at foreign affiliates within a static partial equilibrium framework.

Our paper also adds to the emerging literature that examines the implications of high skilled migration. (See Borjas and Doran 2012; Doran et al. 2014; Peri et al. 2015b,a; Kerr et al. 2015; Mayda et al. 2018; Hanson et al. 2018.) Most of these papers study the empirical impacts of the H1-B policy changes. In addition, our paper is related to the literature that studies unskilled immigration and offshoring in a dynamic general equilibrium model (Mandelman and Zlate 2020). Our model extends the framework in Mehra and Shen (2022) that focuses on firm demand for foreign skilled labor to include two countries, offshoring, and intermediate input trade.

3 Offshoring, Trade, and Skilled Immigrant Hiring Patterns in the US

To motivate our model, this section first describes trends related to the demand for immigrant skilled workers (sector and firm level) and then presents trends related to offshore labor hiring and trade in the US. Domestic firms hire foreign skilled workers in the domestic economy (using the H1-B program), and foreign skilled workers in offshore affiliates located in foreign economies. To avoid confusion between the two, we use the term immigrant to refer to foreign skilled workers employed in the US.[10]

3.1 Demand for Foreign Skilled Workers

Sector level. Around 75% of applications for immigrant skilled workers on average are filed by firms operating within the Professional, Scientific, and Technical Services sector (NAICS Sector 54) as documented in Table A1.[11] We measure demand for immigrant skilled workers as the number of Labor Condition Applications (LCAs) filed by firms that want to hire foreign skilled workers domestically using the H1-B visa program.

Since its inception in 1990, the H1-B visa program has been the dominant entry route for immigrant skilled workers into the US labor force. Before filing an H1-B petition, firms need to submit a Labor Condition Application (LCA) with the Department of Labor in which they specify the number of workers they would like to hire for a particular occupation. The number of LCAs filed by a firm indicates a firm's vacancies for immigrant skilled workers and signals the firm's intention to hire them. Therefore, we use the number of LCAs filed by a firm as a measure of its demand for immigrant skilled workers. Next, we present some firm-level trends related to firm demand for immigrant workers and firm size.

[10] Technically, the H-1B visa is a temporary work visa as it is issued for three years but can be renewed for another three years. It is also a dual intent visa as it can lead to permanent residency if the employer is willing to sponsor the worker for a green card.

[11] Yeaple (2017) also mentions that many of the intensive users of the temporary visa programs are in service industries, such as computer design, publishing, management consulting. Ottaviano et al. (2018a) also note that even in the UK, both immigrants and services trade are concentrated in the same sectors — professional, scientific, and technical activities.

Table 1: Firm Hiring Traits

	Positive hiring (N=1470)		No hiring (N=1273)	
	MNE (type-m)	Non MNE (type-f)	MNE	Non MNE (type-d)
Fraction (firms)	9.187%	44.4%	2.07%	44.33%
Average sales	23984.09	3510.58	5128.07	849.02
Fraction (immigrant worker demand)	81.8%	18.2%	0%	0%

Notes: The full sample includes firms in the Compustat database that are headquartered in the US and have positive sales in each year between 2012–2018. Firms with positive hiring of immigrant workers include firms that have submitted at least 1 LCA application between 2012–2018. A firm is coded as an MNE if 'IDBFLAG=B' in Compustat. Average sales (in millions of USD) is computed from firm-level average annual sales over 2012–2018. Total demand for immigrant workers is computed as the sum of LCA applications submitted by firms during the period.

Firm level. Only a subset of relatively large firms have a positive demand for immigrant skilled workers and an even smaller fraction are Multinational Enterprises (MNEs), i.e. have business operations in at least one other country apart from the domestic economy.

To document this, we extend the dataset used in Mehra and Shen (2022) to include information on multinational firms and present some new statistics in Table 1. While approximately 54% of firms have a positive demand for immigrant skilled workers over the 2012–18 period, the fraction of these firms that are multinational firms is only approximately 9.2%. However, these MNEs account for more than 80% of the total demand for these workers.

In our model, we classify firms into three types: (a) type f — non-MNE firms that hire immigrant workers, (b) type m — MNE firms that hire immigrant workers, and (c) type d — non-MNE firms that do not hire immigrant workers. We ignore firms that are MNEs but do not hire immigrant workers in the model because of their small proportion. Only approximately 2% MNE firms do not hire immigrant workers.

As expected, MNEs are larger compared to non MNEs. Importantly, type-m firms have the highest sales (6.83 times relative to type-f firms), followed by type-f firms (3.36 times relative to type-d firms).[12] Type-d firms are the smallest in terms of sales.

There is considerable persistence across firm types — 90% of type-d firms remain type d over the sample period, 80% of type-f firms remain type f, and 94% of type-m firms remain type m, throughout our sample period.[13] Importantly, among all type-f and type-m firms, those that submit applications for immigrant workers consistently i.e., in each year of our sample, account for the bulk of demand for these workers. 98.63% of the total applications submitted over our reference period are accounted for by these firms. Firms that submit applications infrequently (those that transition between type f to type d or from type m to type d and vice versa) constitute less than 2% of applications submitted over the sample period.

To ease aggregation and computation, we assume a fixed mass of type-d, type-f, and type-m firms in the model. Not accounting for potential switches of firms around the cutoffs from type d to type f or from type f to type m would not have major quantitative implications for our analysis given the very low fraction

[12] For average sales of type-d firms, we take a weighted average of sales for firms in columns (3) and (4).

[13] All firms consistently maintain their MNE status over our sample period, i.e., there are no transitions between MNE to non-MNE, and vice versa.

of applications submitted by such firms.

3.2 Offshore labor Hiring and Trade

Since 2004, the Professional, Scientific, and Technical Services sector has witnessed a noticeable increase in the use of output as an intermediate good domestically, in offshore labor hiring, and in trade.

Offshore labor hiring. Most importantly, this sector has witnessed significant growth in offshore labor employment in recent years. Panel A of Figure 1 reports the share of employment in US majority-owned foreign affiliates as a proportion of total domestic employment within this sector. This share has substantially increased from 7% to around 17% between 2004 and 2018. Panel B shows that this increase has been driven by Asia Pacific — the share of Asia Pacific in US majority-owned foreign affiliate employment in this sector increased from 32% to around 56% over the same period. Within Asia Pacific, 68.3% of labor hired in foreign affiliates was based in India in 2018. China, the second largest employer in Asia Pacific comprised only 7.9% of the total Asia-Pacific employment. Therefore, we focus on India as the motivating Foreign country in the model.[14]

Trade and MNEs. An increase in offshore labor hiring in this sector during this period was accompanied with an increase in trade. Figure A1 shows that between 2004 and 2018, the export share in total industry GDP increased from 9% to 16% and the corresponding import share rose from 5% to 11%.[15]

MNEs and foreign affiliates have played an important role in driving this increase. Figure A1 shows that the share of foreign affiliates in total imports within Information and Communications Technology (ICT) and related sectors has grown significantly and is currently over 70% (BEA services trade data). Correspondingly, the share of non-affiliated firms in imports has fallen over this period. Moreover, MNEs dominate exports in the skilled service sector. The share of US parent companies in ICT and related sectors' exports was 85% in 2017 and non-MNEs constituted only about 7.8% of total services exports.[16]

Based on this, our model includes two channels of imports — (a) import of output produced offshore at a domestically owned- MNE affiliate and (b) import of intermediate inputs from non-affiliated foreign firms. Moreover, since the bulk of exports flow via MNEs in this sector, we assume that only type-m firms (MNEs) export in our model.

In summary, a subset of relatively larger firms, particularly MNEs, in the skilled services sector hire the bulk of immigrant skilled labor in the domestic economy. This sector has witnessed an increase in the share of output used as an intermediate input and in trade. Importantly, there has been a dramatic rise in offshore employment in foreign affiliates of US MNEs in Asia Pacific (particularly India) since 2004. Consistent with this, the share of foreign affiliates in related imports has grown. Note that the H1-B cap was reduced

[14] Yeaple (2017) also documents that India is a considerable outlier for skilled foreign workers in the US via the temporary visa programs.

[15] These calculations are based on data from the Bureau of Economic Analysis (BEA) Input-Output Use tables.

[16] The rest of the services exports in the sector were by majority-owned US affiliates.

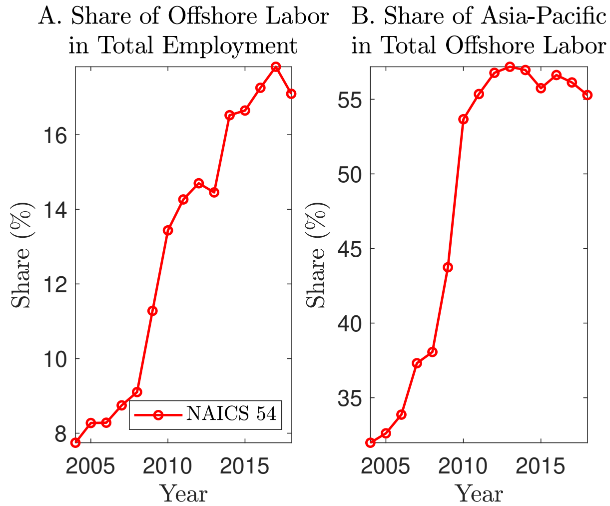

Figure 1: Employment at Foreign Affiliates

Notes: Authors' calculations from BEA data on activities of majority-owned foreign affiliates.

from 195,000 to 65,000 in 2004 and has been binding since then. The data trends suggest that the increase in offshore labor hiring and in the share of imports from foreign-affiliated firms coincided with a period of more restrictive immigration policy.

4 The Model

The baseline model is an extension of Mehra and Shen (2022)'s two sector model: skilled (sector 1) and unskilled (sector 2). Sector 1 features monopolistically competitive firms that differ in relative productivity and firms above a fixed productivity cutoff in the Pareto distribution hire imperfectly substitutable domestic and immigrant skilled labor, while those below the cutoff hire only domestic labor.[17] In order to study the implications of offshoring, we extend the model to a two-country framework (Home and Foreign) and add a third type of firm that has the ability to hire offshore workers in an existing foreign affiliate.

Figure 2 summarizes our model setup. Sector 1 at Home, which represents the US and is our main interest, consists of a representative downstream firm and a continuum of upstream firms. The latter firms differ in their relative productivity and produce differentiated intermediate inputs. Consistent with the data, these upstream firms are classified into three types — (a) non-MNE domestic firms (type f) that hire domestic and immigrant skilled workers, (b) domestically owned MNEs (type m) that hire domestic, immigrant, and skilled foreign workers in Foreign (offshore) affiliates, and (c) Non-MNE domestic firms that hire only domestic skilled workers (type d). Note that domestic skilled workers are employed by all three firm types and

[17] The model matches several features in the data — (a) firms above the cutoff are on average more productive than those below the cutoff, (b) more productive firms submit more applications, and (c) the distribution of foreign worker demand (Pareto) matches the data.

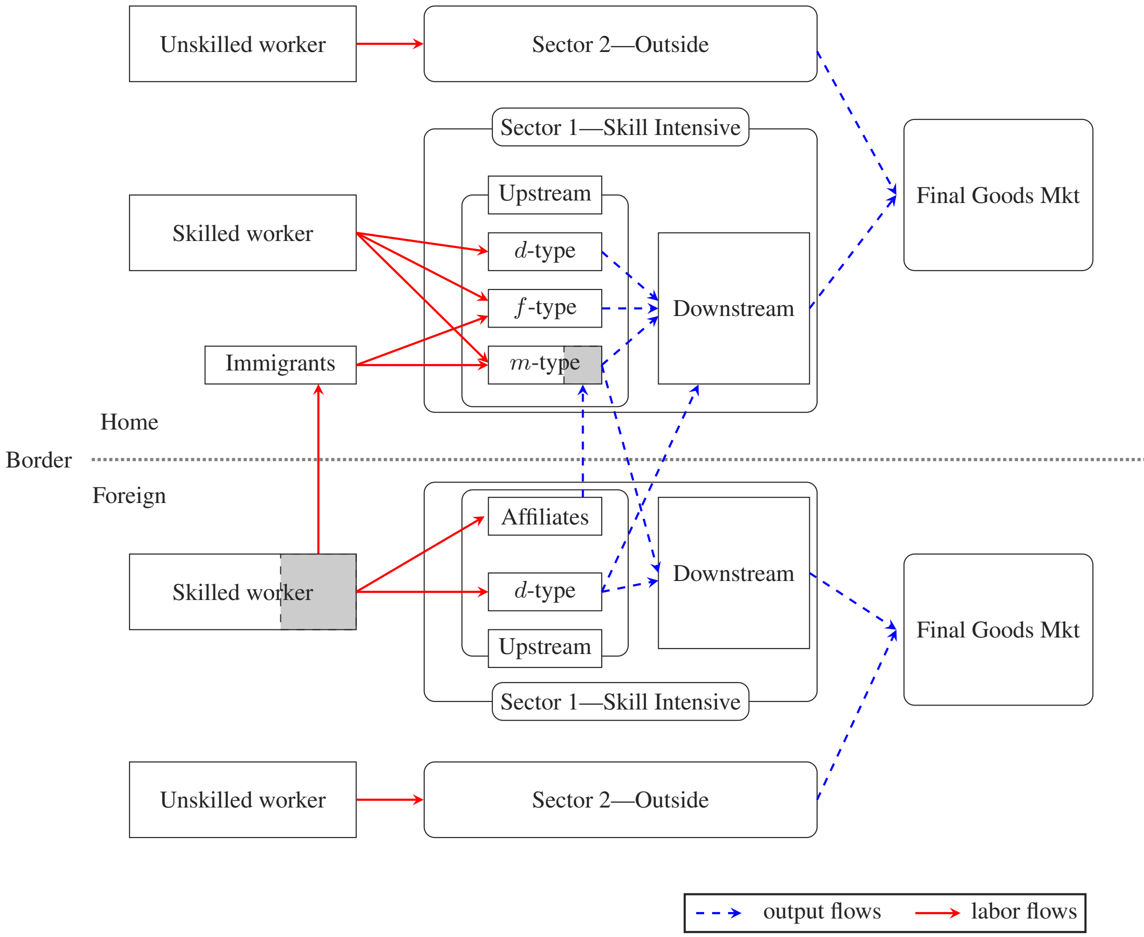

Figure 2: Model Setup

are perfectly mobility across the Home upstream firms, and therefore earn the same skilled wage. Immigrant skilled workers are employed by type-f and type-m firms subject to a cost for hiring each immigrant worker. Offshore workers are employed only by type-m firms in existing foreign affiliates. The type-m firms also export part of their intermediate good to Foreign.

Foreign and domestic workers employed in type-f and type-m firms are assumed to be imperfect substitutes. A key debate in the empirical literature on immigration is related to the elasticity of substitution between natives and immigrants in the same skill group. Our model accounts for the imperfect substitutability between immigrant and domestic workers based on evidence in Ottaviano and Peri (2012).

Type-f and type-m firms optimally choose the quantity of immigrant workers to hire subject to an exogenous immigration policy-imposed cap. Each firm's optimal demand for immigrant labor ensures that the expected cost of hiring an additional worker is equal to the expected discounted benefit of hiring that worker. The cap and aggregate firm demand for immigrant workers endogenously determine the probability/fraction of workers that each firm is able to hire. Type-m firms hire labor offshore till the marginal costs of domestic and offshore production are equalized.

A representative perfectly competitive downstream firm combines output produced by all upstream firms with the imported Foreign intermediate input to produce the composite final good. Essentially, firms in the upstream sector produce different varieties of intermediate inputs related to skilled services and the downstream firm combines the inputs to produce the final skill-intensive good. The rest of the Home economy is simplified by the outside sector labeled sector 2. It consists of a representative firm that produces output using domestic unskilled labor. The final consumption bundle of households in the domestic economy includes output from the representative downstream firm in sector 1 and output produced by sector 2. Note that there are complementarities between output produced by skilled and unskilled labor via the consumption bundle.[18]

The Foreign economy similarly features two sectors — skilled and unskilled. We assume that the Home country is more productive than Foreign, which generates offshoring and immigration in only one direction. Therefore, Foreign upstream (non-affiliated) firms produce output using only their native skilled labor. The downstream firm produces the final composite good by combining intermediate inputs produced by the Foreign non-affiliated upstream firm with the imported intermediate inputs from Home. Part of the skilled Foreign labor is employed by type-m firms' offshore affiliates located in Foreign. Note that we refer to the latter as affiliated firms and the remaining Foreign upstream firms as non-affiliated firms. We denote foreign variables with an asterisk *.

There are certain model assumptions that need to be further qualified. First, immigrant and domestic skilled workers employed by all firms in sector 1 are assumed to earn the same wage. This assumption helps ensures that there is a wedge between the marginal revenue product of an immigrant skilled worker and the wage paid to them, which generates a positive hiring incentive for workers. By law, firms are required to pay a cost for hiring immigrant skilled workers. In a world with flexible wages where immigrant skilled workers are paid their marginal revenue product, there would be no equilibrium demand for these workers since wages would always adjust to be equal to the marginal revenue product. In this case, the net benefit of hiring each worker would be negative in the presence of a positive hiring cost. This scenario would be inconsistent with the data on the number of applications submitted for immigrant skilled workers that indicates a huge demand for such workers. In order to generate a positive incentive for firms to pay immigration hiring costs in the model, there needs to exist a positive wedge between the marginal revenue product and wage paid to each worker. The combination of imperfect substitutabilites between domestic and immigrant workers and same wage paid generates this wedge. The marginal revenue product of immigrant workers turns out to be higher than that of domestic skilled workers given the lower relative availability of immigrant workers. If immigrant skilled workers are assumed to be paid the same wage as domestic skilled workers, this ensures that the wage paid to the former is below their marginal revenue product, which generates positive demand for immigrant workers.

The assumption that immigrant and domestic skilled labor are paid the same wage is consistent with immigration policy — when filing a Labor Condition Application, firms need to attest that they will pay the

[18] Instead of separating the skilled and unskilled sector, we would get similar results from a version of the model that assumes that the downstream firm uses unskilled labor and the skill-intensive inputs to produce the final good.

worker the prevailing compensation for that occupation and the salary has to be consistent with the salary ranges that the Department of Labor considers for an occupation/position of the specified characteristics. Moreover, in the data, the relative wage of native vs foreign-born skilled workers in the US has on average been 1 during relevant time horizon (Figure A2). We compute this ratio using weekly earnings from the monthly CPS surveys.[19]

There is no endogenous firm entry/exit and the constant mass of firms in sector 1 is normalized to 1. Firms in sector 1 do not endogenously choose to become type-d, type-f, or type-m firm. Also, the relative fractions of these firms remain fixed. This assumption simplifies the aggregation and does not affect aggregate results because the fraction of applications submitted by firms that transition between the groups is less than 2%, as discussed in Section 3.1. Implicitly, we are assuming that firms in sector 1 face prohibitively high fixed hiring costs that prevent endogenous switches between the firm types. Therefore, in this paper, we do not focus on the choice to start a foreign affiliate. We focus on the intensive margin of expansion of already existing affiliates in response to immigration cap changes.

Finally, we assume that only type-m firms export to Foreign. Implicitly, sunk export costs prevent the least productive firms from exporting, but we do not explicitly model these costs. This assumption is consistent with data that suggests a large fraction of trade in services flows through MNEs. Over the 2012-17 period, MNEs accounted for more than 90 percent of services exports according to BEA services trade database (Bruner and Grimm 2019).

4.1 Home Households

There are three types of representative infinitely-lived households residing at Home: skilled domestic (s), unskilled domestic (u), and skilled immigrants (f). Each type's lifetime utility is given by

$$\max_{\{C_{j,t}\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_{j,t}), \quad j \in \{s, u, f\}, \tag{1}$$

where $C_{j,t}$ represents the consumption basket and the utility function is given by $U(C_{j,t}) = \ln(C_{j,t})$. Denote $L_{s,t}$, $L_{u,t}$, and $L_{f,t}$ as the measure of domestic skilled, unskilled, and immigrant household's labor supply, respectively. All households supply one unit of labor inelastically.

The aggregate consumption basket $C_{j,t}$ for each household j includes sub-baskets of output from the skilled labor intensive (sector 1) and unskilled labor intensive (sector 2) firms:

$$C_{j,t} = \left(\frac{C_{j,t}^1}{\alpha}\right)^{\alpha} \left(\frac{C_{j,t}^2}{1-\alpha}\right)^{1-\alpha}, \tag{2}$$

[19]Another way to generate this wedge could be to assume that immigrant skilled workers and domestic skilled workers are perfect substitutes and are equally productive (and therefore they generate the same marginal revenue product), but that foreign workers are paid a wage that is lower than domestic workers. However, this assumption would be at odds with the immigration law and data trends.

where $C^1_{j,t}$ and $C^2_{j,t}$ are the baskets of goods produced by firms in sectors 1 and 2, respectively, for household $j \in \{s, u, f\}$. The (expenditure) share of sector 1 goods in consumption is $\alpha \in (0, 1)$. The demand for each type of good by the household is given by $C^1_{j,t} = \alpha C_{j,t}/P_{1,t}$ and $C^2_{j,t} = (1-\alpha)C_{j,t}/P_{2,t}$, where $P_{1,t}$ and $P_{2,t}$ are the aggregate prices of sector 1 and 2 goods, respectively, in units of the final consumption basket. The corresponding price index of final consumption basket is normalized by one as $1 = (P_{1,t})^{\alpha}(P_{2,t})^{1-\alpha}$.

In the baseline model, the represent domestic skilled household owns shares in a mutual fund of firms in the skill-intensive sector (sector 1) and therefore receives dividend income equal to the aggregate real profits of all sector-1 firms, D_t.[20] Labor income is given by $W_{s,t}L_{s,t}$, where $W_{s,t}$ is the real skilled wage. As mentioned above, domestic skilled households are employed by all upstream sector-1 firms and there is perfect labor mobility of domestic skilled households across the firm types. Therefore, the real wage paid to skilled workers, $W_{s,t}$, is the same across all firms. Domestic skilled households pool their real income and their budget constraint is given by $C_{s,t} = D_t + W_{s,t}L_{s,t}$.

Unskilled domestic households and skilled immigrant households enjoy the same consumption basket and consume their real labor incomes: $C_{u,t} = W_{u,t}L_{u,t}$ and $C_{f,t} = W_{s,t}L_{f,t}$ where $W_{u,t}$ is the real wage paid to unskilled labor and is determined competitively in a separate labor market for unskilled labor.

4.2 Home Firms: Skilled Sector (Sector 1)

There are a continuum of heterogeneous monopolistically competitive upstream firms, each producing a differentiated variety $\omega \in \Omega$.[21] Firms are heterogeneous as they produce with different technologies indexed by relative productivity z. We relate each firm to an individual variety.

Firm-specific productivity z follows a Pareto distribution $G(z)$, with shape parameter k, and support on $[z_{min}, \infty)$. As mentioned above, our model features three types of firms — one that employs only domestic skilled labor (type d), the second that employs both domestic and foreign skilled labor (type f), and third that employs all types of skilled labor, including labor at offshore affiliates (type m). Specifically, firms below a fixed productivity cutoff $z_c \in [z_{min}, \infty)$ are type d. Firms with productivity $z_m > z \geq z_c$ are type f, while those with productivity $z \geq z_m$ are type-m. Note that all firms with $z \geq z_c$ hire immigrant skilled workers but only those with $z \geq z_m$ hire workers in offshore affiliates. Hence, the fixed mass of type-d firms is given by $N_d = G(z_c)$, type-f firms is $N_f = G(z_m) - G(z_c)$, and type-m firms is $N_m = 1 - G(z_m)$.

To set ideas, Figure 3 plots the probability distribution function (PDF) of the Pareto distribution and immigrant labor hired across all upstream firms z. Consistent with the data in Table 1, majority of immigrant skilled workers are hired by type-m firms. Moreover, the average productivity of type-m firms is higher than that of type-f firms, which in turn is greater than the average productivity of type-d firms. Also, more productive firms within type f and type m hire more skilled labor.

[20] Since households are representative, the share of aggregate firm profits is one. In Section 7.2, we separate wage and profit earners to consider the implications of alternate profit ownership.

[21] The assumption of monopolistic competition in this sector is important as firms incur costs of hiring immigrant workers, and therefore need to earn positive profits.

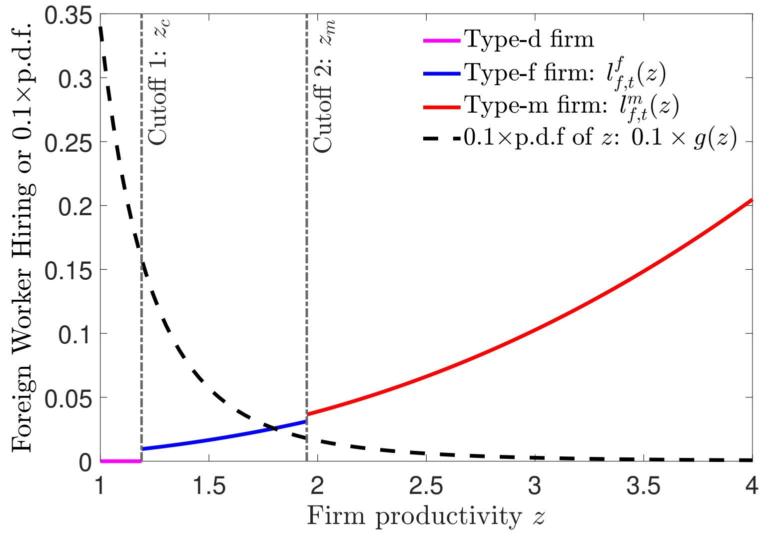

Figure 3: Foreign Workers Hired as a Function of Firm Productivity

4.2.1 Downstream Firm

A perfectly competitive representative producer combines output from all skilled varieties to produce the composite skill-intensive final output. Given our modeling assumption relating each firm to an individual variety, we can index each firm by its relative productivity z. Then, for given productivity cutoffs z_c and z_m, we can write the composite skill-intensive bundle as

$$Y_{1,t} = \left[\int_{z_{min}}^{z_c} y_{d,t}(z)^{\frac{\theta-1}{\theta}} dG(z) + \int_{z_c}^{z_m} y_{f,t}(z)^{\frac{\theta-1}{\theta}} dG(z) + \int_{z_m}^{\infty} y_{h,t}(z)^{\frac{\theta-1}{\theta}} dG(z) + N_d^* (y_{x,t}^*)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}. \tag{3}$$

where $\theta > 1$ is the symmetric elasticity of substitution across all varieties, N_d^* is the mass of the symmetric Foreign upstream firms, $y_{d,t}$, $y_{f,t}$, $y_{h,t}$ are the output sold domestically to the Home downstream firm by type-d, type-f, and type-m firms respectively, and $y_{x,t}^*$ is the imported skill-intermediate input from Foreign upstream firms. Note that while the total output of a type-m firm is $y_{m,t}(z)$, only a component $y_{h,t}(z)$ is sold domestically, while the rest is exported. The Cobb-Douglas aggregator between sectors 1 and 2 in Equation (2) implies that the final demand for sector-1 output satisfies $Y_{1,t} = \alpha Y_t^c / P_{1,t}$, where Y_t^c denotes the aggregate demand for the final consumption basket in the economy.

The downstream firm's demand for each type of intermediate input is given by

$$y_{x,t}^* = \left(\frac{p_{x,t}^*}{P_{1,t}} \right)^{-\theta} Y_{1,t} \quad \text{and} \quad y_{g,t}(z) = \left(\frac{p_{g,t}(z)}{P_{1,t}} \right)^{-\theta} Y_{1,t}, \quad \text{for } g = d, f, h, \tag{4}$$

where $p_{d,t}, p_{f,t}, p_{h,t}, p_{x,t}^*$ are the optimal prices of domestic and foreign (non-affiliated) upstream firms for output sold at Home, all in units of the domestic final good. The aggregate sector-1 price index at Home is given by

$$P_{1,t} = \left[\int_{z_{min}}^{z_c} p_{d,t}(z)^{1-\theta} dG(z) + \int_{z_c}^{z_m} p_{f,t}(z)^{1-\theta} dG(z) + \int_{z_m}^{\infty} p_{h,t}(z)^{1-\theta} dG(z) + N_d^*(p_{x,t}^*)^{1-\theta} \right]^{\frac{1}{1-\theta}}. \quad (5)$$

4.2.2 Upstream Firms

The general production technology of upstream firms in sector 1 is given by

$$y_{i,t}(z) = Z_t z \left[\left(l_{s,t}^i(z)\right)^\gamma + \left(l_{f,t}^i(z)\right)^\gamma \right]^{\frac{1}{\gamma}} + Z_t^* z \frac{l_{o,t}^i(z)}{\tau_o}, \quad i \in d, f, m, \quad (6)$$

where $i \in d, f, m$ denotes the firm type. Then, $l_{f,t}^i(z) = 0$ and $l_{o,t}^i(z) = 0$ if $z_c > z > z_{min}$ (i.e., $i = d$). Also, $l_{o,t}^i(z) = 0$ if $z_m > z \geq z_c$ (i.e., $i = f$). The aggregate productivity at Home and Foreign is Z_t and Z_t^*, respectively, and z denotes the firm-specific productivity. The elasticity of substitution between domestic and immigrant skilled workers is given by $1/(1-\gamma)$. When $\gamma = 1$, all workers are perfect substitutes.

Note that for denoting labor hired by each firm type, we use subscripts s, f to denote domestic skilled and immigrant skilled labor hired at Home, respectively, and superscripts d, f, m to denote the upstream firm type. For instance, $l_{s,t}^m$ is the domestic skilled labor hired by firm type m and $l_{f,t}^f$ is the immigrant skilled labor hired by firm type f.

Only type-m firms hire labor at an offshore affiliate. Output at firm $z \geq z_m$ can be produced using three types of labor — domestic skilled ($l_{s,t}^m$), skilled immigrant ($l_{f,t}^m$), and skilled offshore ($l_{o,t}^m$). A part of the intermediate good can be produced using labor hired offshore, and the productivity of offshore labor is subject to the total factor productivity in Foreign, Z_t^*. Also, importing back output produced offshore impose iceberg costs (τ_o). Both domestically hired and offshore labor hired by firm m gain from the same firm productivity z but offshore labor is subject to a different aggregate productivity with trade costs, Z_t^*/τ_o.

Skilled Immigration Policy. Before describing the optimal hiring and price conditions for the firms, we briefly describe skilled immigration policy in the model. We model immigration policy to mimic US skilled immigration policy. Firms have to pay a hiring cost for each immigrant skilled worker they want to apply for, and there is a policy-imposed cap on the total number of immigrant workers that can be hired each period.[22] Apart from the filing fees paid to the Department of Homeland Security, the main cost incurred is due to the opportunity cost of the time and effort spent in the process, which is captured by the cost, $f_{R,t}$, in the model which is in units of Home consumption. A higher immigration policy cost implies a more restrictive immigration policy.

Recall that in our model, firm types f and m hire immigrant workers and these firms are above the productivity cutoff $z \geq z_c$. We denote the number of applications submitted (or demand for immigrant

[22] Firms in multiple surveys (for instance, by the GAO (2011) report), document a range of direct and indirect costs associated with the H-1B program, including legal and administrative costs.

workers) by firm z of type f and m as $n^f_{e,t}(z)$ and $n^m_{e,t}(z)$, respectively. Then, $N_{e,t} = \int_{z_c}^{z_m} n^f_{e,t}(z)dG(z) + \int_{z_m}^{\infty} n^m_{e,t}(z)dG(z)$ is the aggregate firm demand for immigrant skilled labor in our framework. Given the exogenously set entry cap for immigrant skilled workers $\bar{N}_{e,t}$, the probability or fraction of each application being selected is

$$\mu_t = \frac{\bar{N}_{e,t}}{\int_{z_c}^{z_m} n^f_{e,t}(z)dG(z) + \int_{z_m}^{\infty} n^m_{e,t}(z)dG(z)}. \tag{7}$$

Therefore, if firm $z \geq z_c$ and $i \in \{f, m\}$ submits $n^i_{e,t}(z)$ applications, it will be allocated $\mu_t n^i_{e,t}(z)$ workers. Because the cap has been binding since 2004, we only consider cases where $\mu_t < 1$, i.e., the aggregate demand for skilled immigrant workers across all firms is greater than the cap, and the cap therefore binds. Firms are of measure 0 and take μ_t as given in their hiring decision. A lower cap also represents a more restrictive immigration policy as it lowers the fraction of accepted applications.

Given immigration policy regulations, each immigrant worker is tied to the sponsoring firm, unless they switch employers.[23] Each firm incurs the sunk hiring cost for immigrant skilled workers taking into account the expected discounted value of the immigrant worker over time. A fraction δ of immigrant workers (including newly hired period-t workers) exogenously separate from each firm every period. Foreign workers that end up separating return to their origin country and get added back to the skilled labor supply in Foreign.[24] Therefore, the law of motion for immigrant skilled labor at firm $z \geq z_c$ and $i \in \{f, m\}$ is

$$l^i_{f,t}(z) = (1-\delta)\left(l^i_{f,t-1}(z) + \mu_t n^i_{e,t}(z)\right). \tag{8}$$

Optimality condition of type-d firms. Type-d firms hire only domestic skilled labor. In Appendix C.1, we write out the type-d firm's optimization problem and show that the firm's optimality condition implies that it chooses its price $p_{d,t}(z)$ as a constant markup over marginal cost:

$$p_{d,t}(z) = \frac{\theta}{\theta - 1}\frac{W_{s,t}}{Z_t z}. \tag{9}$$

Optimality conditions of type-f firms. Type-f firms hire imperfectly substitutable domestic and immigrant skilled labor. Appendix C.2 lays out the firm optimization problem and solution. The firm optimally chooses to submit foreign labor applications each period till the expected cost of an application is equal to the expected discounted benefit from hiring an immigrant skilled worker. The optimal hiring decision rule is intertemporal:

$$\frac{f_{R,t}}{\mu_t} = (1-\delta)\left\{\left[\left(\frac{l^f_{f,t}(z)}{l^f_{s,t}(z)}\right)^{\gamma-1} - 1\right]W_{s,t} + \beta\left[\mathbb{E}_t\frac{U'(C_{s,t+1})}{U'(C_{s,t})}\left(\frac{f_{R,t+1}}{\mu_{t+1}}\right)\right]\right\}. \tag{10}$$

[23] Additional fees incurred by the new employers impose frictions for switching and we ignore this in the current model.

[24] For immigrants, there is an exogenous probability of return to the country of origin to account for the fact that these foreign skilled workers are on a temporary work visa and a fraction returns every period.

Since $f_{R,t}$, μ_t, $W_{s,t}$, $C_{s,t}$, $C_{s,t+1}$, μ_{t+1}, $f_{R,t+1}$, are independent of z and identical across firms, the relative labor $l^f_{f,t}(z)/l^f_{s,t}(z)$ is identical across all firms $z_m > z \geq z_c$, which facilitates aggregation.[25]

Profit maximization in period t implies that the price $p_{f,t}(z)$ set by the firm is a proportional markup over the marginal cost:

$$p_{f,t}(z) = \frac{\theta}{\theta - 1}\psi_{f,t}(z), \quad \text{where } \psi_{f,t}(z) = \frac{W_{s,t}}{Z_t z\left[1 + \left(l^f_{f,t}(z)/l^f_{s,t}(z)\right)^{\gamma}\right]^{\frac{1-\gamma}{\gamma}}}. \tag{11}$$

Here, $\psi_{f,t}(z)$ denotes the marginal cost for type-f firm z satisfying $z_m > z \geq z_c$. Market clearing implies that the total supply of output at firm z equals to the total demand:

$$Z_t z\left[(l^f_{s,t}(z))^{\gamma} + (l^f_{f,t}(z))^{\gamma}\right]^{\frac{1}{\gamma}} = \left(\frac{p_{f,t}(z)}{P_{1,t}}\right)^{-\theta} Y_{1,t}. \tag{12}$$

Optimality conditions of type-m firms. Appendix C.3 lays out the firm optimization problem and further details. Similar to type-f firms (Equation 10), the hiring Euler equation for type-m firms can be expressed as

$$\frac{f_{R,t}}{\mu_t} = (1-\delta)\left\{\left[\left(\frac{l^m_{f,t}(z)}{l^m_{s,t}(z)}\right)^{\gamma-1} - 1\right]W_{s,t} + \beta\mathbb{E}_t\left[\frac{U'(C_{s,t+1})}{U'(C_{s,t})}\left(\frac{f_{R,t+1}}{\mu_{t+1}}\right)\right]\right\}, \tag{13}$$

Also similar to type-f firms, the relative labor of type-m firms, $l^m_{f,t}(z)/l^m_{s,t}(z)$, is the same across all firms $\infty > z \geq z_m$. Moreover, we can see from Equations (10) and (13) that $l^f_{f,t}(z)/l^f_{s,t}(z) = l^m_{f,t}(z)/l^m_{s,t}(z)$, i.e. the ratio of immigrant vs domestic skilled labor is the same across type-f and type-m firms, even though type-m firms are larger and hire more of both types of labor.

There are two additional optimality conditions for a type-m firm since it hires labor in an offshore affiliate and also exports output to Foreign.

Every period, each firm chooses offshore labor $l^m_{o,t}(z)$, taking the skilled wages in Foreign, $W^*_{s,t}$, as given. Therefore, if period-t offshore labor hired is $l^m_{o,t}(z)$, then the total wage cost incurred by the firm is $Q_t W^*_{s,t} l^m_{o,t}(z)$ in units of the Home consumption. Here Q_t is the real exchange rate defined as the units of the Home consumption basket needed to purchase one unit of the Foreign consumption basket.

The optimal condition for $l^m_{o,t}(z)$ implies that firms hire offshore labor till the marginal cost of hiring

[25] Note that the wedge between the marginal revenue product and wage paid to an immigrant worker in this setup is given by $m_{f,t}(z) - W_{s,t} = \left[(l^f_{f,t}(z)/l^f_{s,t}(z))^{\gamma-1} - 1\right] W_{s,t}$. This wedge is greater than 0 as $l^f_{f,t}(z) < l^f_{s,t}(z)$ and $\gamma < 1$.

labor offshore is equalized to that of hiring skilled labor domestically.[26]

$$\tau_o Q_t \frac{W^*_{s,t}}{z Z^*_t} = \psi_{m,t}(z), \tag{14}$$

where the optimization also equates the marginal cost of type-m firm to

$$\psi_{m,t}(z) = \frac{W_{s,t}}{Z_t z \left[1 + \left(l^m_{f,t}(z)/l^m_{s,t}(z)\right)^{\gamma}\right]^{\frac{1-\gamma}{\gamma}}}. \tag{15}$$

Exports are subject to an iceberg trade cost τ. The presence of the iceberg trade cost $\tau > 1$ implies that in order to export $y_{x,t}(z)$ units of output, the firm needs to produce $\tau y_{x,t}(z)$. Type-m firm output must satisfy $y_{m,t} = y_{h,t} + \tau y_{x,t}$, where $y_{h,t}$ is the component of the type-m firm sold at Home and $y_{x,t}$ is the component that is exported. Profit maximization implies that the price set by firm $z \geq z_m$ for the domestic downstream firm is $p_{h,t}(z) = [\theta/(\theta - 1)]\psi_{m,t}(z)$. The export price for the Foreign downstream producer is $p_{x,t}(z) = Q_t^{-1} \tau p_{h,t}(z)$, where the export price is in units of Foreign consumption.

4.3 Home Firms: Unskilled Sector (Sector 2)

Sector-2 output is produced by competitive firms that have an identical constant returns to scale technology:

$$Y_{2,t} = Z_t L_{u,t}, \tag{16}$$

where $L_{u,t}$ is the unskilled labor employed by the representative firm. Its price is equal to the marginal cost: $P_{2,t} = W_{u,t}/Z_t$.

4.4 Foreign Households and Firms

Since our focus is on Home country outcomes, we simplify the structure of Foreign households and firms.

4.4.1 Foreign Households

Households in Foreign face a similar maximization problem to Home households. The total supply of inelastic Foreign skilled households is given by $L^{*total}_{s,t}$. Non-emigrant Foreign skilled households are either employed in the non-affiliated Foreign upstream firms or at offshore affiliates. The aggregate mass of Foreign skilled labor employed at offshore affiliates is $L_{o,t}$, and the aggregate mass of Foreign skilled

[26]Note that the interpretation in the model differs from an offshoring model with trade in tasks in the previous literature such as Grossman and Rossi-Hansberg (2008). In their model, firms divide output into tasks and there is a cutoff for the set of tasks performed by domestic and offshore workers and this cutoff is endogenously determined by the equalization of the cost of the marginal task. In contrast, we assume that different types of workers can produce the same output (perform the same task). Firms optimally choose how much of the output is produced by each type of worker, which also leads to equalization of marginal production costs of different workers.

labor employed at the non-affiliated Foreign upstream firms is $L^*_{s,t}$. Here, we omit any superscripts since non-affiliated firms in Foreign only hire their own domestic skilled labor. Therefore, we have

$$L^{*total}_{s,t} = L_{o,t} + L^*_{s,t} + L_{f,t}. \tag{17}$$

There is perfect labor mobility across all Foreign sector-1 firms, and thus the skilled wage in Foreign, $W^*_{s,t}$, is the same for all skilled workers. Similar to Home, the firm profit owners in Foreign are domestic skilled households. All skilled workers that reside in Foreign (i.e., excluding immigrant households $L_{f,t}$) pool their labor income (including income from aggregate profits). The aggregate mass of Foreign unskilled households ($L^*_{u,t}$) consume their labor income, $W^*_{u,t}L^*_{u,t}$, where $W^*_{u,t}$ is the real unskilled wage in Foreign. The consumption basket of both types of households and the corresponding demand functions are similar to households at Home.

4.4.2 Foreign Non-Affiliated Firms

We normalize the constant mass of Foreign non-affiliated upstream producers to N^*_d. Each firm produces output $y^*_{d,t}(\omega)$ using their native skilled workers:

$$y^*_{d,t}(\omega) = Z^*_t l^*_{s,t}(\omega), \tag{18}$$

where $l^*_{s,t}(\omega)$ denotes the foreign skilled labor hired in each non-affiliated Foreign upstream firm. These firms sell output locally and also export to the Home country's downstream firm subject to the iceberg trade cost τ. Therefore, market clearing implies $y^*_{d,t}(\omega) = y^*_{h,t}(\omega) + \tau y^*_{x,t}(\omega)$, where $y^*_{h,t}(\omega)$ is the component of the non-affiliated Foreign upstream output that is sold domestically to the Foreign downstream firm and $y^*_{x,t}(\omega)$ is the component exported to Home. Except for the hiring decision of immigrant and offshore workers, Foreign firms face a similar problem as Home firms. They set prices of output sold domestically as a markup over the marginal cost $p^*_{h,t}(\omega) = [\theta/(\theta-1)](W^*_{s,t}/Z_t{}^*)$, and of output exported to Home as $p^*_{x,t}(\omega) = Q_t \tau p^*_{h,t}(\omega)$.

A representative downstream firm in Foreign combines output produced by the Foreign non-affiliated upstream firm and the intermediate input imported from the Home country. The unskilled sector in Foreign is symmetric to Home.

4.5 Average Productivities, Aggregation, Equilibrium

4.5.1 Average Productivities and Aggregates

The distribution of firm productivity is given by a Pareto distribution $G(z) = 1 - (z_{min}/z)^k$, with lower bound z_{min} and shape parameter $k > \theta - 1$. The firm size distribution and the average productivity of type-d, type-f, and type-m firms remain fixed in the baseline model.

The skill-intensive sector can be represented by three types of firms with average productivities $\tilde{z}_d$, $\tilde{z}_f$, and $\tilde{z}_m$, of mass $N_d = G(z_c)$, $N_f = G(z_m) - G(z_c)$, and $N_d = 1 - G(z_m)$, respectively. Since we assumed that firm-specific productivity draws z are Pareto-distributed, with probability density function $g(z) = kz_{min}^k/z^{k+1}$ and distribution function $G(z) = 1 - (z_{min}/z)^k$ over the support $[z_{min}, \infty)$, the average productivity levels are as follows.[27]

$$\tilde{z}_d \equiv \left[\frac{1}{G(z_c)}\int_{z_{min}}^{z_c} z^{\theta-1}g(z)dz\right]^{\frac{1}{\theta-1}} = \nu z_{min} z_c \left[\frac{z_c^{k-(\theta-1)} - z_{min}^{k-(\theta-1)}}{z_c^k - z_{min}^k}\right]^{\frac{1}{\theta-1}}, \tag{19}$$

$$\tilde{z}_f \equiv \left[\frac{1}{G(z_m) - G(z_c)}\int_{z_c}^{z_m} z^{\theta-1}g(z)dz\right]^{\frac{1}{\theta-1}} = \nu z_m z_c \left[\frac{z_m^{k-(\theta-1)} - z_c^{k-(\theta-1)}}{z_m^k - z_c^k}\right]^{\frac{1}{\theta-1}}, \tag{20}$$

$$\tilde{z}_m \equiv \left[\frac{1}{1 - G(z_m)}\int_{z_m}^{\infty} z^{\theta-1}g(z)dz\right]^{\frac{1}{\theta-1}} = \nu z_m, \tag{21}$$

where $\nu = \{k/[k - (\theta - 1)]\}^{1/(\theta-1)}$ and $k > \theta - 1$.

The aggregate sector-1 outputs at Home and Foreign can be expressed as

$$Y_{1,t} = \left[N_f(y_{f,t}(\tilde{z}_f))^{\frac{\theta-1}{\theta}} + N_d(y_{d,t}(\tilde{z}_d))^{\frac{\theta-1}{\theta}} + N_m(y_{h,t}(\tilde{z}_m))^{\frac{\theta-1}{\theta}} + N_d^*(y_{x,t}^*)^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}, \tag{22}$$

$$Y_{1,t}^* = \left[N_d^*(y_{h,t}^*)^{\frac{\theta-1}{\theta}} + N_m(y_{x,t}(\tilde{z}_m))^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}. \tag{23}$$

The aggregate sector-1 prices at Home and Foreign are given by

$$P_{1,t} = \left[N_d\left(p_{d,t}(\tilde{z}_d)\right)^{1-\theta} + N_f\left(p_{f,t}(\tilde{z}_f)\right)^{1-\theta} + N_m\left(p_{h,t}(\tilde{z}_m)\right)^{1-\theta} + N_d^*(p_{x,t}^*)^{1-\theta}\right]^{\frac{1}{1-\theta}}, \tag{24}$$

$$P_{1,t}^* = \left[N_d^*\left(p_{h,t}^*\right)^{1-\theta} + N_m\left(p_{x,t}(\tilde{z}_m)\right)^{1-\theta}\right]^{\frac{1}{1-\theta}}. \tag{25}$$

The average productivities defined above and the distribution function with cutoffs summarize all the information on the productivity distributions relevant for all macroeconomic variables at Home and our model is isomorphic to one where N_d firms with productivity level $\tilde{z}_d$ produce using only domestic skilled labor, N_f firms with productivity level $\tilde{z}_f$ produce using both domestic and immigrant skilled labor, and N_m firms with productivity level $\tilde{z}_m$ produce using domestic, immigrant, and offshore skilled labor.

The aggregate stock of immigrant skilled workers evolves according to

$$L_{f,t} = (1 - \delta)(L_{f,t-1} + \mu_t N_{e,t}), \tag{26}$$

where $N_{e,t}$ is the aggregate demand for immigrant skilled workers (or the aggregate number of applications submitted) such that $N_{e,t} = N_f n_{e,t}^f(\tilde{z}_f) + N_m n_{e,t}^m(\tilde{z}_m)$ and $L_{f,t} = N_f l_{f,t}^f(\tilde{z}_f) + N_m l_{f,t}^m(\tilde{z}_m)$, respectively. Also, the aggregate stock of workers hired in offshore affiliates and Foreign upstream firms is given by $L_{o,t} = N_m l_{o,t}^m(\tilde{z}_m)$ and $L_{s,t}^* = N_d l_{s,t}^*$, respectively.

[27] The derivations of average productivity levels are similar to Zlate (2016).

4.5.2 Aggregate Accounting and Equilibrium

Labor market clearing of domestic workers requires that the aggregate domestic labor employed is equal to the inelastic supply, i.e., $L_{u,t} = L_u$ and

$$L_{s,t} = L_s = N_d l^d_{s,t}(\tilde{z}_d) + N_f l^f_{s,t}(\tilde{z}_f) + N_m l^m_{s,t}(\tilde{z}_m). \tag{27}$$

Labor market clearing in Foreign satisfies Equation (17), with $L^{*total}_{s,t} = L^{*total}_s$.

The aggregate consumption by households in the Home economy is given by $C_{s,t} + C_{u,t} + C_{f,t}$, i.e., the sum of consumption by domestic skilled, unskilled, and foreign workers residing in the domestic economy. The aggregate accounting equation is as follows.

$$Y^c_t \equiv \left(\frac{Y_{1,t}}{\alpha}\right)^{\alpha} \left(\frac{Y_{2,t}}{1-\alpha}\right)^{1-\alpha} = C_{s,t} + C_{u,t} + C_{f,t} + f_{R,t} N_{e,t}. \tag{28}$$

The sectoral demand for sector-1 and sector-2 output is given by $Y_{1,t} = \alpha Y^c_t / P_{1,t}$ and $Y_{2,t} = (1 - \alpha) Y^c_t / P_{2,t}$, respectively. Balance of trade is given by

$$Q_t N_m p_{x,t}(\tilde{z}_m) y_{x,t}(\tilde{z}_m) - N^*_d p^*_{x,t} y^*_{x,t} = Q_t N_m W^*_{s,t} l_{o,t}(\tilde{z}_m). \tag{29}$$

Appendix D describes the entire system of equations used to solve the model.

5 Qualitative Analysis

We first study some qualitative implications of the model to gain some intuition regarding the forces that affect offshoring and the interrelationships behind offshoring, immigration, and trade. We consider a simplified version of the model with $\gamma = 1$ as we can then solve for $L_{o,t}$ explicitly in this case as a function of exogenous factors.

$$L_{o,t} = \Upsilon^{-1} \left[(\Xi) \boldsymbol{L^{*total}_s} - \left(\Xi + \tau_o \Theta \frac{\boldsymbol{Z_t}}{\boldsymbol{Z^*_t}} \right) \boldsymbol{L_{f,t}} - \left(\tau_o \Theta \frac{\boldsymbol{Z_t}}{\boldsymbol{Z^*_t}} \right) L_s \right], \tag{30}$$

where $A = \tau\tau_o/\tilde{z}_m$, $B = (\tau/\tau_o)^{\theta} \tilde{z}^{\theta-1}$, $\Upsilon = (\theta - 1)/\theta + (\Xi + \Theta)/\theta$, $\Xi = N_m/(N_m + N^*_d A^{\theta-1})$, and $\Theta = (N^*_d \tau)/(Nd^* \tau + \tau_o B)$. Note that A^{-1} represents the price of Home exports relative to Foreign domestic goods. Appendix E gives the details and derivations.

Equation (30) highlights the factors that affect offshore labor hiring by type-m domestic firms. The level of aggregate offshore labor hired in the economy ($L_{o,t}$) is increasing in the availability of aggregate skilled labor in Foreign (L^{*total}_s), decreasing in the stock of immigrant skilled labor at Home ($L_{f,t}$), decreasing in the supply of domestic skilled labor (L_s), and decreasing in the relative aggregate productivity at Home (Z_t/Z^*_t).

It is intuitive that any factor that increases the availability of skilled labor in the Foreign economy (higher L_s^{*total}) and/or reduces the availability of skilled labor at Home (lower $L_{f,t}$ or L_s), would increase the incentive to hire offshore labor. Firms choose to hire offshore labor till the marginal cost of hiring such labor is equal to the marginal cost of hiring domestic workers. If the skilled immigration cap falls at Home, the marginal cost of hiring labor domestically would increase, incentivizing firms to increase offshoring. It is also intuitive that a higher relative aggregate productivity at Home would mean that Home producers would prefer to produce more at Home relative to Foreign, and therefore the labor hired offshore would be lower.

Equation (30) also shows that for a given mass and associated productivities of domestic firms, the main parameters that affect offshoring are τ, τ_o, N_d^*, and θ. In particular, offshore labor hired is increasing in the ratio τ/τ_o. Intuitively, a higher iceberg trade cost relative to the iceberg offshoring cost increases the price of imports from foreign non-affiliated firms relative to the price of output produced by domestic upstream firms.[28] The resulting higher demand for domestically produced intermediate inputs leads to an increase in offshore labor hired.[29]

Next we turn towards imports. The negative relationship between skilled immigrants and the level of offshore labor hired implies that there is a direct negative relationship between skilled immigrants and imports from Foreign affiliated firms.[30] As more skilled labor is available domestically, firms have a lower incentive to hire labor offshore, and this would decrease the component of output produced and imported back from the Foreign affiliate.

To understand the implications for imports from non-affiliated firms, we can express $y_{x,t}^*$ as a function of $L_{o,t}$.

$$y_{x,t}^* = \frac{Z^*\Xi}{N_d^*\tau}\left[L_s^{*total} - L_f\right] - \frac{Z^* L_{o,t}}{N_d^*\tau}\left[\frac{\Xi + (\theta - 1)}{\theta}\right]. \quad (31)$$

To investigate the marginal effects, let us fix the level of offshoring at a constant value. For a given fixed $L_{o,t}$, there is a negative relationship between the stock of skilled immigrant labor ($L_{f,t}$) and imported intermediate inputs from non-affiliated Foreign firms ($y_{x,t}^*$). This implies that if we ignored changes in offshoring, our model would suggest that an increase in skilled immigration would reduce imports from non-affiliated firms. However, once we account for the endogenous negative relationship between immigration and offshoring, there is a net positive relationship between imported intermediate imports from non-affiliates and the stock of skilled immigrant labor – an increase in skilled immigration would tend to increase imports from non-

[28]Note that $\left(\frac{\tau}{\tau_o}\right)^{\theta} \tilde{z}^{\theta-1}$ is the price of imported goods relative to domestically produced output in sector 1. $\tilde{z}$ represents the weighted average of firm productivity of Home upstream firms. Therefore, a higher weighted average firm productivity at home would also lead to a higher relative demand for domestically produced intermediate goods relative to imported goods from non affiliates. See Appendix E for details.

[29]Offshore labor hired is decreasing in the mass of Foreign firms N_d^* as an expansion of foreign non-affiliated firms would reduce labor available for offshore employment. Note that we assumed $\gamma = 1$ to solve Equation (30). However, the aggregate offshore labor also depends on γ. As the elasticity of substitution between domestic and immigrant workers increases (γ falls), the aggregate offshore labor employed falls. As domestically hired workers become more complementary, firms have a lower incentive to hire workers offshore.

[30]Note that the value of imports from foreign-affiliated firms in units of the Home consumption good is given by $Q_t W_{s,t}^* L_{o,t}$.

affiliated firms.

The main implication of Equation (31) is that the qualitative impact of changes in skilled immigration on imports from non-affiliated firms depends on whether or not we account for firms' adjustment in offshore labor hiring. Section 7.1 further explores the associated mechanisms.

In summary, a change in skilled foreign labor availability at Home leads to a firm adjustment in offshoring. The offshoring channel is not only crucial for the direct effects of immigration policy, but it is also important for the impact of immigration on imports for two reasons: (a) offshoring directly responds to immigration which affects imports from affiliated firms, and (b) offshoring indirectly impacts imports from non-affiliated firms. When firms adjust their offshore labor hiring in response to an immigration policy change, the impact of skilled immigration on total imports is ex-ante ambiguous. On the one hand, a decrease in skilled immigration increases offshoring and increases imports from offshore affiliates. On the other hand, imports from non-affiliated foreign firms fall.

6 Calibration

In order to study the dynamics numerically, we calibrate the parameters of the model under the assumption that the steady-state Home economy mimics the US and Foreign mimics India during the 2012–2018 period.[31] The immigration policy cap was binding during this period. We interpret each period as a year to accommodate the annual allocation of the H-1B visa cap. We calibrate the parameters that pertain to the US labor force to match data from the Current Population Survey (CPS). Foreign labor supply parameters are calibrated to match education-wise labor data from the Periodic Labor Force Survey.[32] Data for immigration policy variables are obtained from the United States Citizenship and Immigration Service (USCIS). The steady-state aggregate productivity of the Home country Z is normalized to 1, and that of Foreign is set to 0.43 to match the average relative productivity data for India from the Penn World Tables.[33]

We calibrate some parameters directly from the data or from prior literature (Table 2). For parameters related to the fraction and average sales of firms, we use data presented in Section 3. We set N_d, N_f, and N_m to match the average fraction of firms given in Table 1. We normalize $z_{min} = 1$ and set the shape parameter of the parameter distribution κ to be 3.4 to match the ratio of sales $(\tilde{z}_m/\tilde{z}_f)^{\theta-1} = 6.83$ (Compustat and LCA data). We set $\beta = 0.96$, which implies an annual real interest rate of 4%. The exogenous return shock to Foreign is set to $\delta = 0.1$, in order to match the annual return migration rate of 10% (North 2011). We normalize the aggregate Home domestic skilled labor supply to 1, i.e. $L_s = 1$. The immigration cap $\bar{N}_e$ is set to 0.0022 in order to match the average cap imposed by actual policy (85,000) as a proportion of the normalized average domestic skilled labor in the US. In the data, we measure skilled workers as individuals

[31] In doing so, we acknowledge that the US is much larger than India and that changes in the US can have a substantial general equilibrium effect on India, which would feedback to the US via trade.

[32] Note that for labor force variables, we include data for individuals aged 16 years and above that are employed in the labor force.

[33] We use ctfp (Total Factor Productivity Level at Current PPP) over 2012–2018 to get India's relative aggregate productivity. Other measures (for instance, 'rgdpo', i.e. output-side real GDP at chained PPPs) yield similar values.

Table 2: A Priori Parameters

A Priori Parameter	Notation	Value	Target
Discount factor	β	0.96	Annual interest rate
Elasticity of substitution	θ	3.4	Average markup
Elasticity of substitution	γ	0.95	Ottaviano and Peri (2012)
Return migration	δ	0.1	Average return migration
Immigration cap	$\bar{N}_e$	0.0022	Cap/Domestic skilled labor
Domestic unskilled labor	L_u	1.6	Proportion of US unskilled labor
Foreign skilled labor	L_s^{*total}	0.6	India's skilled labor/US skilled labor
Foreign unskilled labor	L_u^*	4.84	Proportion of Indian unskilled

Table 3: Targeted Moments

Target	Data	Model
Average fraction of immigrant applications approved	0.4	0.4
Skill Premium	1.8	1.6
Offshore labor/total employed	0.0615	0.0619

Table 4: Calibrated Parameters

Calibrated Parameter	Notation	Value
Skill Intensity	α	0.58
Mass of Foreign Intermediate Firms	N_d^*	0.344
Sunk Immigration Cost	f_R	0.74

employed in the labor force with a Bachelor's degree or higher. The aggregate Home unskilled labor, Foreign skilled labor, and Foreign unskilled labor are calibrated to match the ratio of native-born unskilled to skilled labor in the US, the ratio of skilled labor in India relative to the US, and the ratio of unskilled to skilled labor in India, respectively. We set $\gamma = 0.95$ to target an elasticity of substitution between domestic and foreign workers of 20 (Ottaviano and Peri 2012). We set the elasticity of substitution across product varieties in the intermediate skilled-sector to be 3.4 to match an average markup of 1.41 which is consistent with markup estimates in De Loecker et al. (2020).

For iceberg costs, we follow the literature. Anderson and van Wincoop (2004) review literature on estimating and/or calibrating iceberg trade costs (equivalently, tariff equivalent trade costs). It is not surprising there are enormous variations in the value, and the value depends on the trading partner, period and so on. A wide range of recent studies use an iceberg trade cost between 10% and 40%. For instance, Obstfeld and Rogoff (2000) consider 10% to 30% iceberg trade costs, and Ghironi and Melitz (2005) set the costs to be 30%. The multi-sector international trade and macro models of Engel and Wang (2011) and Kim (2021) parameterize iceberg trade costs to 10% and 30%, respectively. Based on these estimates, we set iceberg trade costs in the upstream sector to be $\tau = 1.3$ and we set iceberg costs of importing back the product from offshore to be the same.

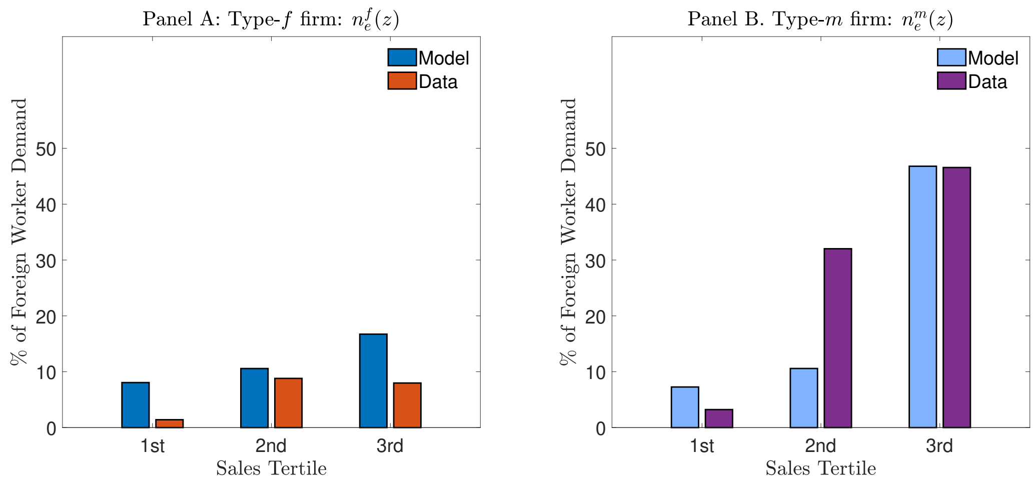

Figure 4: Distribution of Foreign Worker Demand: Data vs Model

Notes: Panel A includes sales tertiles of non-MNE firms with a positive demand for foreign skilled workers. Panel B includes sales tertiles of MNE firms with a positive demand for foreign workers. Both in the model and in the data, the total fraction of demand for each group is computed as the sum of demand by firms in that group as a proportion of total demand for foreign skilled workers.

We set the hiring cost to be constant over time: $f_{R,t} = f_R$. We jointly calibrate $\{\alpha, N_d^*, f_R\}$ to match the targets in Table 3. Data on offshore labor and total labor employed domestically in the Professional, Scientific, and Technical Services sector is taken from the Bureau of Economic Analysis (BEA). Note that for the target on the ratio of offshore labor hired to total sector employment, we use offshore labor employed in India in this sector and not the total offshore labor employed. The total proportion of offshore labor hired relative to domestic employment in this sector is approximately 12% and about half of this is based in India.[34]

The resulting parameter values are highlighted in Table 4.

To further evaluate our model, we compare the model-implied distribution of immigrant-labor demand across firm types f and m with the corresponding distribution in the data. Figure 4 shows that our model generates a distribution of the demand for immigrant workers across the firm types that is close to the data.

[34]In our calibration, sector exports as a proportion of aggregate sector output turns out to be approximately 10% which is lower than the aggregate sector exports to sector output ratio in the US (14%), calculated using the BEA input-output use tables. This is not surprising given that our Foreign country is calibrated to India and not rest of the world. In the absence of corresponding data on sector wise exports to India, we cannot compare the model and data for this target.

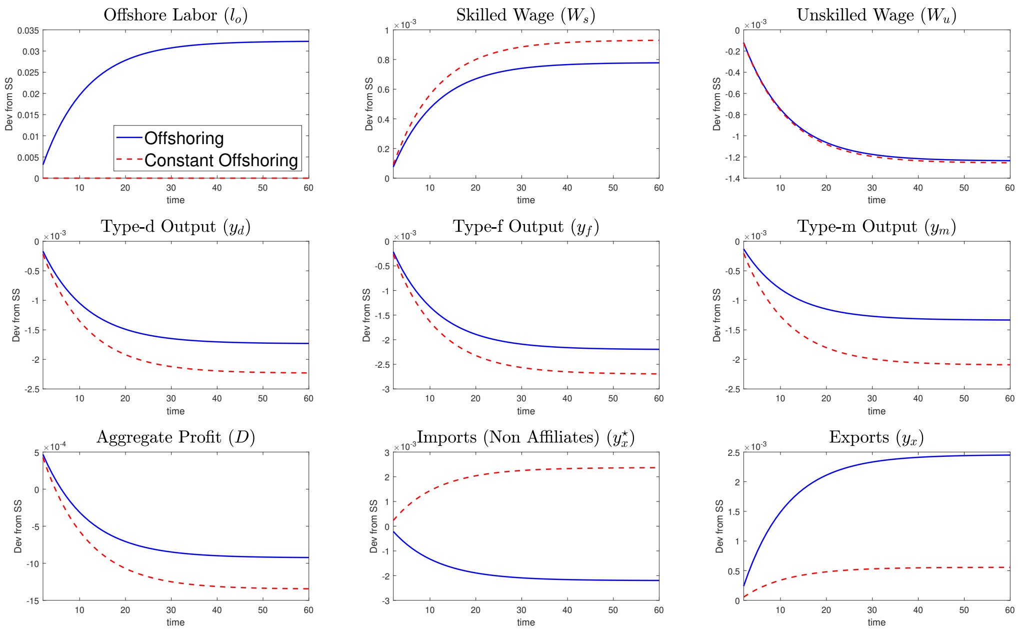

Figure 5: Response to a 10% Immigration Cap Reduction: Offshoring Change versus Constant Offshoring.

Notes: All deviations are in units of percent deviation from the steady state. See Figure A3 for the other variables' response.

7 Immigrant Policy, Transition Dynamics, and Welfare Evaluations

We solve the calibrated model numerically to compute the dynamics and welfare impacts of policy changes.[35] In Section 7.1, we study the responses to a stricter immigration policy by considering an immigration cap reduction and discuss the implications of endogenous changes in offshoring. In Section 7.2, we compute the welfare effects of a 10% cap reduction on domestic households and discuss how the results depend on the offshoring channel. We also analyze the role of transitional dynamics in welfare calculations and the role of alternate profit distribution across households.

7.1 Dynamic Response to a Permanent Cap Reduction

Our main counterfactual exercise studies the impact of a stricter skilled immigration policy. To do that, we consider our model's responses to a permanent 10% cap reduction. The blue solid lines in Figure 5 give the dynamic responses in our benchmark exercise in which we allow the level of offshoring to adjust. Figure A3 in the Appendix graphs some additional impulse responses. A tighter immigration policy leads to

[35] For the perfect foresight solution, transition dynamics from the initial equilibrium to the final equilibrium are found by solving the model as a nonlinear, forward-looking, deterministic system using a Newton-Raphson method, as described in Laffargue (1990). This method simultaneously solves all equations for each period, without relying on low-order, local approximations.

a decline in the fraction of immigrant workers that firms can employ at Home. This is reflected by a decline in the probability μ of being able to hire a skilled immigrant worker. This increased friction incentivizes firms to hire more workers in offshore affiliates. However, not all firms can hire offshore labor and even for the firms that can (type m), iceberg offshoring costs and relatively lower aggregate productivity in Foreign prevents a full substitution of offshore labor for immigrant labor. Therefore, the increase in offshore labor does not fully offset the decline in immigrant labor, and the output produced by type-m firms fall. Output at type-f firms that do not have offshore affiliates also falls. Interestingly, output at type-d firms also falls as domestic skilled labor shifts from type-d to more productive type-f and type-m firms since the demand for skilled labor increases in these firms (Figure A3).[36] Firm profits at all three firm types fall, which also causes aggregate profits (D) in the intermediate skill-intensive sector to fall.

The reduction in the stock of domestically available skilled labor puts pressure on Home skilled wages to increase. Additionally, Home unskilled wages fall because of lower demand for unskilled labor output since sector-1 and sector-2 outputs are complementary via the consumption basket.

In summary, when firms adjust the level of offshoring in response to a stricter immigration policy, part of the decline in skilled immigrant labor is offset by an increase in labor hired offshore, which is consistent with the empirical evidence in Glennon (2020). However, output in all skill-intensive firms falls (including at those firms that don't hire immigrant skilled labor).

To gain some insights regarding the importance of the offshoring channel, we study the responses to the same immigration policy change after fixing the level of offshoring to the initial level in the benchmark case before the cap change. Therefore, in the counterfactual case, we shut down the adjustment in offshoring and study the economy's responses to a 10% immigration cap reduction. The red dashed lines in Figures 5 and A3 plot the responses to this case where firms cannot adjust offshoring. Comparing the blue solid line and red dashed line, we see that the responses to key variables are amplified in the counterfactual case. Importantly, the inability to adjust to the increased hiring friction at Home leads to a larger increase in skilled wages and larger declines in output and profits across type-d, type-f, and type-m firms. Note that the larger decline in output at type-d firms is because a larger fraction of domestic skilled labor moves to type-m firms in equilibrium. While total type-m firm output ($y_{m,t}$) falls because of a fall in domestic sales ($y_{h,t}$), exports by type-m firms ($y_{x,t}$) increases. The increase in exports is larger when firms are able to increase offshore labor hiring.

As discussed in Section 5, the impact of immigration policy changes on imports from non-affiliated firms depends on whether or not we consider the adjustment in offshore labor hiring. As seen in Figure 5, there is a qualitative difference in the impact on these imports. For the case in which firms do not adjust offshoring, imports from non-affiliated firms increase. Intuitively, domestic skill-intensive production falls by more in this case and this leads to increased imports from Foreign non-affiliated firms. Moreover, when Home firms do not adjust offshoring, output produced by foreign non-affiliated upstream firms rises by more as they are able to employ more skilled foreign labor. However, when we do account for the endogenous adjustment

[36]Note that with an elasticity of substitution between domestic and immigrant skilled labor of 20, the two types of labor are relatively good (albeit imperfect) substitutes.

in offshoring, some skilled labor in Foreign shifts from Foreign non-affiliated firms to offshore affiliates, which leads to lower output produced in Foreign non-affiliated firms. This can be seen in Figure A3 that shows that skilled labor employed in Foreign non affiliates ($l^*_{s,t}$) slightly declines when Home firms expand the level of offshoring. This is also reflected in a slight decrease in imports from the Foreign non-affiliated firm in our benchmark case.

On the other hand, when we account for the adjustment in offshoring, we see that imports from offshore affiliated firms increase since a larger component of domestic output is produced offshore. In this framework, the component of imports from foreign affiliate firms in units of the Home consumption good is given by $Q_t W^*_{s,t} N_m l_{o,t}$. Figure A4 shows that imports from affiliated firms increase due to an increase in offshore labor hiring following a 10% immigration cap reduction. However, if we do not consider the endogenous change in offshore labor hiring, our model economy would suggest that imports from non-affiliated firms would fall slightly.

In summary, the quantitative impacts of immigration policy changes on domestic output and wages depend on whether or not we account for firms' adjustment in offshore labor hiring. Moreover, the qualitative impacts of immigration policy changes on imports, particularly on imports from affiliated vs non-affiliated firms, crucially depend on taking into account offshoring changes.

7.2 Welfare Analysis

We calculate welfare impacts after a 10%, perfect foresight reduction in the immigration cap. The welfare gain or loss for each type of domestic household from the immigration policy tightening is computed as the percentage change (Δ) in initial steady-state consumption ($C_{j,-1}$) that would leave the households indifferent between the initial policy and the new policy with the lower cap when the new policy is implemented at time $t = 0$. Transitional dynamics have been included in welfare computations. Thus, Δ solves:

$$\frac{u\left((1+0.01\Delta)C_{j,-1}\right)}{1-\beta} = \sum_{t=0}^{\infty} \beta^t u\left(C_{j,t}\right), \quad \text{for } j \in \{d, u\}. \tag{32}$$

We first consider welfare impacts in our baseline model where skilled domestic households are profit earners. We then consider an alternate profit distribution scenario across household types to understand the separate implications for wage and firm owners. The first two exercises take into account the impact of endogenous changes in firm offshoring (benchmark exercise). Finally, we study the impact of ignoring the adjustment in offshoring (counterfactual exercise).

Baseline. From Panel A in Table 5, we note that under the baseline model where native skilled households earn firm profits (via dividends), a 10% immigration cap reduction leads to a net 0.0240% increase in native skilled welfare. Intuitively, a stricter domestic skilled immigration policy leads to higher domestic skilled wages but lower aggregate firm profits. The welfare of domestic skilled workers increases because the increase in skilled domestic wages outweighs the decline in firm profits.

Table 5: Welfare Impact of 10% Immigration Cap Reduction

Home Households	Skilled	Unskilled	Entrepreneurs
Panel A. Baseline model: profit earners – home skilled workers			
Benchmark – offshoring	0.0240	−0.0869	
Counterfactual – constant offshoring	0.0224	−0.0883	
Panel B. Alternative model: profit earners – entrepreneurs			
Benchmark – offshoring	0.0547	−0.0869	−0.0466
Counterfactual – constant offshoring	0.0654	−0.0883	−0.0763

Note: Values reported above are in percent of initial steady-state consumption.

The welfare loss to domestic unskilled households is -0.0869%. Unskilled workers at Home are hurt after a skilled immigration cap reduction because of the decline in domestic consumption demand, leading to a decrease in demand for unskilled labor and unskilled wages.[37]

Impact of Alternate Profit Distribution. In order to separate out the effects on wages and profits in the welfare calculations, we analyze the welfare effects of an alternate profit distribution scenario in Panel B of Table 5. For this alternate scenario, we introduce a new type of household, the entrepreneur. The representative entrepreneur earns the aggregate firm profits (D_t). Therefore, the new stochastic discount factor for the firms is $\beta_{k,t} \equiv \beta[u'(C_{e,k})/u'(C_{e,t})]$. The budget constraints of the entrepreneurs and domestic skilled households are given by $C_{e,t} = D_t$ and $C_{s,t} = W_{s,t}$, respectively.

From Panel B of Table 5, we see that the welfare gain to domestic skilled workers due to higher wages is approximately 0.0547% in the benchmark exercise where we allow offshoring to endogenously adjust. The entrepreneur household experiences a welfare loss due to decline in firm aggregate profits. This loss amounts to 0.0466% of initial steady-state consumption. The welfare loss to unskilled households remains the same as our baseline profit-distribution case.[38]

Impact of Offshoring. Through this analysis, our counterfactual exercise intended to emphasize the importance of accounting for the adjustment in offshoring by domestic firms after a change in immigration policy. Therefore, we also compute welfare impacts for the case where we keep the level of offshoring constant, following a cap change, i.e., we shut down the adjustment in offshoring.[39] We expect that if we do not account for the change in the offshoring level, firms are likely to be hurt more by the cap reduction,

[37]The complementarity between skilled and unskilled workers in the model arises from the final good consumption basket.

[38]It is important to note that a 10% cap decrease corresponds to roughly 8500 fewer skilled workers every year which amounts to roughly $0.9 \times 8500 \times 10 = 76,500$ fewer workers over ten years. However, if we were to consider large cap changes, for instance, a 200% increase in the immigration cap, it would translate to a lifetime loss of approximately 1.094% for skilled domestic workers and a 1.738% gain for unskilled workers. To put things in perspective, a 200% cap increase would amount to an approximate annual entry of $255,000$ skilled immigrants which would translate into 2,295,000 more workers over 10 years (accounting for exit).

[39]We keep the calibration the same as the benchmark case. However, we keep the level of offshoring fixed at the initial steady-state level before the change in the cap.

Table 6: Welfare Impact of 10% Immigration Cap Reduction

Home Households	Skilled	Unskilled	Entrepreneurs
Alternative model: profit earners – entrepreneurs			
Including transitional dynamics	0.0547	−0.0869	−0.0466
No transitional dynamics	0.0780	−0.1238	−0.0926

Note: Values reported above are in percent of initial steady-state consumption.

and Home skilled households are likely to gain more because of higher pressure on skilled domestic labor markets and a larger resulting increase in wages.

Results from the alternate profit distribution scenario confirm our intuition that when we ignore the adjustment in offshoring, domestic skilled workers experience higher wage and welfare gains, while firm owners experience a larger welfare loss (Panel B of Table 5). In this counterfactual case where we keep the level of offshoring constant, the gain to domestic skilled workers is approximately 19.56% higher than in the benchmark case where firms adjust their offshore labor hiring.[40] Therefore, we would estimate a greater increase in domestic skilled wages after an immigration cap reduction if we ignore the offshoring channel.

To summarize, a stricter skilled immigration policy hurts unskilled workers and entrepreneurs but benefits skilled domestic workers because of higher wages. However, the gains to skilled domestic workers, and losses to firm owners, are overestimated if we do not account for the offshore labor hiring adjustment that follows the stricter immigration policy. Therefore, it is important to consider the offshoring channel when evaluating the welfare effects of skilled immigration policy changes.

7.3 Importance of Dynamics in Welfare Calculations

In our model, accumulating the stock of immigrant skilled workers is like an investment decision for firms and firms are willing to pay the sunk cost of hiring immigrant workers in anticipation of expected discounted future benefits. Therefore, much of the impacts of immigration policy changes are felt over time as the stock of immigrant workers changes over time. This implies that accounting for transitional dynamics matters when evaluating impacts of immigration policy changes. This can be seen from the responses in Figure 5. The endogenous variables sluggishly converge to the new steady state over many decades.

Table 6 compares the welfare impacts from a 10% immigration cap reduction in the alternate profit distribution case when (a) we include transitional dynamics, and (b) we do not include transitional dynamics.[41] If we ignore transitional dynamics, the model significantly overstates the magnitude of the welfare impacts on all households. This is because the impacts take place over time and when we include transitional dynamics, we account for the fact that future impacts are more heavily discounted by households. Therefore, it is important to account for transitional dynamics in this framework.

[40] In the baseline profit distribution case, firm profits decline by more in the counterfactual case which is why the positive welfare impact for domestic skilled workers is lower in the constant offshoring case.

[41] In the latter case, the welfare gain or loss for each type of domestic household is computed as the percentage change in initial steady-state consumption that would leave the households indifferent between the initial policy and the new policy in steady state.

The above results show that it is important to take into account the endogenous changes in offshoring when evaluating impacts of skilled immigration policies. There are a relatively small fraction of firms that have the ability to hire labor in offshore affiliates but these firms account for majority of the demand for immigrant workers and are larger in size. Therefore, their response to immigration policy changes matters for aggregate macroeconomic variables such as firm profits, wages, and welfare. The results also show that it is important to account for dynamics since the structure of immigration policy with sunk hiring costs implies that firms are forward looking and transitional dynamics therefore matter for welfare results.

8 Discussion

By focusing on a two-country framework, we are mainly able to capture bilateral interactions between skilled immigration, offshore labor hiring, and trade. Our model mechanisms are consistent with empirical literature that focus on bilateral interactions.[42] The main model mechanisms are also consistent with the data trends presented in Figure 1 and Figure A1. From the figures we see an increase in the share of offshore labor employed since 2004, particularly in the Asia-Pacific region.[43] Note that this increase in offshoring coincided with an increase in imports and importantly with an increase in the share of foreign affiliates in imports. These facts are consistent with our model. The H1-B cap was reduced from 195,000 to 85,000 in 2004 and has remained unchanged thereafter, which suggests that immigration policy got stricter. Our model would suggest that a stricter immigration policy would increase offshore labor hiring, which in turn would increase output imported back from affiliated firms. Since imports from non-affiliated firms decrease in the model, the share of imports from affiliated firms would increase, as seen in the data. There may have been many other forces that contributed to these trends – for instance, lower communication costs and higher relative productivity growth within this sector in specific Asia-Pacific countries. Some intuition regarding how these factors would influence the level of offshoring in our model are given in Section 5. Our main exercise quantifies the effect of one important channel — the impact of stricter immigration policy on endogenous changes in offshoring and how this impacts the welfare implications of the policy change.

One caveat is that in a more realistic multi-country framework, immigration policy restrictions would affect offshoring activities in multiple countries. Glennon (2020) shows that the expansion of foreign-affiliate activity occurred across multiple countries. However, it was more pronounced in countries that were raw sources of human capital (India and China) compared to countries where it was easier to open and expand foreign affiliates (Canada). Even if foreign affiliate activity increases in multiple countries, the key message of our paper remains unchanged. Firms' response to immigration policy restrictions incentivize more offshoring, and these endogenous changes should be taken into account while evaluating domestic immigration policy changes.

We mainly focus on the substitutabilities channel between immigration and offshore labor hiring that

[42]For instance Ottaviano et al. (2018b) show that an increase in high-skilled immigration in the U.S. leads to a decrease in bilateral imports of intermediate goods.

[43]As mentioned before, 68.3% of the offshore labor hired in Asia Pacific within the relevant sector was based in India. China, the second largest employer in Asia Pacific comprised only 7.9% of total foreign-affiliate employment.

has been documented in firm surveys and the recent literature. However, there may be other forces in action that may lead to complementarities between immigrant and offshore worker. For instance, it is plausible to argue that significantly lowering immigration policy frictions (by increasing the immigration cap) may lead to a significant number of firms transitioning from type d to f.[44] If growth of firm productivity is tied to the availability of skilled labor, more firms could also potentially transition from type-f to type-m, as more firms would be able to incur the prohibitively high fixed offshoring costs that we implicitly impose in the model. This could lead to an increase in aggregate offshoring driven by the extensive margin. The current model cannot account for potential complementarities between immigration and offshoring that would arise through this channel.[45] Complementarities between immigration and offshoring could also exist via improved ethnic ties. We leave a more nuanced focus on these channels for future work.

The current model ignores unskilled migration. The main reasons are that the source countries of unskilled migrants and policies associated with unskilled immigration are very different. Regarding the source country, Mexico is the leading source of unskilled immigrants for the US. Moreover, there has been a marked slowdown of unskilled immigration to the US since the mid 2000s compared to earlier decades (Hanson et al. 2017). Regarding immigration policy, while there are some formal routes of entry, much of the unskilled immigration has been undocumented. Adding unskilled immigration to the model would require adding a third country and alternate immigration policies. While this may add other insights, it would not change the key message of the paper — frictions imposed by skilled immigration policy incentivize firms to increase offshoring activities and it is quantitatively important to account for this channel when studying the implications of immigration policy changes.

Even if the model ignores unskilled immigration, the model does account for complementarities between skilled labor and domestic unskilled labor. In the model, consumers consume a basket of goods produced by skilled and unskilled labor. A decrease in skilled immigration leads to a lower demand for output produced by unskilled labor. This is reflected in lower wages and welfare of unskilled labor following a skilled immigration policy tightening (Section 7.2). Therefore, there exist complementarities between unskilled and skilled labor via the consumption basket.[46] This channel has been documented by Hong and McLaren (2015).

9 Conclusion

We build a two-country dynamic general equilibrium model with skilled immigration, offshore labor hiring, and trade in skill-intensive intermediate inputs. The model is consistent with various facts in the data related to firm demand for foreign skilled workers and firm size. We employ the calibrated model to study the

[44] As mentioned above, the fixed firm productivity cutoffs in the current model were motivated by facts in the data.

[45] In the current model, when the immigration cap increases, type-f and type-m firm output increases. However, since the marginal cost of hiring skilled workers domestically falls following the larger availability of skilled labor at Home, domestic firms reduce offshore labor hiring.

[46] In this setup, if we add unskilled immigration, an increase in unskilled immigration would lead to welfare gains for skilled households because of these complementarities.

interaction between skilled immigration policy changes in the US and offshore labor hiring. In the model, a lower skilled immigration cap increases offshoring at the intensive margin. It is crucial to consider firm adjustments in offshore labor hiring following an immigration policy change, even if only a small subset of firms engage in offshore labor hiring. In particular, if we do not account for an adjustment in offshoring, we would overestimate the positive effect on wages of domestic skilled workers after an immigration cap decline. Much of the current literature has ignored this channel when evaluating the welfare impact of skilled immigration policy changes. However, given recent debates surrounding stricter skilled immigration policies, it has become even more important to consider firm responses that would potentially offset the impact of the policy changes.

We also show that it is essential to account for firm adjustment in offshoring and the affiliation of the foreign firm when evaluating the impact of immigration on imports. The paper highlights the importance of considering the general equilibrium relationships between migration, trade, and offshoring when designing immigration and trade policy changes. The model is a first step in studying these interactions in a macroeconomic general equilibrium framework.

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Appendix

A Additional Tables and Figures

Table A1: Sector-Wise Average Demand for H-1B (2014-2018)

Sector	Share of Total Average Foreign Worker Demand (2014–2018,%)
Professional, Scientific, and Technical Services	74.89
Manufacturing	8.49
Information	4.00
Finance and Insurance	2.86
Educational Services	2.58
Health Care and Social Assistance	1.99
Retail Trade	1.80
Administrative and Support and Waste Management and Remediation Services	1.09
Wholesale Trade	0.66
Construction	0.25
Management of Companies and Enterprises	0.23
Transportation and Warehousing	0.21
Other Services (except Public Administration)	0.17
Accommodation and Food Services	0.16
Real Estate and Rental and Leasing	0.16
Mining, Quarrying, and Oil and Gas Extraction	0.14
Utilities	0.10
Arts, Entertainment, and Recreation	0.09
Public Administration	0.08
Agriculture, Forestry, Fishing and Hunting	0.05

Notes: Authors' calculations using the Labor Condition Application (LCA) database for H1-B workers (Department of Labor).

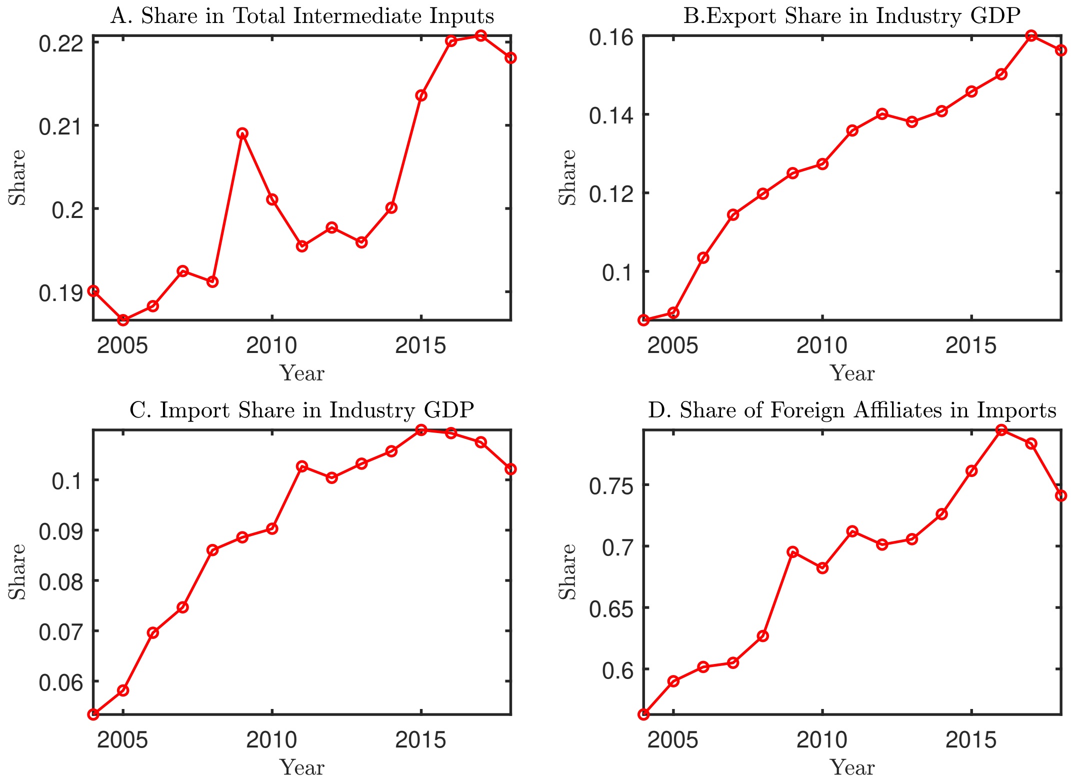

Figure A1: Rising Importance of Skilled Service Sector in the US

Notes: Authors' calculations from Bureau of Economic Analysis (BEA) Input-Output Tables for NAICS sector 54 (professional, scientific, and technical services sector). Data by affiliation computed from the BEA services trade data for ICT and business service sectors.

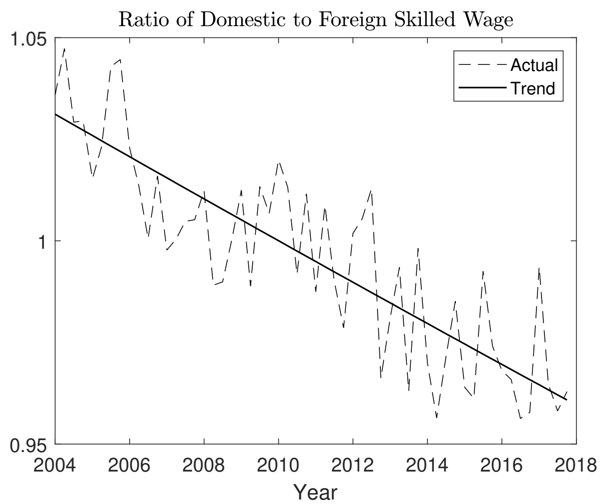

Figure A2: Immigrants' Earnings and Skill Premium 2004 – 2017

Notes: Authors' calculations using Current Population Survey monthly samples (accessed through IPUMs). We define skilled as those individuals with a Bachelor's degree or higher foreign-born as those born outside the US.

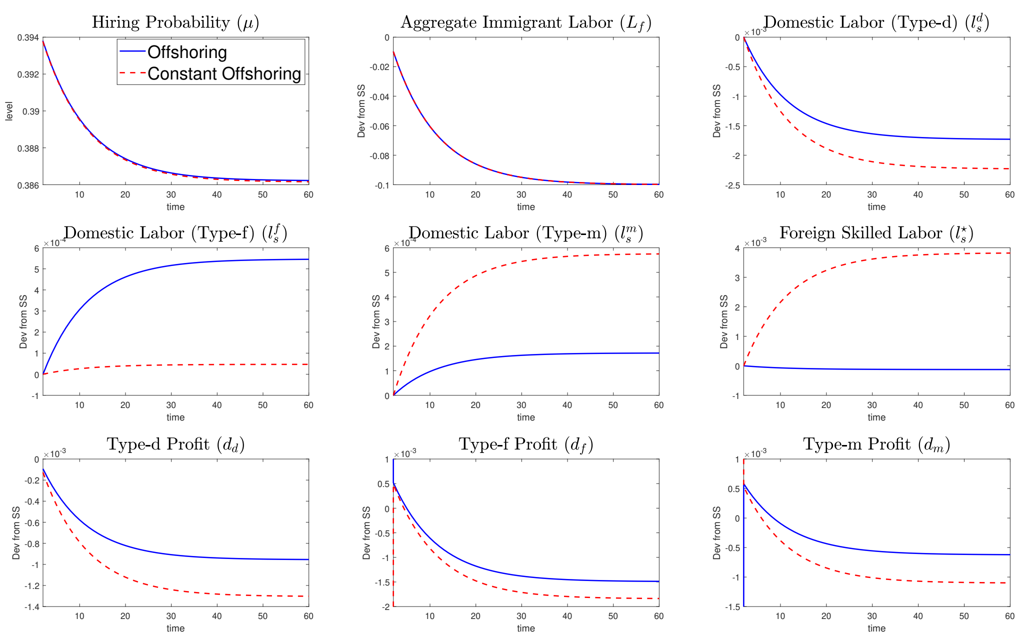

Figure A3: Response to a 10% Immigration Cap Reduction— Additional Variables: Offshoring Change versus Constant Offshoring.

Notes: All deviations are in units of percent deviation from the steady state.

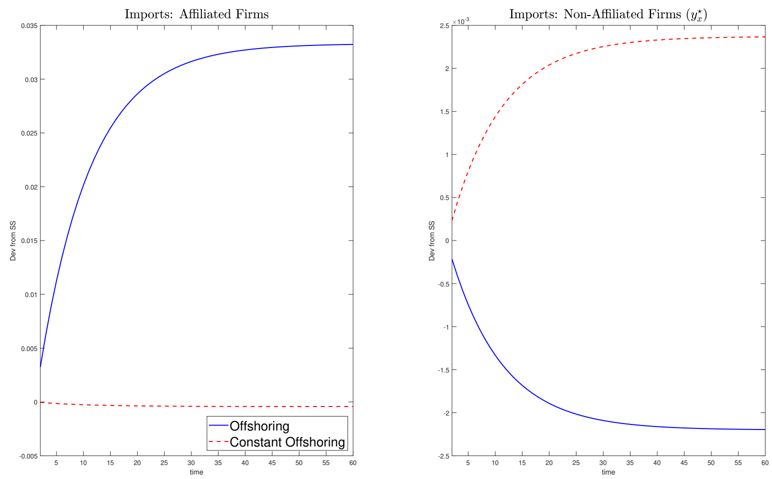

Figure A4: Response to a 10% Immigration Cap Reduction— Imports from Affiliated vs Non-Affiliated firms

Notes: All deviations are in units of percent deviation from the steady state.

B H-1B Program: Institutional Framework and Background

Since the implementation of the H-1B visa program in 1990, it has been the main method of entry into the US workforce for foreign college-educated professionals. According to the US Department of State, H-1B visa holders constituted 66.1% of all skilled foreign entrants in 2014. The other major visa categories for foreign skilled workers are L-1 (for transfer of employees across multinational firms, 29.3%) and TN (visas for Canadian and Mexican NAFTA professional workers, 4.6%). The proportion of entrants from the latter two visa categories has been increasing since 2001, but the H-1B visa program still remains the dominant entry mode. Thus, most studies that analyze the impact of skilled foreign workers in the US focus on the H-1B visa program. Though the H-1B visa is a temporary visa as it is issued for three years (and can be renewed for another three years), it is a dual intent visa as it can lead to permanent residency if the employer is willing to sponsor the worker for a green card.

The H-1B program has been subject to an annual quota on new visa issuances. The initial visa cap was 65,000, which was subsequently increased to 115,000 in 1999 and 2000 after the cap was met in 1997. The cap was further increased to 195,000 from 2001 through 2003. In 2001, cap exemptions were introduced for employees of higher education, non-profit, and government research organizations. In 2004, the cap was reduced back to 65,000, but 20,000 additional visas were allocated for workers who had obtained a master's degree or higher from a US institution. The cap applies only to new H-1B visa issuances for for-profit firms.

In order to obtain an H-1B visa, there are several steps to be followed and firms are central to this process. The first step requires the firm that wants to hire a foreign worker to file a Labor Condition Application (LCA) with the department of labor. In the application, the firm specifies the nature of the occupation and attests that the firm will pay the worker the greater of the actual compensation paid to other employees in the same job or the prevailing compensation for that occupation. The rationale given for this attestation is to help protect domestic worker wages. The LCA request also certifies that the employer must hire a foreign worker because a US citizen is not qualified, available, or willing to work in that job position.

LCA forms can request one or more foreign workers for a particular occupation, and thus they signal firm vacancies in specific occupations for foreign workers. LCAs are processed relatively quickly, and so firms can file them either after hiring workers or in anticipation of hiring. However, there are some limitations of using the LCA database. The LCA database contains records for every request submitted, but this is only an intermediate step in the process toward the final visa approval. An LCA is submitted for every H-1B request, whether new or a renewal, and each LCA can contain multiple H-1B workers.

Once the LCA has been approved by the Department of Labor, it is sent to the United States Citizenship and Immigration Services (USCIS), along with the I-129 form[47] and the required visa fees. This is the final step and firms have from April 1st until the beginning of the next fiscal year to file petitions for H-1B visa applications. The crucial fact is that employees can apply for an H-1B visa only if they have a job offer from an employer with an LCA approval. The employer cannot file more than one I-129 for the same prospective employee. Most of the filing and legal fees are borne by the employer. If the number of H-1B visa petitions

[47]This proves the worker's qualifications.

(I-129 forms) that fall within the non-exempt category exceeds the cap, the USCIS randomly selects visas for processing via a lottery system until the 65,000 cap is reached. The total number of petitions filed does not give an indication of the true demand because the government stops collecting H-1B petitions once it has determined that the cap has been reached for a given year.

In recent years, the Department of Homeland security has been considering amendments in its regulations regarding the process by which the US Citizenship and Immigration Services (USCIS) selects H-1B petitions for the filing of the H-1B cap subject petitions, but no major changes have been implemented yet. In 2020, the USCIS implemented a pre-registration process that begins on March 1 for potential employees that want to file an H-1B petition. If the USCIS receives enough registrations by March 18 (based on historic projections), they randomly select registrations. An H-1B cap-subject petition may only be filed by a petitioner whose registration was selected. Therefore, while the USCIS has slightly streamlined the procedure, the immigration cap and procedure for allocation remain effectively the same.

C Firm Optimization Problems

C.1 Type-d Firms

Type-d firms hire only domestic skilled labor to produce output with the production technology: $y_{d,t}(z) = Z_t z l^d_{s,t}(z)$, where Z_t is the aggregate productivity in the economy and $l^d_{s,t}(z)$ is the domestic skilled labor hired by firm z, for $z < z_c$. We use the superscript d to denote the domestic skilled labor in firm type d to differentiate it from the skilled domestic labor hired in type-f and type-m firms, which we denote as $l^f_{s,t}(z)$ and $l^m_{s,t}(z)$, respectively.

Each firm takes skilled wages as given to maximize profits subject to its technology and output demand:

$$\max_{\{p_{d,t}(z), y_{d,t}(z), l^d_{s,t}(z)\}} \left[p_{d,t}(z) y_{d,t}(z) - W_{s,t} l^d_{s,t}(z) \right], \tag{C1}$$

$$\text{s.t. } y_{d,t}(z) = Z_t z l^d_{s,t}(z), \tag{C2}$$

$$y_{d,t}(z) = \alpha \left(\frac{p_{d,t}(z)}{P_{1,t}} \right)^{-\theta} \frac{Y^c_t}{P_{1,t}}. \tag{C3}$$

Profit maximization yields that the pricing function is a markup over the marginal cost:

$$\psi_{d,t}(z) = \frac{W_{s,t}}{Z_t z}, \tag{C4}$$

$$p_{d,t}(z) = \frac{\theta}{\theta - 1} \psi_{d,t}(z), \tag{C5}$$

where $\psi_{d,t}(z)$ is the marginal production cost of the type-d firm with productivity z and the Lagrange multiplier on the production technology.

C.2 Type-f Firms

Each period, a subset of sector-1 firms (type f) produce output using imperfectly substitutable domestic and immigrant skilled labor. The production technology is given by

$$y_{f,t}(z) = Z_t z \left[(l^f_{s,t}(z))^\gamma + (l^f_{f,t}(z))^\gamma \right]^{\frac{1}{\gamma}}, \tag{C6}$$

where $z_m > z \geq z_c$, and $l^f_{s,t}(z)$ and $l^f_{f,t}(z)$ are the domestic and immigrant skilled labor employed, respectively.

Each firm optimally chooses prices, skilled labor, dividends, and the new immigrant skilled labor hiring each period, to maximize the present discounted value of real net revenues, taking skilled wages and hiring costs as given. Firms discount future real cash flows using the skilled household's discount factor since these households earn dividends on mutual fund holding of shares at firms. The profit maximization problem is given by

$$\max_{\substack{\{n^f_{e,t}(z), l^f_{f,t}(z), l^f_{s,t}(z), \\ p_{f,t}(z), y_{f,t}(z)\}_{t=0}^{\infty}}} \mathbb{E}_o \sum_{t=0}^{\infty} \beta^t U'(C_{s,t}) \left[p_{f,t}(z) y_{f,t}(z) - W_{s,t}(l^f_{s,t}(z) + l^f_{f,t}(z)) - f_{R,t} n^f_{e,t}(z) \right],$$

subject to the following constraints:

1. Production technology:
$$y_{f,t}(z) = Z_t z \left[(l^f_{s,t}(z))^\gamma + (l^f_{f,t}(z))^\gamma \right]^{\frac{1}{\gamma}}.$$

2. Law of motion for foreign workers:
$$l^f_{f,t}(z) = (1-\delta)(l^f_{f,t-1}(z) + \mu_t n^f_{e,t}(z)).$$

3. Demand:
$$y_{f,t}(z) = \alpha \left(\frac{p_{f,t}(z)}{P_{1,t}} \right)^{-\theta} Y^c_t / P_{1,t}.$$

The first order conditions w.r.t. $n^f_{e,t}(z)$ and $l^f_{f,t}(z)$ imply that firms optimally choose to submit foreign labor applications each period till the expected cost of an application is equal to the expected discounted benefit from hiring a foreign skilled worker:

$$\frac{f_{R,t}}{\mu_t} = (1-\delta) \left\{ m_{f,t}(z) - W_{s,t} + \beta \mathbb{E}_t \left[\frac{U'(C_{s,t+1})}{U'(C_{s,t})} \left(\frac{f_{R,t+1}}{\mu_{t+1}} \right) \right] \right\}, \tag{C7}$$

where $m_{f,t}(z)$ is the marginal revenue product of each foreign skilled worker. The left hand side of Equation (C7) is the cost of hiring one additional foreign worker. Note that $\mu_t < 1$ increases the cost of hiring. Intuitively, in order to hire one worker, firms need to submit $1/\mu_t$ applications.

The right hand side of Equation (C7) gives the expected benefit of one additional immigrant worker — the marginal revenue product from an additional foreign worker net of wage paid, plus the future cost saving of hiring workers today, adjusted for the probability of return δ.

The marginal revenue product of hiring a foreign skilled worker is given by

$$m_{f,t}(z) \equiv \psi_{f,t}(z) Z_t z (l^f_{f,t}(z))^{\gamma-1} \left[(l^f_{s,t}(z))^\gamma + (l^f_{f,t}(z))^\gamma \right]^{\frac{1-\gamma}{\gamma}}, \tag{C8}$$

where $\psi_{f,t}(z)$ is the marginal cost of production and the Lagrange multiplier on the production technology. Note that the marginal revenue product depends on the relative labor ratio $l^f_{s,t}(z)/l^f_{f,t}(z)$ across firms.

The optimal choice of domestic skilled labor implies

$$W_{s,t} = \psi_{f,t}(z) Z_t z (l^f_{s,t}(z))^{\gamma-1} \left[(l^f_{s,t}(z))^\gamma + (l^f_{f,t}(z))^\gamma \right]^{\frac{1-\gamma}{\gamma}}, \tag{C9}$$

where $W_{s,t}$ is the skilled wage paid to all skilled workers. Therefore, we can express the wedge between the marginal revenue product and the wage paid to foreign workers each period as follows.[48]

$$m_{f,t}(z) - W_{s,t} = \left[\left(l^f_{f,t}(z)/l^f_{s,t}(z) \right)^{\gamma-1} - 1 \right] W_{s,t} \tag{C10}$$

This wedge is greater than 0 as $l^f_{f,t}(z) < l^f_{s,t}(z)$ and $\gamma < 1$. Substituting Equation (C10) into Equation (C7), we can write the hiring Euler equation as

$$\frac{f_{R,t}}{\mu_t} = (1-\delta) \left\{ \left[\left(l^f_{f,t}(z)/l^f_{s,t}(z) \right)^{\gamma-1} - 1 \right] W_{s,t} + \beta \mathbb{E}_t \left[\frac{U'(C_{s,t+1})}{U'(C_{s,t})} \left(\frac{f_{R,t+1}}{\mu_{t+1}} \right) \right] \right\}. \tag{C11}$$

Since $f_{R,t}$, μ_t, $W_{s,t}$, $C_{s,t}$, $C_{s,t+1}$, μ_{t+1}, and $f_{R,t+1}$, are independent of z and the same across firms, we see that the relative labor $l^f_{f,t}(z)/l^f_{s,t}(z)$ is the same across all firms z, which facilitates aggregation across firms.

Profit maximization in period t implies that the price $p_{f,t}(z)$ set by the firm is a proportional markup over the marginal cost:

$$p_{f,t}(z) = \frac{\theta}{\theta - 1} \psi_{f,t}(z). \tag{C12}$$

C.3 Type-m firms

Output is subject to the following production technology.

$$y_{m,t}(z) = Z_t z \left[(l^m_{s,t}(z))^\gamma + (l^m_{f,t}(z))^\gamma \right]^{\frac{1}{\gamma}} + Z^*_t z \frac{l^m_{o,t}(z)}{\tau_o} \tag{C13}$$

The revenue of the firm includes total value of sales to the domestic downstream firm $(p_{h,t}(z) y_{h,t}(z))$

[48]This follows because $m_{f,t}(z) - W_{s,t} = \psi_{f,t}(z) Z_t z \left[(l^f_{s,t}(z))^\gamma + (a l_{f,t}(z))^\gamma \right]^{\frac{1-\gamma}{\gamma}} \left[a (a l_{f,t}(z))^{\gamma-1} - (l^f_{s,t}(z))^{\gamma-1} \right]$. We can divide both sides by Equation (C9) to get Equation (C10).

and total sales to the foreign downstream firms $Q_t p_{x,t}(z) y_{x,t}(z)$. The costs include costs incurred due to immigration policy, wages paid to domestic and immigrant workers employed in the Home country, and wages paid to foreign offshore workers employed in Foreign.

Similar to type-f firms, type-m firms discount future real cash flows using the skilled household's discount factor since these households earn dividends on mutual fund holding of shares at firms. The profit maximization problem is given by

$$\max_{\substack{\{p_{h,t}(z), y_{h,t}(z), p_{x,t}(z),\\ y_{x,t}(z), n^m_{e,t}(z), l^m_{f,t}(z),\\ l^m_{o,t}(z), l^m_{s,t}(z)\}_{t=0}^{\infty}}} \mathbb{E}_o \sum_{t=0}^{\infty} \beta^t U'(C_{s,t})[p_{h,t}(z) y_{h,t}(z) + Q_t p_{x,t}(z) y_{x,t}(z) - f_{R,t} n^m_{e,t}(z) -$$

$$W_{s,t}\left[l^m_{f,t}(z) + l^m_{s,t}(z)\right] - Q_t W^*_{s,t} l^m_{o,t}],$$

subject to the following constraints:

1. $Z_t z \left[(l^m_{s,t}(z))^\gamma + (l^m_{f,t}(z))^\gamma\right]^{\frac{1}{\gamma}} + Z^*_t z l^m_{o,t}(z)/\tau_o = y_{h,t}(z) + \tau y_{x,t}(z)$
2. $y_{h,t}(z) = \left(\frac{p_{h,t}(z)}{P_{1,t}}\right)^{-\theta} Y_{1,t}$
3. $y_{x,t}(\omega) = \left(\frac{p_{x,t}(z)}{P^*_{1,t}}\right)^{-\phi} Y^*_{1,t}$
4. $l^m_{f,t}(z) = (1-\delta)\left(l^m_{f,t-1}(z) + \mu_t n^m_{e,t}(z)\right)$.

The first constraint spells out the market clearing condition. The second and third constraints specify the equilibrium demand for domestic and export sales, respectively. Firms take wages and immigration policy as given.

Optimality condition wrt $l^m_{s,t}$ implies

$$W_{s,t} = \psi_{m,t}(z) Z_t z (l^m_{s,t}(z))^{\gamma-1}\left[(l^m_{s,t}(z))^\gamma + (l^m_{f,t}(z))^\gamma\right]^{\frac{1-\gamma}{\gamma}}, \tag{C14}$$

which can be expressed as:

$$W_{s,t} = \psi_{m,t}(z) Z_t z \left[1 + \left(l^m_{f,t}(z)/l^m_{s,t}(z)\right)^\gamma\right]^{\frac{1-\gamma}{\gamma}}, \tag{C15}$$

where $\psi_{m,t}$ is the marginal cost of production.

The optimal condition wrt offshoring implies that firms hire offshore labor till the marginal cost of hiring labor offshore is equalized with that of hiring domestically available skilled labor as follows.

$$\tau_o Q_t \frac{W^*_{s,t}}{z Z^*_t} = \psi_{m,t}(z) \tag{C16}$$

Additionally, similar to type-f firms, type-m firms hire and submit applications for skilled immigrant workers such that the expected discounted benefit generated from an additional skilled immigrant worker is equal to the expected cost of hiring immigrant workers:

$$\frac{f_{R,t}}{\mu_t} = (1-\delta)\left[\left(\left(\frac{l^m_{f,t}(z)}{l^m_{s,t}(z)}\right)^{\gamma-1} - 1\right) W_{s,t} + \beta\left\{\mathbb{E}_t \frac{U'(C_{s,t+1})}{U'(C_{s,t})}\left(\frac{f_{R,t+1}}{\mu_{t+1}}\right)\right\}\right]. \tag{C17}$$

Profit maximization implies that the price set by firm $z \geq z_m$ for the domestic final good producer is $p_{h,t}(z) = [\theta/(\theta-1)](\psi_{m,t}(z))$ and the export price for the Foreign final good producer is $p_{x,t}(z) = Q_t^{-1}\tau p_{m,t}(z)$, where the export price is in units of Foreign consumption.

D Model Summary

D.1 Home

The representative households' budget constraints are

$$C_{s,t} = W_{s,t}L_s + D_t, \tag{D1}$$

$$C_{u,t} = W_{u,t}L_u, \tag{D2}$$

$$C_{f,t} = W_{s,t}L_{f,t}. \tag{D3}$$

Given fixed cutoffs, the average productivities of each group of firms are given by

$$\tilde{z}_d = \nu z_{min} z_c \left[\frac{z_c^{k-(\theta-1)} - z_{min}^{k-(\theta-1)}}{z_c^k - z_{min}^k}\right]^{\frac{1}{\theta-1}}, \tag{D4}$$

$$\tilde{z}_f = \nu z_m z_c \left[\frac{z_m^{k-(\theta-1)} - z_c^{k-(\theta-1)}}{z_m^k - z_c^k}\right]^{\frac{1}{\theta-1}}, \tag{D5}$$

$$\tilde{z}_m = \nu z_m. \tag{D6}$$

where $\nu = \left[\frac{k}{k-(\theta-1)}\right]^{\frac{1}{\theta-1}}$ and $k > (\theta-1)$.

The representative type-d firm's equations are described by

$$y_{d,t}(\tilde{z}_d) = Z_t \tilde{z}_d l^d_{s,t}(\tilde{z}_d), \tag{D7}$$

$$y_{d,t}(\tilde{z}_d) = \alpha \left(\frac{p_{d,t}(\tilde{z}_d)}{P_{1,t}} \right)^{-\theta} Y^c_t / P_{1,t}, \tag{D8}$$

$$p_{d,t}(\tilde{z}_d) = \frac{\theta}{\theta - 1} \frac{W_{s,t}}{Z_t \tilde{z}_d}, \tag{D9}$$

$$d_{d,t}(\tilde{z}_d) = p_{d,t}(\tilde{z}_d) y_{d,t}(\tilde{z}_d) - W_{s,t} l^d_{s,t}(\tilde{z}_d). \tag{D10}$$

The representative type-f firm's equations are described by

$$y_{f,t}(\tilde{z}_f) = Z_t \tilde{z}_f \left((l^f_{s,t}(\tilde{z}_f))^\gamma + (l^f_{f,t}(\tilde{z}_f))^\gamma \right)^{\frac{1}{\gamma}}, \tag{D11}$$

$$y_{f,t}(\tilde{z}_f) = \alpha \left(\frac{p_{f,t}(\tilde{z}_f)}{P_{1,t}} \right)^{-\theta} Y^c_t / P_{1,t}, \tag{D12}$$

$$p_{f,t}(\tilde{z}_f) = \frac{\theta}{\theta - 1} \frac{W_{s,t}}{Z_t \tilde{z}_f \left[1 + \left(l^f_{f,t}(\tilde{z}_f) / l^f_{s,t}(\tilde{z}_f) \right)^\gamma \right]^{\frac{1-\gamma}{\gamma}}}, \tag{D13}$$

$$d_{f,t}(\tilde{z}_f) = p_{f,t}(\tilde{z}_f) y_{f,t}(\tilde{z}_f) - W_{s,t} \left[l^f_{s,t}(\tilde{z}_f) + l^f_{f,t}(\tilde{z}_f) \right] - f_{R,t} n^f_{e,t}(\tilde{z}_f), \tag{D14}$$

$$\frac{f_{R,t}}{\mu_t} = (1 - \delta) \left\{ \left[\left(\frac{l^f_{f,t}(\tilde{z}_f)}{l^f_{s,t}(\tilde{z}_f)} \right)^{\gamma - 1} - 1 \right] W_{s,t} + \beta \mathbb{E}_t \left[\frac{U'(C_{s,t+1})}{U'(C_{s,t})} \left(\frac{f_{R,t+1}}{\mu_{t+1}} \right) \right] \right\}. \tag{D15}$$

The representative type-m firm's equations are described by

$$y_{h,t}(\tilde{z}_m) + \tau y_{x,t}(\tilde{z}_m) = \tilde{z}_m \left\{ Z_t \left[(l^m_{s,t}(\tilde{z}_m))^\gamma + (l^m_{f,t}(\tilde{z}_m))^\gamma \right]^{1/\gamma} + Z^*_t \frac{l^m_{o,t}(\tilde{z}_m)}{\tau_o} \right\}, \tag{D16}$$

$$y_{x,t}(\tilde{z}_m) = \alpha \left(\frac{p_{x,t}(\tilde{z}_m)}{P^*_{1,t}} \right)^{-\theta} Y^{c*}_t / P^*_{1,t}, \tag{D17}$$

$$y_{h,t}(\tilde{z}_m) = \alpha \left(\frac{p_{h,t}(\tilde{z}_m)}{P_{1,t}} \right)^{-\theta} Y^c_t / P_{1,t}, \tag{D18}$$

$$p_{h,t}(\tilde{z}_m) = \frac{\theta}{\theta - 1} \frac{W_{s,t}}{Z_t \tilde{z}_m \left[1 + \left(l^m_{f,t}(\tilde{z}_m) / l^m_{s,t}(\tilde{z}_m) \right)^\gamma \right]^{\frac{1-\gamma}{\gamma}}}, \tag{D19}$$

$$p_{x,t}(\tilde{z}_m) = Q^{-1}_t \tau p_{h,t}(\tilde{z}_m), \tag{D20}$$

$$d_{m,t}(\tilde{z}_m) = p_{h,t}(\tilde{z}_m) y_{h,t}(\tilde{z}_m) + Q_t p_{x,t}(\tilde{z}_m) y_{x,t}(\tilde{z}_m) - W_{s,t} \left[l^m_{s,t}(\tilde{z}_m) + l^m_{f,t}(\tilde{z}_m) \right] \\ - f_{R,t} n^m_{e,t}(\tilde{z}_m) - Q_t W^*_{s,t} l^m_{o,t}(\tilde{z}_m), \tag{D21}$$

$$\frac{f_{R,t}}{\mu_t} = (1 - \delta) \left\{ \left[\left(\frac{l^m_{f,t}(\tilde{z}_m)}{l^m_{s,t}(\tilde{z}_m)} \right)^{\gamma - 1} - 1 \right] W_{s,t} + \beta \mathbb{E}_t \left[\frac{U'(C_{s,t+1})}{U'(C_{s,t})} \left(\frac{f_{R,t+1}}{\mu_{t+1}} \right) \right] \right\}, \tag{D22}$$

$$\tau_o Q_t \frac{W^*_{s,t}}{Z^*_t} = \frac{W_{s,t}}{Z_t \tilde{z}_m \left[1 + \left(l^m_{f,t}(\tilde{z}_m) / l^m_{s,t}(\tilde{z}_m) \right)^\gamma \right]^{\frac{1-\gamma}{\gamma}}}, \tag{D23}$$

$$\frac{l^m_{f,t}(\tilde{z}_m)}{l^m_{s,t}(\tilde{z}_m)} = \frac{l^f_{f,t}(\tilde{z}_f)}{l^f_{s,t}(\tilde{z}_f)}. \tag{D24}$$

The aggregations and market clearing conditions are

$$P^{1-\theta}_{1,t} = N_d \left(p_{d,t}(\tilde{z}_d) \right)^{1-\theta} + N_f \left(p_{f,t}(\tilde{z}_f) \right)^{1-\theta} + N_m \left(p_{h,t}(\tilde{z}_m) \right)^{1-\theta} + N^*_d (p^*_{x,t})^{1-\theta}, \tag{D25}$$

$$P_{2,t} = W_{u,t} / Z_t, \tag{D26}$$

$$Y_{1,t} = \alpha \frac{1}{P_{1,t}} Y^c_t, \tag{D27}$$

$$Y^c_t = \left(\frac{Y_{1,t}}{\alpha} \right)^\alpha \left(\frac{Y_{2,t}}{1 - \alpha} \right)^{1-\alpha}, \tag{D28}$$

$$D_t = N_d d_{d,t}(\tilde{z}_d) + N_f d_{f,t}(\tilde{z}_f) + N_m d_{m,t}(\tilde{z}_m), \tag{D29}$$

$$1 = (P_{1,t})^\alpha (P_{2,t})^{1-\alpha}, \tag{D30}$$

$$L_s = N_d l^d_{s,t}(\tilde{z}_d) + N_f l^f_{s,t}(\tilde{z}_f) + N_m l^m_{s,t}(\tilde{z}_m), \tag{D31}$$

$$L_{f,t} = N_f l^f_{f,t}(\tilde{z}_f) + N_m l^m_{f,t}(\tilde{z}_m), \tag{D32}$$

$$N_{e,t} = N_f n^f_{e,t}(\tilde{z}_f) + N_m n^m_{e,t}(\tilde{z}_m). \tag{D33}$$

(D34)

The law of motion for the aggregate foreign workers is described as

$$L_{f,t} = (1-\delta)\left(L_{f,t-1} + \mu_t N_{e,t}\right), \tag{D35}$$

$$\mu_t = \frac{\bar{N}_e}{N_{e,t}}. \tag{D36}$$

D.2 Foreign

The representative households' budget constraints are

$$C^*_{s,t} = W^*_{s,t}(L_{o,t} + L^*_{s,t}) + D^*_t, \tag{D37}$$

$$C^*_{u,t} = W^*_{u,t} L^*_u. \tag{D38}$$

The representative skill-intensive firms equations are described by

$$Z^*_t l^*_{s,t} = y^*_{h,t} + \tau y^*_{x,t}, \tag{D39}$$

$$y^*_{h,t} = \alpha \left(\frac{p^*_{h,t}}{P^*_{1,t}}\right)^{-\theta} Y^{c*}_t / P^*_{1,t}, \tag{D40}$$

$$y^*_{x,t} = \alpha \left(\frac{p^*_{x,t}}{P_{1,t}}\right)^{-\theta} Y^{c}_t / P_{1,t}, \tag{D41}$$

$$p^*_{h,t} = \frac{\theta}{\theta-1}\frac{W^*_{s,t}}{Z^*_t}, \tag{D42}$$

$$p^*_{x,t} = Q_t \tau p^*_{h,t}, \tag{D43}$$

$$d^*_{d,t} = p^*_{h,t} y^*_{h,t} + Q^{-1}_t p^*_{x,t} y^*_{x,t} - W^*_{s,t} l^*_{s,t}. \tag{D44}$$

The aggregations and market clearing conditions are

$$(P^*_{1,t})^{1-\theta} = N^*_d \left(p^*_{h,t}\right)^{1-\theta} + N_m \left(p_{x,t}(\tilde{z}_m)\right)^{1-\theta}, \tag{D45}$$

$$P^*_{2,t} = W^*_{u,t}/Z^*_t, \tag{D46}$$

$$Y^*_{1,t} = \alpha \frac{1}{P^*_{1,t}} Y^{c*}_t, \tag{D47}$$

$$Y^{c*}_t = \left(\frac{Y^*_{1,t}}{\alpha}\right)^{\alpha} \left(\frac{Y^*_{2,t}}{1-\alpha}\right)^{1-\alpha}, \tag{D48}$$

$$D^*_t = N^*_d d^*_{d,t}, \tag{D49}$$

$$Y^c_t = C^*_{s,t} + C^*_{u,t}, \tag{D50}$$

$$1 = (P^*_{1,t})^{\alpha}(P^*_{2,t})^{1-\alpha}, \tag{D51}$$

$$L^{*total}_s = L_{o,t} + L_{f,t} + L^*_{s,t}, \tag{D52}$$

$$L_{o,t} = N_m l_{o,t}(\tilde{z}_m) \tag{D53}$$

$$L^*_{s,t} = N^*_d l^*_{s,t} \tag{D54}$$

Balance of trade is given by

$$Q_t N_m \rho_{x,t}(\tilde{z}_m) y_{x,t}(\tilde{z}_m) - N^*_d \rho^*_{x,t} y^*_{x,t} = Q_t N_m W^*_{s,t} l^m_{o,t}(\tilde{z}_m). \tag{D55}$$

E Analytical Solution

We lay down the steps for obtaining Equation (30) in the main text. What helps us pin down this variable is the link between foreign and domestic skilled wages that is obtained through the offshoring condition in Equation C16.

Imposing $\gamma = 1$ and using the skill-intensive intermediate sector price setting equations ($p_{d,t}$, $p_{f,t}$, $p_{x,t}$, $p_{h,t}$, $p^*_{d,t}$, and $p^*_{x,t}$), we can get the following relationships.

$$y_{d,t}(\tilde{z}_d) = \left(\frac{\tau \tilde{z}_d}{\tau_o}\right)^{\theta} y^*_{x,t}, \tag{E1}$$

$$y_{f,t}(\tilde{z}_f) = \left(\frac{\tau \tilde{z}_f}{\tau_o}\right)^{\theta} y^*_{x,t}, \tag{E2}$$

$$y_{h,t}(\tilde{z}_m) = \left(\frac{\tau \tilde{z}_m}{\tau_o}\right)^{\theta} y^*_{x,t}, \tag{E3}$$

$$y_{x,t}(\tilde{z}_m) = \left(\frac{\tau \tau_o}{\tilde{z}_m}\right)^{-\theta} y^*_{h,t}. \tag{E4}$$

This means that if $\tau/\tau_o > 1$ (iceberg trade costs are greater then iceberg offshoring costs), demand for imports $y^*_{x,t}$ is lower relative to the demand for domestic goods $y_{d,t}$, $y_{f,t}$,$y_{h,t}$ due to a lower price of Home goods. However, (price and demand) of exported goods reflects the multiplicative effect of iceberg trade and offshoring costs.

We will be using these demand relationships in the solution. Implicit in the solution is that both countries have the same constant markups over marginal cost. Also, the offshoring optimality condition requires that the marginal cost of production at Home and in the offshore affiliate is the same across both countries. This also assumes that the Foreign skilled workers in the offshore affiliate and in the Foreign intermediate are paid the same skilled wages, i.e., perfect labor mobility between the two types of firms.

Consider the trade balance equation:

$$N_m Q_t p_{x,t}(\tilde{z}_m) y_{x,t}(\tilde{z}_m) - N_d^* p_{x,t}^* y_{x,t}^* = Q_t W_{s,t}^* L_{o,t}, \tag{E5}$$

where $L_{o,t} = N_m l_{o,t}^m(\tilde{z}_m)$. Substituting for prices, we can simplify this to

$$N_m \tau_o \tau \frac{y_{x,t}(\tilde{z}_m)}{\tilde{z}_m} - N_d^* \tau y_{x.t}^* = \frac{\theta - 1}{\theta} Z_t^* L_{o,t}. \tag{E6}$$

Consider the Foreign intermediate goods market clearing:

$$Z_t^*(L_s^{*total} - L_{f,t} - L_{o,t})/N_d^* = y_{h,t}^* + \tau y_{x,t}^*. \tag{E7}$$

Using Equation (E4), we can get

$$Z_t^*(L_s^{*total} - L_{f,t} - L_{o,t})/N_d^* = \left(\frac{\tau\tau_o}{\tilde{z}_m}\right)^{\theta} y_{x,t}(\tilde{z}_m) + \tau y_{x,t}^*. \tag{E8}$$

Also, adding up the market clearing equations of type-d, type-f, and type-m firms, and using labor market clearing conditions, we get

$$Z_t(L_s + L_{f,t}) + Z_t^* L_{o,t}/\tau_o = N_d \frac{y_{d,t}(\tilde{z}_d)}{\tilde{z}_d} + N_f \frac{y_{f,t}(\tilde{z}_f)}{\tilde{z}_f} + \frac{(y_{h,t}(\tilde{z}_m) + \tau y_{x,t}(\tilde{z}_m))}{\tilde{z}_m} N_m, \tag{E9}$$

which can be expressed as:

$$Z_t(L_s + L_{f,t}) + Z_t^* L_{o,t}/\tau_o = \left(\frac{\tau}{\tau_o}\right)^{\theta} \left[N_d \tilde{z}_d^{\theta-1} + N_f \tilde{z}_f^{\theta-1} + N_m \tilde{z}_m^{\theta-1}\right] y_{x,t}^* + \tau N_m \frac{y_{x,t}(\tilde{z}_m)}{\tilde{z}_m}. \tag{E10}$$

Define $\tilde{z}^{\theta-1} \equiv N_d \tilde{z}_d^{\theta-1} + N_f \tilde{z}_f^{\theta-1} + N_m \tilde{z}_m^{\theta-1}$ as the weighted average productivity of all Home skill-intensive upstream firms. Then we can write

$$Z_t(L_s + L_{f,t}) + Z_t^* L_{o,t}/\tau_o = \left(\frac{\tau}{\tau_o}\right)^{\theta} \tilde{z}^{\theta-1} y_{x,t}^* + \tau N_m \frac{y_{x,t}(\tilde{z}_m)}{\tilde{z}_m}. \tag{E11}$$

In this framework, the aggregate stock of skilled foreign workers is determined by the entry cap (as the cap is binding) as well as the exogenous probability of return. This is because $L_{f,t} = (1-\delta)(L_{f,t-1}+\mu_t N_{e,t})$ and $\mu_t N_{e,t} = \bar{N}_{e,t}$. Therefore we take aggregate $L_{f,t}$ as exogenous and solve for $L_{o,t}$ as a function of the aggregate immigrant skilled labor.

Then, the system boils down to Equations (E6), (E8), and (E11) in three variables ($L_{o,t}$, $y^*_{x,t}$, $y_{x,t}(\tilde{z}_m)$). These are summarized below.

$$N_m \tau_o \tau \frac{y_{x,t}(\tilde{z}_m)}{\tilde{z}_m} - N^*_d \tau y^*_{x,t} = \frac{\theta - 1}{\theta} Z^*_t L_{o,t}, \tag{E12}$$

$$Z^*_t \left(L^{*total}_s - L_{f,t} - L_{o,t} \right) / N^*_d = \left(\frac{\tau \tau_o}{\tilde{z}_m} \right)^{\theta} y_{x,t}(\tilde{z}_m) + \tau y^*_{x,t}, \tag{E13}$$

$$Z_t(L_s + L_{f,t}) + Z^*_t L_{o,t}/\tau_o = \left(\frac{\tau}{\tau_o} \right)^{\theta} \tilde{z}^{\theta-1} y^*_{x,t} + \tau N_m \frac{y_{x,t}(\tilde{z}_m)}{\tilde{z}_m}. \tag{E14}$$

These equations highlight the interlinkages between input demand (domestic and foreign), offshoring, and immigration (under the binding cap).

To solve for $L_{o,t}$, we define $A = \tau\tau_o/\tilde{z}_m$ and $B = (\tau/\tau_o)^{\theta} \tilde{z}^{\theta-1}$. Note that A^{-1} represents the price of Home exports relative to foreign domestic goods. Therefore, a higher A means a lower relative demand for Home exports relative to the foreign upstream firm. Similarly B represents the relative price of imports from foreign non-affiliated firms relative to domestically produced output. Note that $\tilde{z}$ is like a weighted average of Home upstream firm productivity. A higher B implies a higher demand for domestically produced output relative to imported output for the Home downstream firm.

By using Equations (E6), (E8), and (E11), we can solve for the aggregate $L_{o,t}$ to get Equation (30) in the main text.

$$L_{o,t} = \Upsilon^{-1} \left[(\Xi) \, \boldsymbol{L^{*total}_s} - \left(\Xi + \tau_o \Theta \frac{\boldsymbol{Z_t}}{\boldsymbol{Z^*_t}} \right) \boldsymbol{L_{f,t}} - \left(\tau_o \Theta \frac{\boldsymbol{Z_t}}{\boldsymbol{Z^*_t}} \right) L_s \right], \tag{E15}$$

where

$$\Upsilon = \frac{\theta - 1}{\theta} + \frac{1}{\theta}\Xi + \frac{1}{\theta}\Theta, \tag{E16}$$

$$\Xi = \frac{N_m}{N_m + N^*_d A^{\theta-1}}, \tag{E17}$$

$$\Theta = \frac{N^*_d \tau}{N^*_d \tau + \tau_o B}. \tag{E18}$$

Note that all the coefficients are positive. Therefore, we can see from Equation (30) that the aggregate offshore labor hired $L_{o,t}$ is increasing in the availability of skilled labor in Foreign (L^{*total}_s), decreasing in the stock of immigrant skilled labor ($L_{f,t}$), and decreasing in relative productivity at home Z_t/Z^*_t.

Further, we can solve for $y^*_{x,t}$ as a function of $L_{o,t}$ using Equations (E6), (E8), and (E11) to get Equation (31) in the text.

$$y^*_{x,t} = \frac{Z^*\Xi}{N^*_d\tau}\left[L^{*total}_s - L_f\right] - \frac{Z^*L_{o,t}}{N^*_d\tau}\left[\frac{\Xi + (\theta - 1)}{\theta}\right] \tag{E19}$$