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On the Response of Inflation and Monetary Policy to an Immigration Shock*

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Abstract

An immigration shock has an ambiguous effect on inflation, since there are multiple channels working in both directions. On one hand, aggregate demand increases with a suddenly larger population, creating inflationary pressure. On the other hand, the labor market becomes slacker as immigrants search for jobs, containing wage growth and creating disinflationary pressure. With these and other channels operating, the response of an inflation-targeting central bank is not obvious. We study these channels in a New Keynesian general equilibrium model of a small open economy with search frictions in the labor market. The analysis is grounded on motivating empirical evidence that suggests that the net effect of an immigration shock on inflation is negative. To discipline the model, we focus on Chile, an emerging country that has experienced a substantial immigration shock in recent years. The net disinflationary effect of immigration is mainly driven by the labor supply channel, which is supported by evidence on how immigrants integrate to the labor market. We also study the role of issues such as the lower human capital of immigrants, the remittances that they send to their home countries, and their consumption preferences, which are likely relatively biased toward foreign goods, among others.

Resumen

Un shock de inmigración tiene un efecto ambiguo sobre la inflación, porque hay múltiples canales que operan en ambas direcciones. Por un lado, la demanda agregada aumenta con el crecimiento de la población, lo que genera presiones inflacionarias. Por otro lado, las holguras del mercado laboral aumentan mientras los inmigrantes buscan empleo, lo que contiene el crecimiento de los salarios y genera presiones desinflacionarias. Con estos y otros canales operando, la respuesta de un banco central con metas de inflación a un shock de inmigración no es obvia. En este trabajo estudiamos estos canales en un modelo Neo-Keynesiano de economía pequeña y abierta con fricciones de búsqueda en el mercado laboral. El análisis se motiva por evidencia empírica que apunta a un efecto neto negativo de la inmigración sobre la inflación. Para disciplinar el modelo, nos enfocamos en Chile, una economía emergente pequeña y abierta que ha recibido una ola inmigratoria importante en años recientes. El efecto neto desinflacionario de la inmigración se explica principalmente por el canal de oferta laboral, lo que es consistente con evidencia sobre la manera en que los inmigrantes se integran al mercado de trabajo. También estudiamos el rol de aspectos como el menor capital humano de los inmigrantes, las remesas que envían a sus países de origen, y sus preferencias de consumo, que probablemente están relativamente sesgadas hacia bienes importados, entre otros.

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1 Introduction

An immigration shock has a theoretically ambiguous effect on inflation, since there are multiple channels working in both directions. On one hand, aggregate demand increases with a suddenly larger population, but it takes time for supply to respond, since immigrants integrate gradually to the labor market. This demand channel creates inflationary pressure. On the other hand, the labor market becomes slacker as immigrants search for jobs, containing wage growth. This labor supply channel creates disinflationary pressure. With these and other channels operating, the response of an inflation-targeting central bank to an immigration shock is not obvious.

We study the demand and labor supply channels, as well as other channels, their effects on inflation, and the response of monetary policy, in a dynamic stochastic general equilibrium model with three key features: (i) search frictions in the labor market, (ii) nominal rigidities, and (iii) a small open economy structure. The search-and-matching specification of the labor market allows us to analyze the effects of immigration on the extensive margin of labor supply (employment and unemployment) of immigrants and natives. In particular, we model immigrants that must search for jobs upon arrival, which delays their integration to the labor market. Regarding nominal rigidities, we use a New Keynesian model with standard Calvo-style staggered price setting. This specification allows us to study the inflationary effects of immigration, and the response of an inflation-targeting central bank. Finally, the open economy structure is useful for modeling features of immigration that affect inflation through open economy channels, such as the fact that immigrants typically send part of their income as remittances to their home countries, or that they may have preferences that are relatively biased toward foreign goods. Remittances, for instance, would weaken the demand channel, as immigrants would have less disposable income available for consumption, thus mitigating inflationary pressures. However, remittances are capital outflows, which would depreciate the exchange rate, other things equal, increasing inflationary pressures due to the higher prices of imported goods. Therefore, the effect of remittances on inflation is also ambiguous.

The analysis is grounded on motivating empirical evidence that suggests that higher levels of immigration are associated with *lower* aggregate inflation, which points to the disinflationary forces of immigration dominating its inflationary forces. In a panel of seven Latin American countries, a 1 percentage point (pp) increase in the share of Venezuelan immigrants in a country's labor force is associated with a 0.7pp decline in year-on-year inflation. Venezuelan immigration is useful, because it is driven by the domestic crisis in that country, and is thus largely exogenous from the perspective of host countries. A negative relation between immigration and inflation is consistent with several other studies, with our point estimate lying in the upper range of other analyses. Accordingly, our baseline model simulations consider parameterizations that deliver an inverse relation between an immigration shock and inflation.

The model is further estimated and calibrated to match data from Chile, a small open emerging country that has experienced a substantial immigration shock in recent years. In addition to fitting standard aggregate variables at business cycle frequency, such as output, consumption, investment, inflation, and the monetary policy rate, we model the integration of immigrants to the local labor market following evidence on the Chilean experience, and findings of the related literature. This is crucial for the overall effect of the shock on the macroeconomy and inflation. Indeed, the net disinflationary effect of immigration is mainly driven by the strength of the labor supply channel, which is supported by evidence on immigrants

working substantially more hours than natives across all occupational categories. This evidence, in turn, is consistent with literature pointing to immigrants obtaining lower disutility from labor, which amplifies the labor supply effect of immigration.[1]

We also study other characteristics that differentiate immigrants from natives and affect the macroeconomy and inflation, such as human capital, remittances, and consumption preferences. Although immigrants and natives have similar years of education, immigrants have lower human capital than natives due to the lower quality of education in their home countries. Due to this feature, an immigration shock lowers the economy's average labor productivity, creating inflationary pressure.[2] Immigrants typically send a fraction of their income to their home countries as remittances. We find that this features has important aggregate effects on consumption and the real exchange rate, but negligible effects on inflation, at least under our parameterization. The reason for this is that remittances generate opposing forces on inflation that nearly cancel each other. Specifically, the disinflationary pressure of lower disposable income available for consumption nearly cancels the inflationary pressure of a depreciating exchange rate. Finally, we consider that immigrants exhibit consumption preferences that are relatively biased toward foreign goods. As in the case of remittances, this feature generates opposing forces on inflation. Since immigrants are relatively biased toward foreign goods, demand for domestic goods is mitigated, which contains wage growth and inflation. However, biased preferences toward foreign goods generate depreciating pressure on the exchange rate, which in turn puts upward pressure on inflation. Under our calibration, the net effect of heterogeneous consumption preferences is slightly deflationary.

We would like to acknowledge a limitation of our model. A labor union bargains for wages on behalf of all workers in the economy. This is a standard assumption in the literature on medium-scale DSGE models with search frictions in the labor market, since it affords considerable tractability on the optimal wage and labor decision of households without affecting the dynamics of the average wage, employment, or hours worked. But of course, it implies that all workers receive the same wage, as firms cannot differentiate between immigrants and natives. We depart slightly from this standard assumption to capture some of the aggregate implications of wage heterogeneity. After negotiating the wage with the representative firm, the union redistributes total wage income among immigrants and natives according to their share in total employment and their relative productivity. This redistribution has aggregate implications, since, as we previously mentioned, immigrants and natives have heterogeneous consumption preferences over domestic and foreign goods. Average home bias in the model economy not only depends on the share of immigrants in the population, but on the total labor income of the different groups, as we explain below. Similarly, aggregate remittances not only depend on the share of immigrants in the population, but also on their share in total labor income. Therefore, while we may not be able to speak directly to the large literature that studies the effects of immigration on the distribution of wages among native and immigrant workers across aspects such as their skill level,[3] we believe that our modeling strategy allows us to capture some implications of wage heterogeneity for the aggregate effects of immigration, while keeping the model tractable.

[1] See, for example, Chassamboulli and Palivos (2014), and Battisti, Felbermayr, Peri, and Poutvaara (2017).

[2] The difference in human capital of immigrants and natives is important for the macroeconomic effects of the immigration shock. However, we take this difference as exogenous and abstract from the decision to accumulate human capital. We believe this is a reasonable assumption, since our focus is on the effects of immigration at business-cycle frequencies. Boldrin and Montes (2015) show that low-skilled immigration could induce natives to increase human capital accumulation.

[3] See Dustmann, Schönberg, and Stuhler (2016) for a survey of this literature.

The paper is structured as follows. The next section reviews the related literature. Section 3 presents evidence that supports our modeling approach to study the effects of an immigration shock on inflation. Section 4 describes our New Keynesian small open economy DSGE model, including our parameterization strategy. We analyze the effects of an immigration shock on inflation, the monetary policy rate, and other variables in section 5. This analysis proceeds in three steps. We first consider a benchmark case in which immigrants are identical to natives and integrate seamlessly to the labor market. In this case, immigration generates no effects on inflation. In the second step, we present our baseline simulation of an immigration shock, which incorporates all the features that differentiate immigrants from natives, and assumes immigrants must search for jobs upon arrival. The baseline parameterization is designed to generate the negative relation between immigration and inflation observed in the data. In the third step, we study the role of each of the features and assumptions that differentiate immigrants from natives. Section 6 concludes.

2 Related Literature

The literature on the macroeconomic effects of immigration is scarce, and very few papers study, even secondarily, its implications for inflation and monetary policy. Burriel, Fernández-Villaverde, and Rubio-Ramírez (2010) build a medium-scale small open economy DSGE model for business-cycle analysis in Spain that includes shocks to population growth in order to consider the substantial immigration flow that Spain received in the late 1990s and early 2000s. The authors are not concerned with the characteristics that differentiate immigrants from natives, nor particularly concerned with the effect of immigration on inflation and the monetary policy rate. However, under their parameterization, a shock to population growth is expansionary and generates a decline in inflation and the monetary policy rate, similarly to our paper. Immigration in their model is simply an increase in the size of the population. We borrow their technique for introducing shocks to the population and add several characteristics that differentiate immigrants from natives. A distinctive feature of our model is the presence of search frictions, which allow us to study the process through which immigrants integrate to the labor market.

Using a vector autoregressive approach, Furlanetto and Robstad (2019) study the macroeconomic effects of immigration in Norway, finding a delayed small and positive effect on inflation, though the response of monetary policy is not investigated. The authors argue that the increase in inflation is due to the exchange rate depreciating in response to the shock, which puts upward pressure on the price of imported goods. Furlanetto and Robstad (2019) conjecture that the exchange rate depreciation might be due to the remittances immigrants send to their home countries. Bentolila, Dolado, and Jimeno (2008) argue that immigration is the key driver of the flattening of the Phillips curve in Spain, and set up a model featuring mechanisms through which immigration reduces inflation, such as lower bargaining power for immigrants, and a steeper labor supply curve. The macroeconomic effects of immigration are also studied by Engler, Honjo, MacDonald, Piazza, and Sher (2020), who adapt the IMF's semi-structural FSGM model to simulate the effects of migration flows,[4] which are modeled as a combination of a series of simultaneous exogenous shocks to the labor force, human capital characteristics, labor misallocation,

[4]The FSGM model, described in Andrle, Blagrave, Espaillat, Honjo, Hunt, Kortelainen, Lalonde, Laxton, Mavroeidi, Muir, Mursula, and Snudden (2015), features microfounded equations for consumption and investment, an aggregate Cobb-Douglas production function, and reduced-form specifications for trade, inflation, and labor supply dynamics.

unemployment, and public expenditure. Compared to their implementation, our paper presents a more thorough modeling and analysis of the various channels through which immigration shocks may affect the economy, emphasizing the role of heterogeneity between natives and immigrants. We analyze several dimensions of this heterogeneity, including human capital, consumption preferences, integration to the labor market, and the propensity to transfer funds abroad (remittances).[5]

Several empirical papers study the effect of immigration using data on the prices of many goods and services. The results of this literature are a useful benchmark, along with our own empirical estimation, when parameterizing our DSGE model to deliver an inverse relation between an immigration shock and inflation. Using data on a panel of cities in mostly advanced economies, Zachariadis (2012) finds that a 10% increase in the share of immigrants in total employment decreases prices of final products by as much as 3%. Lach (2007) finds that the inflow of migrants to Israel from the former Soviet Union generated a decrease in prices, such that a 1 percentage point (pp) increase in the ratio of immigrants to natives in a city decreases goods prices by 0.5pp. Cortes (2008) finds that a 10% increase in the share of low-skilled immigrants in the labor force of U.S. cities decreases the price of immigrant-intensive services by 2%, which is consistent with a labor supply effect that contains wages and prices. Finally, Frattini (2008) finds that, in the UK, a 1pp increase in the immigrants-to-natives ratio leads to a 0.2% decline in the prices of low-skill-intensive services, but a 0.14%–0.18% increase in the price of low-value grocery goods. A quantitative comparison of the results of these papers is difficult, because they refer to specific goods or services, and because some papers use the native population as a benchmark of the increase in immigration, whereas others use the labor force or employment. However, taking all this evidence together, as well as our own empirical estimation, we will consider a parameterization of our model such that a 1% increase in the share of immigrants in the labor force is associated with a decline of 0.5% in the CPI, and evaluate the sensitivity of our results to parameterizations that deliver an effect in the range of -0.3% to -0.7%.

Several articles in the literature previously mentioned model differences in the human capital of immigrant and native workers. For the case of Chile, we consider two aspects of the human capital of immigrants. First, although immigrant and native workers display similar years of education (Aldunate, Contreras, de la Huerta, and Tapia, 2019), there are large disparities in education quality across countries. Therefore, we adjust the human capital of immigrants according to the lower education quality of their home countries.[6] A second aspect, which we consider in an extension of the baseline results, is that immigrants experience a transitory period of underemployment, or "downgrading", as they adapt to the local labor market, i.e., a period during which they cannot fully exercise the productivity associated with their human capital.[7]

[5]Other papers that study immigration from a general-equilibrium perspective include Hazari and Sgro (2003), Moy and Yip (2006), Ben-Gad (2004), Ortega (2000), Chassamboulli and Palivos (2014), Battisti et al. (2017), Storesletten (2000, 2003), Arias and Guerra-Salas (2019), Caliendo, Opromolla, Parro, and Sforza (2023), Kiguchi and Mountford (2017), Stähler (2017), Liu (2010), Smith and Thoenissen (2019), and Mandelman and Zlate (2012). However, these papers focus on aspects of migration such as its effect on output, fiscal policy, the labor market outcomes of natives, and capital accumulation. They do not consider the effect of immigration on inflation and monetary policy.

[6]When available, we rely on PISA scores. When PISA scores are not available, we estimate them using the cross-sectional relation between PISA scores and GDP per capita.

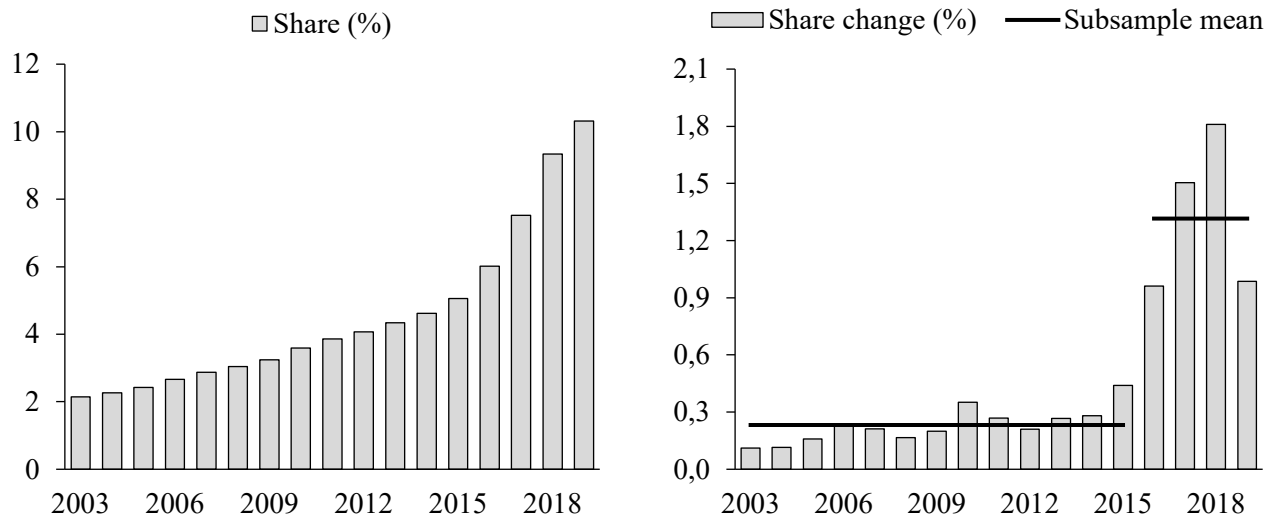
[7]Arias and Guerra-Salas (2019) study the medium- and long-term effects of immigration in Chile in a real overlapping-generations framework, with households of different skill levels and an informal sector. In their paper, immigrants experience a transitory underemployment, or downgrading, spell.

3 Motivating Evidence

3.1 The Immigration Shock

The key features of our simulations are motivated by evidence on the immigration shock that Chile has received in recent years. Figure 1 shows the extent of this immigration wave. Between 2015 and 2019, the share of immigrants in the total labor force doubled, jumping from 5.1% to 10.3%. Between 2003 and 2015, the share of immigrants in the labor force increased by 0.2 percentage points (pp) per year, on average, but between 2016 and 2019, this flow increased more than sixfold, to an average of 1.3pp per year. This evidence motivates us to study the effects of an immigration shock that is *exogenous* from the perspective of Chile, since it is unlikely that anything that happened there could account for such an inflow of migrants. Economic growth, for instance, was sluggish in Chile during this period. Instead, this immigration flow is mainly driven by the economic and social crisis in Venezuela,[8] which is largely exogenous from the perspective of Chile.[9] Indeed, data from the First National Survey of Migration in Chile show that 45% of immigrants aged 18 and older that arrived between 2016 and 2020 are Venezuelan. This is, by far, the largest group of immigrants from a single country, since the second source of immigrants is Haiti, with 19% (see table 2 below).

Figure 1: Share of Immigrants in Chile's Labor Force



Notes.— Source: National Statistics Institute.

3.2 The Inverse Relation Between Immigration and Inflation

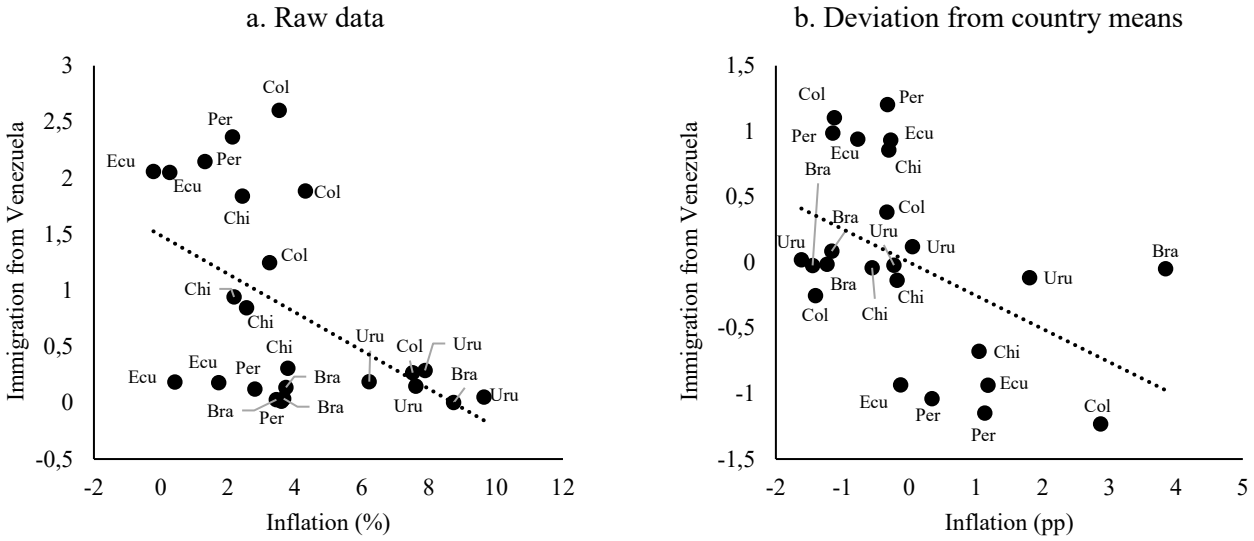
We now offer motivating empirical evidence that suggests that higher immigration is associated with *lower* inflation. We exploit the fact that Venezuelan migration in recent years is largely exogenous from

[8] McAuliffe and Khadria (2019) estimate that, by mid-2019, political and economic turmoil had resulted in four million displaced Venezuelans worldwide.

[9] Mandelman and Zlate (2012) study the business cycle effects of *endogenous* decisions on migration and remittances in a two-country DSGE model calibrated to the U.S. and Mexico.

the perspective of host countries.[10] Figure 2 plots the relation between immigration from Venezuela and aggregate inflation in six Latin American countries, from 2016 to 2019.[11] Panel a shows a negative relation in the raw data, i.e., higher immigration flows are associated with lower inflation. Panel b shows that this negative relation is robust to expressing immigration and inflation as deviations from each country's mean.

Figure 2: Venezuelan Immigration and Inflation in a Panel of Latin American Countries



Notes.— Immigration from Venezuela is expressed as the change, in percentage points, of its share of the labor, with respect to the previous year. The figures plot data on six Latin American countries (Brazil, Chile, Colombia, Ecuador, Peru, and Uruguay) for four years (2016–2019). Sources: Data on Venezuelan immigration is from various "Migration Trends in the Americas" reports from the International Organization for Migration, a United Nations agency. Data on inflation is from the IMF's World Economic Outlook.

To investigate the empirical relation between immigration and inflation more formally, we regress the inflation rate on immigration from Venezuela, and control for other drivers of inflation as summarized in fluctuations of the nominal exchange rate (NER).[12] The empirical specification is given by:

$$\pi_{it} = \alpha + \beta I_{it} + \gamma \epsilon_{it} + \mu_i + v_{it}, \tag{1}$$

where π_{it} is country i's average year-on-year inflation rate in year t, I_{it} is immigration from Venezuela to country i in year t, expressed as the change, in percentage points, of its share of the labor force, with respect to the previous year, ϵ_{it} is nominal exchange rate depreciation, expressed as the percent change of the yearly average NER (domestic currency per U.S. dollar) with respect to the previous year, α is a common constant, μ_i are country fixed effects, and v_{it} is an error term. β is the key coefficient of

[10] Although Venezuelan immigration is largely exogenous from the perspective of host countries, the impact on inflation might be heterogeneous. For example, wealthier immigrants are more likely to settle in farther countries such as Chile, whereas poorer migrants are more likely to travel by land and settle in neighboring countries such as Colombia. Our analysis, therefore, captures an average effect of Venezuelan immigration to Latin American countries.

[11] The six countries are Brazil, Chile, Colombia, Ecuador, Peru, and Uruguay. Immigration from Venezuela is expressed as the change, in percentage points, of its share of the labor force, with respect to the previous year. Inflation in year t is the average year-on-year growth rate of the consumer price index across the twelve months of the year.

[12] In small open emerging countries, foreign shocks are important drivers of inflation through their impact on the nominal exchange rate. See, for example, García-Cicco and García-Schmidt (2020).

interest, as it captures the relation between immigration and inflation. The coefficient γ, on the other hand, captures the relation between inflation and NER depreciation. We estimate a panel generalized least squares (GLS) regression with cross-section weights, to deal with cross-section heteroskedasticity.[13]

Table 1 confirms that inflation and immigration are inversely related. The coefficient on immigration (β) is an economically significant -0.67, which is also statistically significant at the 1% level. A 1 percentage point (pp) increase in the share of Venezuelan immigrants in a country's labor force is associated with a 0.67pp decline in year-on-year inflation. As expected, NER depreciation is positively related to inflation, as suggested by a positive and significant value of γ. A 1% depreciation is associated with an increase of 0.11pp in inflation. The second-to-last row of table 1 shows that the null hypothesis of jointly zero country fixed effects is strongly rejected, which supports the use of a regression with country fixed effects. Of course, we acknowledge that these results should be interpreted with care, since they are based on an unbalanced panel of seven cross-sections and four time periods, with 27 observations.

Table 1: Panel Regression of Inflation on Venezuelan Immigration

Dependent variable: Inflation (π_{it})	
Intercept (α)	7.21***
	(0.46)
Immigration (I_{it})	-0.67***
	(0.21)
ER depreciation (ϵ_{it})	0.11**
	(0.04)
Adj. R^2 within	0.90
H_0: $\mu_i = 0$	F(6,18)=16.38***
Obs (unbalanced)	27

Notes.— "***" and "**" denote significance at the 1% and 5% levels, respectively. Unbalanced panel GLS regression of the yearly average inflation rate (in percent) on immigration from Venezuela (expressed as the change, in percentage points, of its share of the labor force with respect to the previous year), and nominal exchange rate (NER) depreciation (percent change of the yearly average NER with respect to the previous year), with country fixed effects, and cross-section weighting to deal with cross-section heteroskedasticity. The regression considers data on 7 countries (Argentina, Brazil, Chile, Colombia, Ecuador, Peru, and Uruguay) for the 2016–2019 period. The panel is unbalanced because there is no trustworthy data on inflation for Argentina in 2016. Sources: Data on nominal exchange rates is from the IMF's International Financial Statistics. For sources on Venezuelan immigration and inflation, see the note to figure 2.

Following our empirical results on the relation between inflation and immigration, as well as those from other papers, discussed in section 2, our baseline parameterization of the DSGE model will feature disinflationary forces that dominate the inflationary forces of immigration, such that a 1% increase in the share of immigrants in the labor force will generate a decline in prices in a range of 0.3% to 0.7%.

[13]The panel GLS regression includes an additional country—Argentina, which is not included in figure 2, since Argentina's inflation is so high that it would dwarf the other countries due to its effect on the scale of the figure.

3.3 Integration of Immigrants to the Labor Market

The way immigrants integrate to the local labor market is crucial for the macroeconomic effects of immigration. This subsection discusses evidence on the integration of immigrants to the labor market in Chile that informs our modeling strategy. Specifically, we study the human capital of immigrants relative to natives, and differences in hours worked and the unemployment rate of immigrants and natives.

Although immigrants and natives have similar years of education (Aldunate et al., 2019), there are wide disparities in the quality of education across countries. Therefore, we use cross-country differences in standardized test scores to adjust the human capital of immigrants in the model. In particular, we use data on the Program for International Student Assessment (PISA). Table 2 shows that five countries account for 89% of immigrants aged 18 and older in the 2016–2020 period: Venezuela (45%), Haiti (19%), Colombia (10%), Peru (8%), and Bolivia (7%). The last column of the table shows PISA scores, which are averages of Reading, Math, and Science tests taken in 2018. Colombia and Peru participate in PISA, so their scores are official. For Venezuela, Haiti and Bolivia, which do not participate in the program, we estimate their PISA score using a quadratic regression of PISA scores on real GDP per capita for a sample of 67 countries.[14] Figure 3 shows the fitted relation between PISA scores and GDP per capita.[15] It marks Chile, Colombia and Peru, countries that participate in PISA, as well as Venezuela, Haiti and Bolivia, countries for which we estimate their PISA score based on the regression results.

Based on the share of immigrants from Venezuela, Haiti, Colombia, Peru, and Bolivia, and their PISA score, we compute how the level of human capital in Chile changes due to this immigration shock. Let $\alpha = 0.0540$ denote the share of immigrants in Chile's population (5.4%). Let $P5 = 360.8$ denote the weighted average PISA score from the five countries, and $PCh = 437.7$ denote Chile's PISA score. Note that the education quality in the five key source countries is nearly 20% lower than in Chile, since $P5/PCh = 0.82$. Normalizing Chile's level of human capital prior to the shock to 100, the post-shock level is given by $(1-\alpha) \times 100 + \alpha(P5/PCh \times 100) = 99.05$. In words, the size of the immigration shock and the lower education quality of the source countries induce a decline of nearly 1% in Chile's average quality-adjusted education level. As explained in section 4.7, we will calibrate the effect of the reduced education quality on human capital and labor productivity based on the the elasticities reported by Égert, de la Maisonneuve, and Turner (2022).[16]

In addition to the lower education quality of immigrants, an extension of our baseline simulation considers the possibility that immigrants lose job- or country-specific human capital when moving across countries, as suggested by the literature on occupation-specific human capital and job displacement.[17] Since at least part of the job- or country-specific human capital should be recoverable, this feature generates a transitory spell of underemployment or downgrading. In other words, the fact that it may be difficult for newly arrived workers to find jobs that match their qualifications may lead them to experience a period during which they cannot fully exercise the productivity associated with their human capital. The evidence from Chile seems to confirm that immigrants experience a period of underemployment or

[14] We consider all countries that participate in PISA in 2018, except those with a population lower than 1 million and/or GDP per capita higher than USD 80,000.

[15] The regression is given by $PISA = 341.7 + 0.0058 \times GDPpc - 5.4091e^{-8} \times GDPpc^2$, where $PISA$ is the 2018 average score of Reading, Math and Science tests, and $GDPpc$ is GDP per capita in 2017. The regression R^2 is 0.48.

[16] In a related paper, Canova and Ravn (2000) also model the integration of East Germany to the West as an inflow of migrants with permanently lower human capital, despite having similar years of education.

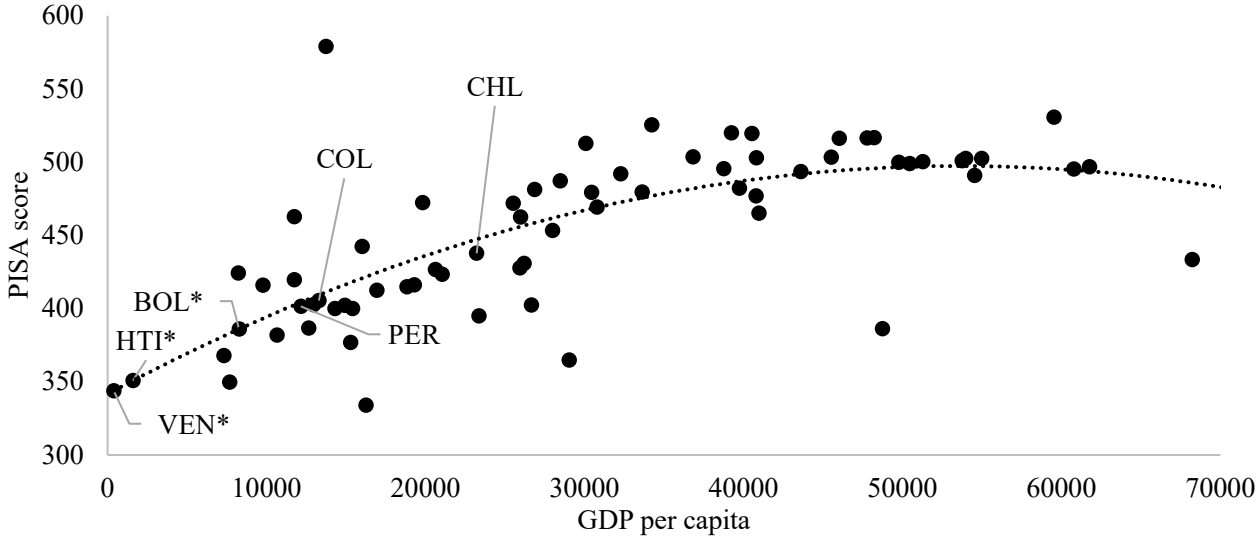
[17] See, for example, Kletzer (1998), Davis and Wachter (2011), Krolikowski (2017), and Kambourov and Manovskii (2009).

Table 2: Sources of Immigration (2016–2020) and Education Quality

Country of origin	Number of immigrants (18+)	Share of immigrants	PISA score
Venezuela	339,521	45%	343.9†
Haiti	143,353	19%	350.8†
Colombia	75,449	10%	405.3
Peru	60,359	8%	401.7
Bolivia	52,814	7%	386.0†
Other	82,994	11%	
	Chile		
Population (18+)	13,965,811		
PISA score	437.7		

Notes.— The PISA score is the 2018 average of Reading, Math, and Science tests. Venezuela, Haiti and Bolivia do not report official PISA scores. Their scores, marked with a "†", are fitted values from a regression of PISA scores on real GDP for a sample of 67 countries. Chile's population of 18 years and older is from the 2017 census. Sources: Data on immigration of people 18 and older are from the First National Survey of Migration in Chile. Data on PISA scores are from the OECD.

Figure 3: Fitted Relation of PISA Scores and GDP per Capita



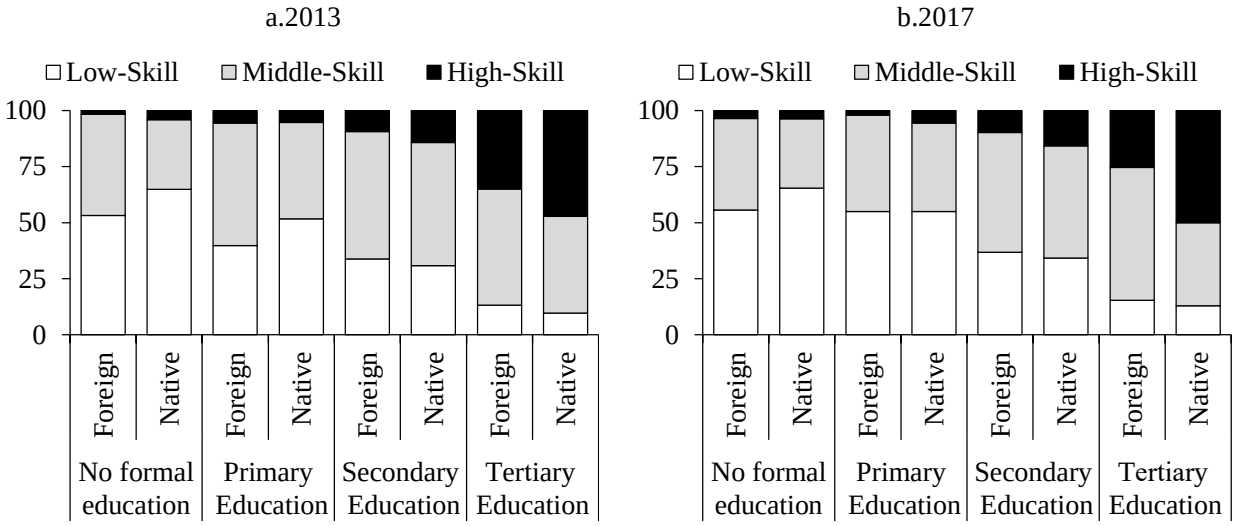
Notes.— The figure shows the relation between PISA scores and GDP per capita for 67 countries. The dotted line displays a regression given by $PISA = 341.7 + 0.0058 \times GDPpc - 5.4091e^{-8} \times GDPpc^2$, where $PISA$ is the 2018 average score of Reading, Math and Science tests, and $GDPpc$ is 2017 GDP per capita. The regression R^2 is 0.48. The dots for Venezuela (VEN), Haiti (HTI), and Bolivia (BOL) are fitted values, since these countries do not participate in PISA. Sources: Data on PISA scores are from the OECD. GDP per capita is constructed from the Penn World Table 10.0, which offers data on expenditure-side real GDP at chained PPPs (in million 2017 U.S. dollars), and population. We exclude from the regression countries with less than 1 million inhabitants and/or more than USD 80,000 GDP per capita.

downgrading. Figure 4 shows employment by education level and skill level of the occupation before and during the immigration wave.[18] In 2013 (left panel), *before* the immigration shock, 47% of natives

[18]This evidence comes from the CASEN survey, which is conducted roughly every two years. Since the recent immigration wave began around 2015, data from 2013 are prior to it, whereas those from 2017 are after the immigration wave began. The latest survey is from 2020, but we do not use it, since it may have limitations associated with the challenges of conducting a survey during the Covid-19 pandemic.

with tertiary education held high-skill jobs, whereas 35% of immigrants with tertiary education held high-skill jobs, a gap of 12 percentage points. In 2017 (right panel), during the early stages of the recent immigration wave, this gap doubles because a lower fraction of highly educated immigrants hold high-skill jobs, 25% compared with 50% for natives. During the immigration wave, therefore, a larger fraction of highly educated immigrants work in jobs that require lower skills. We interpret this evidence as reflecting a transitory difficulty to find jobs that match immigrants' qualifications.[19] An extension of our baseline simulation, therefore, allows for partially transitory underemployment.[20]

Figure 4: Employment by Education Level and Skill Level of Occupation



Notes.— Source: Aldunate et al. (2019). The underlying data come from the CASEN survey. The classification of occupations by skill level follows Lagakos, Moll, Porzio, Qian, and Schoellman (2018). Individuals with primary education have 1–8 years of schooling, those with secondary education have 9–12 years of schooling, and those with tertiary education have 13 or more years of schooling.

We now discuss evidence on the differences in hours worked and the unemployment rate of immigrants and natives. Figure 5 shows that immigrants work, on average, 9.6% more weekly hours than natives. Indeed, immigrants work longer hours than natives across all occupational categories. For the model, we interpret this evidence as suggesting heterogeneity in the labor supply preferences of immigrants and natives, such that immigrants are willing to work longer hours for a given wage or, put another way, to accept jobs for lower wages.[21] This pattern can result from immigrants displaying lower labor disutility. There is support for this mechanism in the literature. In the paper by Chassamboulli and Palivos (2014), immigrants display lower labor disutility due to the inherent problems of residing in a foreign country, such as lack of social networks or more difficult access to government help programs. Battisti et al. (2017) discuss two additional reasons for immigrants displaying lower labor disutility. First, because some of the non-monetary payoffs from working described by Jahoda (1981), such as social contact beyond the family, can be higher for immigrants. And second, because immigrants may be able to extract less value

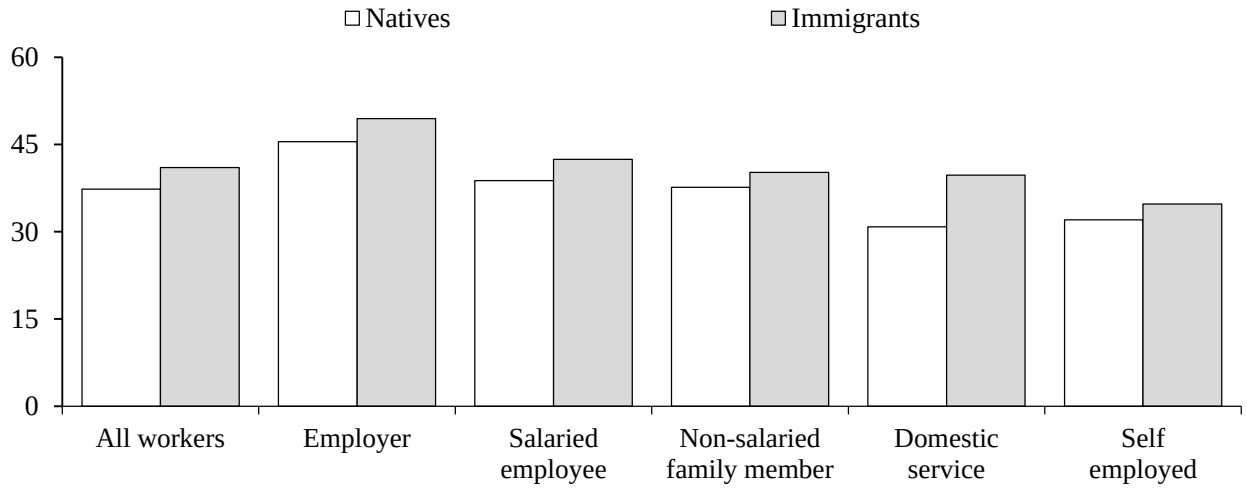
[19] This evidence is suggestive of a downgrading spell, but it is not conclusive, since it refers to different cohorts of immigrants. Ideally, we would study panel data tracking the skill level of the occupation of immigrants, but unfortunately such data are not available.

[20] Arias and Guerra-Salas (2019) also use this evidence to support the assumption of underemployment for immigrants in Chile during this period. Dustmann et al. (2016) discuss evidence of a similar adjustment for the U.S.

[21] Unfortunately, there is no reliable evidence on wages for immigrants in Chile.

from leisure outside their home country.

Figure 5: Hours Worked of Immigrants and Natives



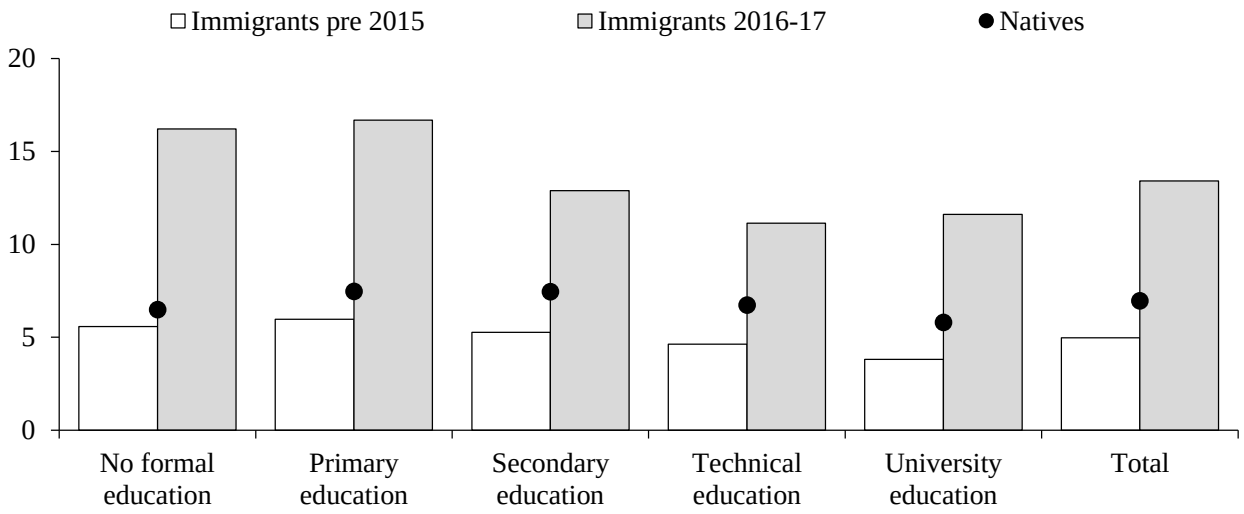
Notes.— Source: Calculations based on data from the National Statistics Institute's employment survey; average between 2017:M12 and 2018:M8.

Finally, we discuss evidence on the unemployment rate of immigrants. The data suggest two facts: (i) the unemployment rate of immigrants increases temporarily following an immigration shock, and (ii) in the long run, immigrants have a lower unemployment rate than natives. The first of these facts suggests most immigrants do not arrive with a contract, so they search for jobs, pushing the unemployment rate upwards. Our baseline simulation of an immigration shock considers, therefore, that all immigrants arrive as unemployed. The second fact may reflect that immigrants are able to find jobs more quickly, or hold jobs for longer. Figure 6 shows evidence consistent with the fact that immigrants arrive as unemployed members of the labor force. Using data from the 2017 Census, it shows that the unemployment rate among recently arrived immigrants (those that arrived after 2016) is substantially higher than that among immigrants that arrived prior to that year, regardless of their education. The figure also shows that the average unemployment rate among natives is about 2 percentage points higher than that among the group of immigrants that arrived prior to the latest immigration wave. Since the high unemployment rate among recently arrived immigrants is likely to be transitory, we interpret this evidence as suggesting that immigrants have a lower unemployment rate than natives in the long run. We emphasize that the evidence is suggestive of this fact, but it is not conclusive, since it comes from analyzing the unemployment rate of different cohorts of immigrants. Ideally, we would study panel data tracking the evolution of immigrants' employment status, but unfortunately such data are not available, to the best of our knowledge.

International evidence on labor market flows of immigrants points to higher separation rates than natives, but also to higher job finding rates. We implement both of these features in the calibration of the model, and parameterize them such that the higher job finding rate dominates the higher job separation rate, resulting in a lower long-run unemployment rate for immigrants.[22] Heterogeneity in job finding

[22]Since the higher job finding rate for immigrants in steady state, which results in a lower steady state unemployment rate, is governed by the calibration of a parameter (m^L), our framework can be easily applied to economies where immigrants have a higher long-run unemployment rate than natives.

Figure 6: Unemployment Rate of Immigrants and Natives



Notes.— Source: Aldunate et al. (2019), based on data from the 2017 census.

rates may be explained by differences in mobility and how those differences affect job finding probabilities when the geographical distribution of job opportunities is not homogeneous. Bowles (1970) discusses how low mobility costs increase the ability of workers to arbitrage potential disequilibria across spatially separated labor markets. In a related paper, Bentolila, Blanchard, Calmfors, de la Dehesa, and Layard (1990) show a negative correlation between workers' mobility and equilibrium unemployment. Basso, D'Amuri, and Peri (2019) find empirical evidence on higher mobility of immigrants in the Euro Area and the U.S. By searching for jobs in a wider geographical area, migrants are more likely to find available jobs, improving their job finding probability. Heterogeneity in job separation rates can be explained, in turn, by differences in the ability to hold jobs. Battisti et al. (2017) find that immigrants in Europe tend to have higher job separation rates than natives.[23]

The next section describes a DSGE model that incorporates these features of the data.

4 The DSGE Model

Our model builds on the Central Bank of Chile's large-scale dynamic stochastic general equilibrium (DSGE) model (see García, Guarda, Kirchner, and Tranamil, 2019) to allow for exogenous variation in the size of the population and for differences between immigrants and natives across a range of important issues that allow us to reproduce the empirical patterns discussed in the previous section. This is a small open economy model with nominal and real rigidities, and search frictions in the labor market, among other features. Following Burriel et al. (2010), we model immigration shocks as exogenous changes to the size of the representative household. Immigrants arrive as unemployed workers who search for jobs, and send a fraction of their income as remittances to their home country.

[23]The case of Chile, where the long-run unemployment rate among immigrants is lower than that of natives, may differ from other countries. Battisti et al. (2017) document unemployment rates between 0.9 and 3.5 percentage points higher for immigrants than natives among 20 advanced economies, including 16 E.U. member states, plus Australia, Canada, Switzerland, and the U.S. However, as we mentioned in the previous footnote, our model could be easily re-calibrated to match the relative unemployment rates of immigrants and natives found in other countries.

The model also features Ricardian and non-Ricardian (hand-to-mouth) households subject to involuntary unemployment, there is habit formation in consumption, adjustment costs in investment, firms face a Calvo-pricing problem, there is imperfect exchange rate pass-through into import prices due to local currency price stickiness, and the economy also exports a commodity good. The small open economy is buffeted by a range of domestic and foreign shocks. For brevity, we only present the features of the extended model that are crucial for our analysis.

4.1 Households

The extensions of the model are mainly focused on the households and their participation in the labor market. The model is populated by a continuum of infinitely lived households of two types: non-Ricardian (NR) and Ricardian (R), with mass $L_t\omega$ and $L_t(1-\omega)$, respectively, where $\omega \in (0,1)$ is the share of non-Ricardian households, and L_t denotes the size of the population or labor force, which is given by the exogenous process $L_t = (L_{t-1})^{\rho_L}(L)^{1-\rho_L}\mu^L$, with $\log \mu^L \sim N(0, \sigma_{\mu L})$.[24,25] Household members are either employed (N_t) or unemployed (U_t) in period t, with $n_t = N_t/L_t$ being the employment rate, i.e., the share of members currently employed, and $u_t = U_t/L_t$ the unemployment rate. Each type of household has identical preferences. Each period t, utility is a function of per capita consumption services $\hat{C}_t^s$, and h_t, the number of hours worked by the household's employed members.[26] Expected discounted utility of a representative household of type $j \in \{R, NR\}$ is then given by:

$$E_t \sum_{s=0}^{\infty} \beta^s L_{t+s} \varrho_{t+s} \left[\frac{1}{1-\sigma} \left(\hat{C}_{t+s}^{s,j} \right)^{1-\sigma} - n_{t+s} \Xi_{t+s}^j \right], \qquad j \in \{R, NR\}, \tag{2}$$

where E_t is the expectation conditional on period t information, $\beta \in (0,1)$ is the discount factor, ϱ_t is an exogenous preference shock, and $\sigma > 0$ is the inverse intertemporal elasticity of substitution. $\Xi_t^j = \Theta_t^j \kappa_t (A_{t-1}^H)^{1-\sigma} \frac{h_t^{1+\phi}}{1+\phi}$ denotes the total disutility of work of an employed household member, where A_t^H is a non-stationary technology index for home goods that is needed here to maintain a balanced growth path, $\phi \geq 0$ is the inverse Frisch elasticity of labor supply, and, following Galí, Smets, and Wouters (2012), Θ_t^j is an endogenous preference shifter that regulates the strength of the wealth effect on labor supply.[27] The variable κ_t is an additional preference shifter that captures the average employed household member's labor disutility, and is a weighted average of the disutility of immigrants (κ_t^M) and natives (κ_t^L):[28]

$$\kappa_t = (1 - \omega_t^{M,NH\phi})\kappa^L + \omega_t^{M,NH\phi} \kappa_t^{M,N}, \tag{3}$$

where $\omega_t^{M,NH\phi} \equiv N_t^M (h_t^M)^{1+\phi} / N_t h_t^{1+\phi}$ is the share of the households total labor disutility that can be attributed to migrants, with $n_t \kappa_t h_t^{1+\phi} = n_t^M \kappa_t^M (h_t^M)^{1+\phi} + n_t^L \kappa_t^L (h_t^L)^{1+\phi}$. The labor disutility of natives is denoted by κ^L and is assumed to be constant, while $\kappa_t^{M,N}$ is the labor disutility of working

[24] We abstract from the decision to participate in the labor market, so we use the terms "population" and "labor force" interchangeably.

[25] Shocks to L_t are quasi-permanent, since the persistence parameter ρ_L is nearly one, though not exactly one to maintain stationarity. We thus assume that immigrants that arrive do not subsequently leave the economy.

[26] Throughout the paper we denote per capita variables with a hat ($\hat{X}_t = X_t/L_t$).

[27] This endogenous shifter is designed so that a parameter in the $[0,1]$ range, which is estimated, governs the strength of the wealth effect. On one extreme, preferences are of the CRRA type. On the other extreme, the wealth effect disappears, as in the formulation of preferences due to Greenwood, Hercowitz, and Huffman (1988).

[28] When differentiating between immigrants and natives, we use superscripts M and L, respectively.

immigrants. The disutility of working immigrants in period t ($\kappa_t^{M,N}$) depends on the disutility of the previously employed ($\kappa_{t-1}^{M,N}$), and on the disutility of those that find a job in period t. The latter are either previously arrived but unemployed immigrants ($\kappa_{t-1}^{M,U}$), or newly arrived immigrants. Therefore, the labor disutility of working immigrants evolves as:

$$\begin{aligned}\kappa_t^{M,N} = {} & \omega_t^{N^M,-1}\left(\rho^{M,\kappa}\kappa_{t-1}^{M,N} + \left(1-\rho^{M,\kappa}\right)\kappa^M\right) + \omega_t^{N^M,U}\left(\rho^{M,\kappa}\kappa_{t-1}^{M,U} + \left(1-\rho^{M,\kappa}\right)\kappa^M\right) \\ & + \omega_t^{N^M,M}\left(1-\delta^{M,\kappa}\right)\kappa^M,\end{aligned} \tag{4}$$

where $\omega_t^{N^M,-1} \equiv (1-\rho_t^M)N_{t-1}^M/N_t^M$, $\omega_t^{N^M,U} \equiv (1-\rho_t^M)\mathcal{M}_{t-1}^M/N_t^M$, and $\omega_t^{N^M,M} \equiv (1-\rho_t^M)(1-\lambda^{M,U})\Delta L_t/N_t^M$ are the shares of immigrants employed in period t, that in period $t-1$ were employed, unemployed, or still living abroad, respectively.[29]

The first two terms of equation (4) describe the convergence of previously arrived immigrants to their steady-state labor disutility (κ^M) as they integrate to the economy and rebuild social networks. The third term shows the effect of newly arrived employed immigrants on average labor disutility. Immigrants' labor disutility is lower upon arrival, as they enter the country without social networks or safety nets. The parameter $\delta^{M,\kappa}$ denotes the initial labor disutility drop due to losing recoverable social capital, and $\rho^{M,\kappa}$ denotes the persistence of the transitory effect.

The average disutility of unemployed immigrants, $\kappa^{M,U}$, evolves in a similar way:

$$\begin{aligned}\kappa_t^{M,U} = {} & \omega_t^{U^M,-1}\left(\rho^{M,\kappa}\kappa_{t-1}^{M,U} + \left(1-\rho^{M,\kappa}\right)\kappa^M\right) + \omega_t^{U^M,N}\left(\rho^{M,\kappa}\kappa_{t-1}^{M,N} + \left(1-\rho^{M,\kappa}\right)\kappa^M\right) \\ & + \omega_t^{U^M,M}\left(1-\delta^{M,\kappa}\right)\kappa^M,\end{aligned} \tag{5}$$

where $\omega_t^{U^M,-1} \equiv U_{t-1}^M - (1-\rho_t^M)\mathcal{M}_{t-1}^M/U_t^M$, $\omega_t^{U^M,N} \equiv N_{t-1}^M\rho_t^M/U_t^M$, and $\omega_t^{U^M,M} \equiv (\lambda^{M,U} + (1-\lambda^{M,U})\rho_t^M)\Delta L_t/N_t^M$ are the shares of immigrants unemployed in period t, that in period $t-1$ were unemployed, employed, or living in a foreign country, respectively.

Per capita consumption services $\hat{C}_t^{s,j}$ are a constant elasticity of substitution (CES) bundle of the household's per capita consumption purchases $\hat{C}_t^j$, and the government's per capita consumption purchases $\hat{C}_t^G \equiv C_t^G/L_t$.[30] Additionally, the household forms habits with respect to average per capita private consumption:

$$\hat{C}_t^{s,j} = \left[(1-o_{\hat{C}})^{\frac{1}{\eta_{\hat{C}}}}\left(\hat{C}_t^j - \varsigma\check{\hat{C}}_{t-1}^j\left(\frac{L_{t-1}}{L_t}\right)^{1-\lambda^{M,C}}\right)^{\frac{\eta_{\hat{C}}-1}{\eta_{\hat{C}}}} + o_{\hat{C}}^{\frac{1}{\eta_{\hat{C}}}}\left(\hat{C}_t^G\right)^{\frac{\eta_{\hat{C}}-1}{\eta_{\hat{C}}}}\right]^{\frac{\eta_{\hat{C}}}{\eta_{\hat{C}}-1}},$$

where $o_{\hat{C}}$ denotes the share of government consumption goods in the CES bundle, $\eta_{\hat{C}}$ denotes the elasticity of substitution between private and public per capita consumption purchases, and $\check{\hat{C}}_{t-1}^j$ denotes average per capita consumption across households of type j (with $\hat{C}_t^j = \check{\hat{C}}_t^j$ in equilibrium), which each household takes as given. Finally, the parameter $\lambda^{M,C}$ controls whether newly arrived immigrants consider

[29] As we explain below, ρ_t^M is the separation rate of immigrants, $\mathcal{M}_{t-1}^M$ is the number of matches immigrants make in period $t-1$, which become productive in period t, N_t^M is the number of employed immigrants, and $\lambda^{M,U}$ is the share of immigrants that arrive as unemployed, which is equal to 1 in our baseline simulations.

[30] Government consumption also contributes to private utility, as in Coenen, Straub, and Trabandt (2013). Note that this formulation assumes that government consumption goods are rival.

the consumption level of previous residents when forming their habits.

4.1.1 Ricardian Households

Only Ricardian households save and borrow by purchasing domestic-currency-denominated bonds (B_t^R) and by trading foreign-currency bonds (B_t^{R*}) with foreign agents, both being non-state contingent assets. They also purchase an investment good (I_t^R), which determines their stock of physical capital for next period (K_t^R), and receive dividends (D_t^R) from the ownership of domestic firms, as well as net rents REN_t^{R*} from abroad. They pay a tax rate τ^L on labor income, τ^C on consumption, τ^D on dividends, and τ^K on capital income. Additionally, unemployed members receive an amount UB_t of unemployment benefits.

Let r_t, r_t^* and r_t^K denote the gross real returns on B_{t-1}^R, B_{t-1}^{R*} and the services from capital $K_t^{S,R}$, respectively, and let rer_t be the real exchange rate (i.e., the price of foreign consumption goods in terms of domestic consumption goods). We allow for the distinction between capital services ($K_t^{S,R}$), which are used in the production of goods, and physical units of capital (K_{t-1}^R), which are owned by the households and follow a law of motion governed by the investment and depreciation rates. Capital services are defined as the productive potential of the available physical capital stock for a given utilization rate $\bar{u}_t$ chosen by the households:

$$K_t^{S,R} = \bar{u}_t K_{t-1}^R, \tag{6}$$

Following Christiano, Trabandt, and Walentin (2011), investment goods are also needed for the maintenance of private capital. This expenditure is a function of utilization: $\phi_{\bar{u}}(\bar{u}_t)K_{t-1}$. These maintenance costs are deducted from capital taxation, and their functional form follows García-Cicco, Kirchner, and Justel (2015):

$$\phi_{\bar{u}}(\bar{u}_t) = \frac{r^K}{\Phi_{\bar{u}}}\left(e^{\Phi_{\bar{u}}(\bar{u}_t - 1)} - 1\right), \tag{7}$$

where the parameter $\Phi_{\bar{u}} \equiv \phi''_{\bar{u}}(1)/\phi'_{\bar{u}}(1) > 0$ governs the importance of these utilization costs.

The amount of physical capital that immigrants bring will affect the economy's capital-labor ratio, and therefore output per worker, wages and the rate of return to capital, and saving and investment decisions. Immigrants arrive with a fraction $\lambda^{M,k}$ of natives' steady state per capita capital stock. The physical capital stock evolves according to the following law of motion:

$$K_t^R = (1-\delta)K_{t-1}^R + \left[1 - \phi_I\left(\frac{I_t^R}{I_{t-1}^R}\right)\right]\varpi_t I_t^R + \lambda^{M,k}\left[(L_t^M - L_{t-1}^M)\frac{A_{t-1}k^R}{L}\right], \tag{8}$$

with depreciation rate $\delta \in (0,1]$, where ϖ_t is an investment shock that captures changes in the efficiency of the investment process (see Justiniano, Primiceri, and Tambalotti, 2011), I_t^R denotes capital augmenting investment expenditures, and $\phi_I\left(I_t^R/I_{t-1}^R\right) \equiv (\Phi_I/2)\left(I_t^R/I_{t-1}^R - a\right)^2$ are convex investment adjustment costs with elasticity $\Phi_I = \phi''_I(a) \geq 0$. When $\lambda^{M,k}$ is equal to zero, all immigrants arrive without any capital stock; this is the case in our baseline simulation. When $\lambda^{M,k}$ is equal to one, the immigration shock does not affect the per capita capital stock.

The period-by-period per capita budget constraint of the representative Ricardian household is then given by:

$$\begin{aligned}\left(\hat{B}_t^R + rer_t \hat{B}_t^{R*}\right) - \left(\frac{\hat{B}_{t-1}^R}{\gamma_t^L} + rer_t \frac{\hat{B}_{t-1}^{R*}}{\gamma_t^L}\right) &= rer_t R\hat{E}N_t^{R*} + \hat{TR}_t^R + (1-\tau_t^L) W_t h_t n_t + (1-n_t)\, UB_t \\ &+ (r_t - 1)\frac{\hat{B}_{t-1}^R}{\gamma_t^L} + (r_t^* - 1)\, rer_t \frac{\hat{B}_{t-1}^{R*}}{\gamma_t^L} + (1-\tau_t^D)\hat{D}_t^R \\ &+ \frac{\hat{K}_{t-1}^R}{\gamma_t^L}\left[r_t^K \bar{u}_t \left(1-\tau_t^K\right) + \tau_t^K p_t^I \left(\delta + \phi_{\bar{u}}\left(\bar{u}_t\right)\right)\right] \\ &- (1+\tau_t^C)\hat{C}_t^R - p_t^I\left(\hat{I}_t^R + \frac{\hat{K}_{t-1}^R}{\gamma_t^L}\phi_{\bar{u}}\left(\bar{u}_t\right)\right) - \hat{T}_t^R. \end{aligned} \tag{9}$$

With $\gamma_t^L \equiv \frac{L_t}{L_{t-1}}$ denoting the period's population growth. Per capita net rents from abroad $R\hat{E}N_t^{R*}$ have a positive component due to ownership of firms abroad that evolves exogenously, and a negative component due to remittances that immigrants send to their home countries:

$$R\hat{E}N_t^{R*} = \overline{ren}^{R*}\xi_t^{ren}/(L_t/L) - \lambda^{M,R}\,\omega_t^{M,y}\,\frac{W_t h_t n_t}{rer_t}, \tag{10}$$

where $\overline{ren}^{R*} \geq 0$, ξ_t^{ren} is an exogenous process that affects received rents, $\lambda^{M,R} \geq 0$ is the fraction of labor income that employed immigrants send to their home countries, and $\omega_t^{M,y}$ is the share of households' total labor income that the union allocates to immigrant workers, which we assume is based on their share in total labor supplied and their relative labor productivity. We explain the process of wage negotiation and distribution of labor income below.

The household chooses C_t^R, I_t^R, K_t^R, B_t^R, B_t^{R*}, and $\bar{u}_t$ to maximize (2) subject to (6)-(9), taking r_t, r_t^*, r_t^K, rer_t, T_t^R, REN_t^{R*}, TR_t^R, D_t^R and $\check{C}_t^R$ as given.

The nominal interest rates are implicitly defined as

$$\begin{aligned} r_t &= R_{t-1}\left(\pi_t\right)^{-1}, \\ \pi_t &= \left(\frac{P_t}{P_{t-1}}\right)\frac{1+\tau_t^C}{1+\tau_{t-1}^C} \\ r_t^* &= R_{t-1}^* \xi_{t-1}\left(\pi_t^*\right)^{-1}, \\ \pi_t^* &= \frac{P_t^*}{P_{t-1}^*}, \end{aligned}$$

where π_t and π_t^* denote the gross inflation rates of the domestic and foreign consumption-based price indices, after tax in the domestic case. A debt-elastic country premium (ξ_t) is given by :

$$\xi_t = \bar{\xi}\exp\left[-\psi\left(\frac{rer_t B_t^*}{p_t^Y Y_t} - \frac{rerb^*}{p^Y y}\right) + \frac{\zeta_t^O - \zeta^O}{\zeta^O} + \frac{\zeta_t^U - \zeta^U}{\zeta^U}\right], \qquad \psi > 0, \qquad \bar{\xi} \geq 1,$$

where ζ_t^O and ζ_t^U are observed and unobserved exogenous shocks to the country premium, respectively, and ψ denotes the elasticity of the premium to the country's net asset position (see Adolfson, Laséen, Lindé, and Villani, 2008; Schmitt-Grohé and Uribe, 2003). The foreign nominal interest rate R_t^* evolves

exogenously, whereas the domestic central bank sets R_t.

4.1.2 Non-Ricardian Households

The subset of households that do not have access to asset markets or investment in physical capital simply consume their disposable income every period. They face the following per capita budget constraint:

$$(1+\tau_t^C)\hat{C}_t^{NR} = (1-\tau_t^L)W_t h_t n_t + (1-n_t)\,UB_t + \hat{TR}_t^{NR} - \hat{T}_t^{NR} - \lambda^{M,R}\,\omega_t^{M,y}\,W_t h_t n_t, \tag{11}$$

where the last term refers to remittances sent by immigrant workers. Thus, non-Ricardian households solve a much simpler period-by-period problem.

4.2 Labor Market

Following Kirchner and Tranamil (2016) and Guerra-Salas, Kirchner, and Tranamil (2021), the labor market features search-and-matching frictions as in Mortensen and Pissarides (1994), allowing for both exogenous and endogenous separations, as in Cooley and Quadrini (1999), and den Haan, Ramey, and Watson (2000).

By assumption, Ricardian and non-Ricardian workers have the same productivity, although immigrants have lower productivity than natives. As in Boscá, Domenech, and Ferri (2011), a labor union negotiates a labor contract based on households' average productivity and average labor disutility. This implies that firms cannot differentiate between different kinds of workers (Ricardian and non-Ricardian, o natives and immigrants). As in Gertler, Sala, and Trigari (2008), hours are re-optimized every period to ensure that the marginal rate of substitution between consumption and leisure equals the value product of an additional hour supplied, so the ratio of hours worked of immigrants to natives satisfies:

$$\frac{h_t^M}{h_t^L} = \left(z_t^{M,\ell} \frac{\kappa^L}{\kappa_t^{M,n}} \right)^{\frac{1}{\phi}}. \tag{12}$$

The wage features nominal rigidity as in Hall (2005), so a notional norm for wages is negotiated every period via Nash bargaining, and actual compensation is defined as a weighted average between the negotiated notional wage and the wage from the previous period. Once average wages and hours are negotiated, the union assigns the total wage income among immigrants and natives based on their total hours supplied and their relative productivity. The share of total labor income allocated to immigrant members of the representative household can be expressed as:

$$\omega_t^{M,y} = \frac{N_t^M h_t^M z_t^{M,\ell}}{N_t h_t z_t^{\ell}}, \tag{13}$$

where $z_t^{M,\ell}$ and z_t^{ℓ} are the labor productivity of immigrants and the economy's average, respectively.

As previously mentioned, the evidence for Chile suggests that immigrants display a lower long-run unemployment rate than natives, accompanied by a higher unemployment rate upon arrival. This long-run difference, in turn, may be due to heterogeneity in job finding and/or job separation rates. As we mentioned in section 3.3, heterogeneity in employment inflows may be explained by differences in mobility

and how those differences affect job finding rates. Heterogeneity in employment outflows can be explained, in turn, by differences in the ability to hold jobs. We now discuss how this heterogeneity is implemented in the model.

Job finding rate: The aggregate matching function, which defines the number of new employment relationships that are productive in period $t+1$, follows a standard Cobb-Douglas specification:

$$\mathcal{M}_t = m_t V_t^{1-\mu} U_t^{\mu}, \tag{14}$$

where U_t is the total number of unemployed workers searching for a job, V_t is the number of vacancies posted by firms, μ is the match elasticity parameter, and m_t is average match efficiency, a weighted average of natives' and immigrants' job finding efficiency:

$$m_t = (1-\omega_t^{M,U})m^L + \omega_t^{M,U} m^M, \tag{15}$$

where $\omega_t^{M,U}$ is the share of immigrants in the total unemployment pool, and m^L and m^M denote the job finding efficiency of natives and immigrants, respectively. Allocating total matches from (14) to natives and immigrants proportionally to their matching-efficiency-weighted unemployment shares, so that $\mathcal{M}_t^L = \mathcal{M}_t(1-\omega_t^{M,U})m^L/m_t$, and $\mathcal{M}_t^M = \mathcal{M}_t\omega_t^{M,U}m^M/m_t$, we can express the job finding probabilities for natives and immigrants as:

$$s_t^L = s_t \frac{m^L}{m_t}, \tag{16}$$

$$s_t^M = s_t \frac{m^M}{m_t}, \tag{17}$$

where $s_t = m_t(V_t/U_t)^{1-\mu}$ is the average job finding rate of the economy.

Job separation rate: At the beginning of each period, a fraction of all employment relations terminate exogenously. In the aggregate, they are destroyed at a rate ρ_t^x, a weighted average of natives and immigrants:

$$\rho_t^x = (1-\omega_t^{M,\widetilde{N}})\rho^{L,x} + \omega_t^{M,\widetilde{N}}\rho^{M,x}, \tag{18}$$

where $\omega_t^{M,\widetilde{N}} \equiv \frac{N_{t-1}^M + \mathcal{M}_{t-1}^M + (1-\lambda^{M,U})\Delta L_t}{N_{t-1}+\mathcal{M}_{t-1}}$ is the share of immigrants in the total employment pool at the beginning of the period, with $\lambda^{M,U}$ denoting the fraction of immigrants that arrive unemployed in period t, and $\rho^{L,x}$ and $\rho^{M,x}$ are the exogenous separation rates of natives and immigrants, respectively.

Workers that do not separate exogenously may separate endogenously at rate ρ_t^n if the worker's operating cost $\widetilde{c}_t$ is greater than an endogenously determined threshold $\overline{c}_t$, so that $\rho_t^n = P(\widetilde{c}_t > \overline{c}_t)$. The operating cost is assumed to be i.i.d. across workers and time. The evolution of employment is then given by $N_t = (1-\rho_t)\left[N_{t-1} + \mathcal{M}_{t-1}\right]$, where $\rho_t = \rho_t^x + (1-\rho_t^x)\rho_t^n$ is the total separation rate. We assume firms are not allowed to discriminate between immigrants and natives in their decision to endogenously terminate a relationship, so that $\rho_t^{L,n} = \rho_t^{M,n} = \rho_t^n$, and the only source of heterogeneity in separation

rates of natives and immigrants is due to differences in the exogenous component:

$$\rho_t^L = \rho^{L,x} + (1 - \rho^{L,x})\rho_t^n, \tag{19}$$

$$\rho_t^M = \rho^{M,x} + (1 - \rho^{M,x})\rho_t^n. \tag{20}$$

The evolution of the number of unemployed natives and immigrants is given by:

$$U_t^L = \left(1 - s_{t-1}^L(1 - \rho_t^L)\right) U_{t-1}^L + \rho_t^L N_{t-1}^L, \tag{21}$$

$$U_t^M = \left(1 - s_{t-1}^M(1 - \rho_t^M)\right) U_{t-1}^M + \rho_t^M N_{t-1}^M + \left(\lambda^{M,U} + \rho_t^M(1 - \lambda^{M,U})\right) \Delta L_t. \tag{22}$$

The stock of currently unemployed native workers (U_t^L) is given by those that had a job in the previous period but were separated, plus the number of previously unemployed workers that were unable to find a job. The evolution of unemployed immigrants (U_t^M) follows the same structure, but includes an additional term related to the expansion of the labor force due to immigration in period t: $\Delta L_t \equiv L_t - L_{t-1}$. When $\lambda^{M,U}$ takes a value of 1, all immigrants arrive as unemployed; this is our baseline calibration. When $\lambda^{M,U} = U/L$, the share of immigrants that arrive as unemployed is identical to the share of natives that are unemployed in steady state, a case in which the immigration shock does not have any effect, on impact, on labor market tightness.

We can then track the evolution of employed natives and immigrants as a function of their previous employment levels, their idiosyncratic separation rates, and new matches:

$$N_t^L = \left(1 - \rho_t^L\right)\left(N_{t-1}^L + \mathcal{M}_{t-1}^L\right), \tag{23}$$

$$N_t^M = \left(1 - \rho_t^M\right)\left(N_{t-1}^M + \mathcal{M}_{t-1}^M + (1 - \lambda^{M,U})\Delta L_t\right). \tag{24}$$

The probability that a firm fills a vacancy is $e_t = \mathcal{M}_t/v_t$. The number of vacancies posted, as well as the endogenous job separation threshold $\bar{c}_t$, are optimally determined by profit maximizing firms.

4.3 Core Consumption Goods and Heterogeneous Consumption Baskets

We allow for immigrants to have different tastes than natives. As a result, immigration not only impacts the overall demand for goods and services but also influences the composition of the average consumption basket. In particular, if immigrants prefer goods from their home country, immigration will also affect macroeconomic dynamics through an imports demand channel. The literature finds support for such a mechanism. Genc, Gheasi, Nijkamp, and Poot (2012) document, in a meta-analysis of more than 300 papers, an average elasticity of imports to bilateral migration of 0.17. Similar results are found by Figueiredo, Lima, and Orefice (2020), who show that a 1% increase in bilateral migration implies a 0.19% boost in bilateral imports. Zhang (2020), on the other hand, directly estimates the influence of immigration on the host country's average home bias. By computing the import share of total expenditure as a function of migration, he finds that, on average, a one percentage point increase in the share of migrants from a given country in the population leads to a 0.35 percentage point increase in the share of total expenditure devoted to imports from that country.

In our model, the final consumption good is a bundle of core, agricultural, and energy goods. We

model heterogeneity in consumption bundles focusing on the core good (C_t^Z), which is the most important component of the total consumption bundle. Average home bias (AHB) across households defines the weight of locally produced intermediate goods on the core and food[31] consumption bundles C_t^Z and C_t^A, so that, for $i = \{A, Z\}$:

$$C_t^i = \left[AHB_t^{\frac{1}{\eta_i}} \left(X_t^{i,H} \right)^{\frac{\eta_i - 1}{\eta_i}} + (1 - AHB_t)^{\frac{1}{\eta_i}} \left(X_t^{i,F} \right)^{\frac{\eta_i - 1}{\eta_i}} \right]^{\frac{\eta_i}{\eta_i - 1}}, \tag{25}$$

where $X_t^{i,H}$ and $X_t^{i,F}$ denote the demand for home and foreign goods, respectively, η_i denotes the elasticity of substitution, and averaga home bias AHB_t is a weighted average of the bias of immigrants and natives:

$$AHB_t = (1 - \omega_t^{M,y}) AHB^L + \omega_t^{M,y} AHB^M, \tag{26}$$

where the weight $\omega_t^{M,y}$ is the share of total labor income allocated to immigrants, as shown in equation (13). This choice of weighting for the economy's average home bias, as opposed, for example, to one based on the share of immigrants in the population, intuitively reflects that households with higher income have a greater impact on the economy's average consumption basket.

4.4 Wholesale Domestic Goods and the Human Capital of Immigrants

As previously mentioned, the evidence points to immigrants displaying lower human capital than natives due to lower education quality. The evidence also suggests immigrants may experience a transitory underemployment or downgrading spell. We model these effects of immigration on the economy's human capital, in reduced form, as affecting average labor productivity. The only use of labor in the model economy is in the production of wholesale domestic goods, which also use oil and capital services as inputs. Labor and capital services form a composite input given by:

$$Y_t^{\tilde{Z}} = \left(\tilde{K}_t \right)^{\alpha} \left(A_t^H z_t^{\ell} N_t h_t \right)^{1-\alpha}, \tag{27}$$

where $\tilde{K}_t$ is a bundle of private and public capital services, $N_t h_t$ are total hours worked, A_t^H is a non-stationary labor-augmenting technology index, and z_t^{ℓ} is an average labor productivity shifter that adjusts due to heterogeneity between natives' and immigrants' human capital:

$$z_t^{\ell} = (1 - \omega_t^{M,NH}) + \omega_t^{M,NH} z_t^{M,\ell}, \tag{28}$$

where the weight $\omega_t^{M,NH} \equiv N_t^M h_t^M / N_t h_t$ is immigrants' share in total hours worked, and $z_t^{M,\ell} < 1$ denotes the average labor productivity of immigrants relative to natives. The evolution of $z_t^{M,\ell}$ can be written as a weighted average of the productivity of previously employed and newly employed immigrant workers:

$$z_t^{M,\ell} = \frac{N_{t-1}^M}{N_t^M} \left(\rho^{M,z} z_{t-1}^{M,\ell} + \left(1 - \rho^{M,z} \right) z^{M,\ell} \right) + \left(1 - \frac{N_{t-1}^M}{N_t^M} \right) \left(1 - \delta^{M,z} \right) z^{M,\ell}. \tag{29}$$

As in the case of labor disutility, this process is designed to allow for permanent and transitory components in the productivity gap of immigrants. Our baseline simulations feature only a permanent

[31] Consumption of fuel and other energy goods is assumed to be fully imported. See García et al. (2019) for details.

component—immigrants have steady state labor productivity $z^{M,\ell} < 1$, which is permanently lower than that of natives (normalized to one). In an extension to the baseline results, we allow for a transitory underemployment or downgrading spell. The second term of equation (29) shows the additional and transitory effect of newly employed immigrants on labor productivity, governed by parameter $\delta^{M,z}$. As immigrants rebuild country- and job-specific human capital and find jobs more suited to their qualifications, this underemployment or downgrading spell dissipates. The first term in the equation describes the convergence of previously employed immigrants to their steady-state productivity ($z^{M,\ell}$), where the speed of convergence is governed by the persistence parameter $\rho^{M,z}$.

4.5 Monetary Policy

Monetary policy is carried out according to a Taylor rule of the form:

$$R_t = (R_{t-1})^{\rho_R} \left[\overline{R}_t \left(\frac{\widetilde{\pi}_t}{\bar{\pi}_t} \right)^{\alpha_\pi} \left(\left(\frac{L_{t-1}^{z^\ell}}{L_t^{z^\ell}} \right)^{\lambda^{M,CB}} \frac{y_t^D}{y_{t-1}^D} \right)^{\alpha_y} \right]^{1-\rho_R} \exp(\varepsilon_t^R),$$

where $y_t^D \equiv Y_t^D / A_{t-1}$ is a measure of GDP computed as a gap with respect to the economy's non-stationary productivity path, ε_t^R is an AR(1) exogenous process that captures deviations from the rule, $\bar{\pi}_t$ is the inflation target, and $\widetilde{\pi}_t$ is the inflation rate monitored by the central bank, which is an average of present and expected total and core inflation rates:[32]

$$\widetilde{\pi}_t = \left[\left(\pi_t^Z \right)^{\alpha_{\pi Z}} (\pi_t)^{1-\alpha_{\pi Z}} \right]^{1-\alpha_{\pi E}} \left[\left(E_t \pi_{t+4}^Z \right)^{\alpha_{\pi Z}} (E_t \pi_{t+4})^{1-\alpha_{\pi Z}} \right]^{\alpha_{\pi E}},$$

where $\pi_t^Z = \frac{P_t^Z}{P_{t-1}^Z} \left(\frac{1+\tau_t^C}{1+\tau_{t-1}^C} \right)$ is the after-tax core inflation rate, $\alpha_{\pi Z} \in (0,1)$ governs the importance of core inflation relative to headline inflation, and $\alpha_{\pi E} \in (0,1)$ governs the importance of expected relative to current inflation. The parameter $\lambda^{M,CB}$ allows the central bank to correct its measure of GDP growth by the productivity-adjusted change in the labor force, with $L_t^{z^\ell} \equiv L_t (z_t^\ell)^{1-\alpha}$.

4.6 Aggregation across Households

Aggregate variables add up per-capita quantities from non-Ricardian and Ricardian households considering their respective demographic mass, $L_t(\omega)$ and $L_t(1-\omega)$:

[32] As in Christiano et al. (2011), the measure of GDP tracked by the central bank excludes operation, vacancy, and capital utilization costs.

$$C_t = L_t \left(\omega \hat{C}_t^{NR} + (1-\omega) \hat{C}_t^R \right), \tag{30}$$

$$TR_t = L_t \left(\omega \hat{TR}^{NR} + (1-\omega) \hat{TR}^R \right), \tag{31}$$

$$T_t = L_t \left(\omega \hat{T}_t^{NR} + (1-\omega) \hat{T}_t^R \right), \tag{32}$$

$$K_t = K_t^R = L_t \left((1-\omega) \hat{K}_t^R \right), \tag{33}$$

$$K_t^S = K_t^{S,R} = L_t \left((1-\omega) \hat{K}_t^{S,R} \right), \tag{34}$$

$$I_t = I_t^R = L_t \left((1-\omega) \hat{I}_t^R \right), \tag{35}$$

$$B_t^{Pr} = B_t^R = L_t \left((1-\omega) \hat{B}_t^R \right), \tag{36}$$

$$B_t^{Pr*} = B_t^{R*} = L_t \left((1-\omega) \hat{B}_t^{R*} \right), \tag{37}$$

$$D_t = D_t^R = L_t \left((1-\omega) \hat{D}_t^R \right). \tag{38}$$

4.7 Calibration

We take the parameters that are not related to immigration from García et al. (2019). The subset of parameters related to the mechanisms by which immigration affects the economy, summarized in Table 3, are calibrated either to match selected moments from the data, or following the literature. We comment on this subset of parameters below.

To calibrate the parameters related to the steady state productivity differential of immigrants, we use data on the quality of their education systems. As discussed in section 3.3, we proxy education quality by the performance of source countries in PISA tests. Our empirical findings suggest that the education quality of immigrants is 18% lower, on average, than natives ($z^{\ell,M,ed} = -0.18$). Since this is modeled as affecting economy-wide average labor productivity, we also consider Égert et al.'s (2022) estimates of the pass-through from test scores to productivity, denoted by $\eta^{ed,z}$, of 0.72.[33] These estimates imply that immigrants' steady state labor productivity is 19% lower than natives' ($z^{M,\ell} = 0.81$).[34]

Regarding heterogeneity in preferences for labor supply, we set the economy-wide labor disutility in steady state (κ) as in García et al. (2019), to obtain a steady state level of hours worked (h) of 0.3. We calibrate immigrants' steady state labor disutility (κ^M) to match the fact that they work 9.6% more hours than natives, on average, as discussed in section 3.3 (see figure 5). Since, as in Gertler et al. (2008), we assume a labor union and firms agree to an efficient allocation of hours worked, where the marginal value product of a worker-hour equals the marginal cost of work for an employed household member, it follows that the ratio of steady state hours worked of immigrants relative to natives is given by $\frac{h^M}{h^L} = \left(z^{M,\ell} \frac{\kappa^L}{\kappa^M} \right)^{\frac{1}{\phi}}$, and then the ratio of disutility parameters can be expressed as $\lambda^{M,\kappa} \equiv \kappa^M / \kappa^L = z^{M,\ell} \left(\frac{h^L}{h^M} \right)^{\phi}$, where ϕ denotes the inverse Frisch elasticity.[35]

Our choice of parameters for the labor disutility of immigrants relative to natives allows us to align the results from the model with the overall disinflationary effects of immigration found in our own empirical

[33] This is a simple average of Égert et al.'s (2022) reported range of 0.66-0.79.

[34] Relative TFP $\equiv (z^{M,\ell})^{1-\alpha} = 1 - (-z^{\ell,M,ed} \times \eta^{ed,z})$, where the labor share $(1-\alpha)$ is set at $2/3$.

[35] See García et al. (2019) for details on the functional form for equilibrium hours.

estimates, shown in section 3.2, as well as those in the literature.[36] For the transitory dynamics of labor disutility, we set a value of 3 for $\delta^{M,\kappa}$, which generates a decline of roughly 0.5% in the price level, about the midpoint of the empirical benchmarks. In figure 9 we additionally show the sensitivity of our results to values of 2 and 4 for the disutility parameter $\delta^{M,\kappa}$, which generate declines of roughly 0.3% and 0.7% in the price level, which lie near the lower and upper bounds of the benchmarks. We further assume a one year half-life for the recovery of the transitory component of the decline in labor disutility.

The share of labor income that immigrants send to their home country as remittances, $\lambda^{M,R}$, is calibrated to 17% , consistent with balance-of-payments data from the Central Bank of Chile, mean income data from the Supplementary Income Survey, and estimates of the number of employed immigrants from Aldunate et al. (2019).

Regarding consumption preferences, we calibrate the steady state value of average home bias AHB at 0.79, based on (one minus) the ratio of imports over expenditures for the 2008-2016 period. The steady state home bias of immigrants and natives, on the other hand, is pinned down by the long-term relationship implied by equation (26), and by:

$$\eta^{M,HB} = (AHB^L - AHB^M)\frac{(1-u^M)z^{M,\ell}}{(1-u)z^{\ell}}, \tag{39}$$

where $\eta^{M,HB} \equiv \frac{\partial(1-AHB)}{\partial(^{L^M}/_L)}$ denotes the long-term relationship between home bias and immigration that, following the findings from Zhang (2020), we set to 0.35. This value implies that for a 1 percentage point increase in the share of migrants in the total population, the share of foreign goods in the average consumption basket will increase by 0.35 percentage points.

For the parameters that govern the status of immigrants upon arrival, we set $\lambda^{M,U}$ to one and $\lambda^{M,k}$ to zero, meaning all immigrants arrive as unemployed workers that search for jobs, and do not bring any physical capital.

With respect to the job finding rates of immigrants and natives, we set the steady state match efficiency of natives (m^L) to yield a steady state unemployment rate equal to the sample average. We then calibrate the relative job finding efficiency of immigrants ($\lambda^{M,m} \equiv m^M/m^L$) to get a steady state unemployment rate for immigrants that is 2 percentage points lower than that of natives, as observed in Chilean data (see Aldunate et al., 2019). For job separation rates, the rate for natives $\rho^{L,x}$ is set so that the ratio of exogenous separations over total separations is 2/3, as in den Haan et al. (2000). The exogenous separation rate for immigrants $\rho^{M,x}$ is calibrated to get a relative job destruction hazard rate $\lambda^{M,\rho} \equiv \rho^M/\rho^L$ equal to 1.36, as in Battisti et al. (2017).

Finally, the steady-state share of immigrants in the labor force ω_M is set to 7.2% to match the observed average between 2015 and 2018.

5 Results

To analyze the various channels through which immigration affects the macroeconomy, we proceed in three steps. First, we study an immigration shock under a parameterization of the model that eliminates any

[36] In addition to our own empirical findings, we take as benchmarks the estimates from Zachariadis (2012) and Lach (2007), which show a decline in prices of 0.3 and 0.5 percentage points after a one percent increase in the share of immigrants.

Table 3: Selected Calibrated Parameters

Parameter	Description	Value	Source/Target
ω^M	SS share of immigrants in the economy	0.07	Average 2015-2018
$z^{\ell,M,ed}$	Immigrants' relative education quality	-0.18	Own estimations (PISA tests)
$\eta^{ed,z}$	Education-productivity pass-through	0.72	Égert et al. (2022)
h^M/h^L	SS immigrants' relative hours supplied	1.096	Aldunate et al. (2019)
$\delta^{M,\kappa}$	Immigrants' transitory labor disutility drop	3	CPI effect $\sim -0.5\%$
$\rho^{M,\kappa}$	Persistence of transitory drop in κ^M	0.84	One year half-life
$\lambda^{M,R}$	Remittances as share of labor income	0.17	Aldunate et al. (2019)
AHB	SS average consumption home bias	0.67	García et al. (2019)
$\eta^{M,HB}$	Home bias elasticity to immigration	0.35	Zhang (2020)
$\lambda^{M,U}$	Share of immigrants that arrive unemployed	1	Assumption
$\lambda^{M,k}$	Capital stock brough in by migrants	0	Assumption
ρ^L	Natives' job destruction rate	0.04	García et al. (2019)
ρ^x/ρ	Share of exogenous separations	0.66	García et al. (2019)
$\lambda^{M,\rho}$	Relative job destruction rate	1.36	Battisti et al. (2017)
$\lambda^{M,m}$	Relative match efficiency of immigrants	1.87	$u^L - u^M = 0.02$
$\lambda^{M,CB}$	Taylor Rule's GDP adjustment for pop. growth	0	Assumption

Notes.— The table shows selected parameters related to the simulated immigration shock. See García et al. (2019) for a complete list of the model's calibrated parameters and targeted steady state values, as well as details on its estimated parameters.

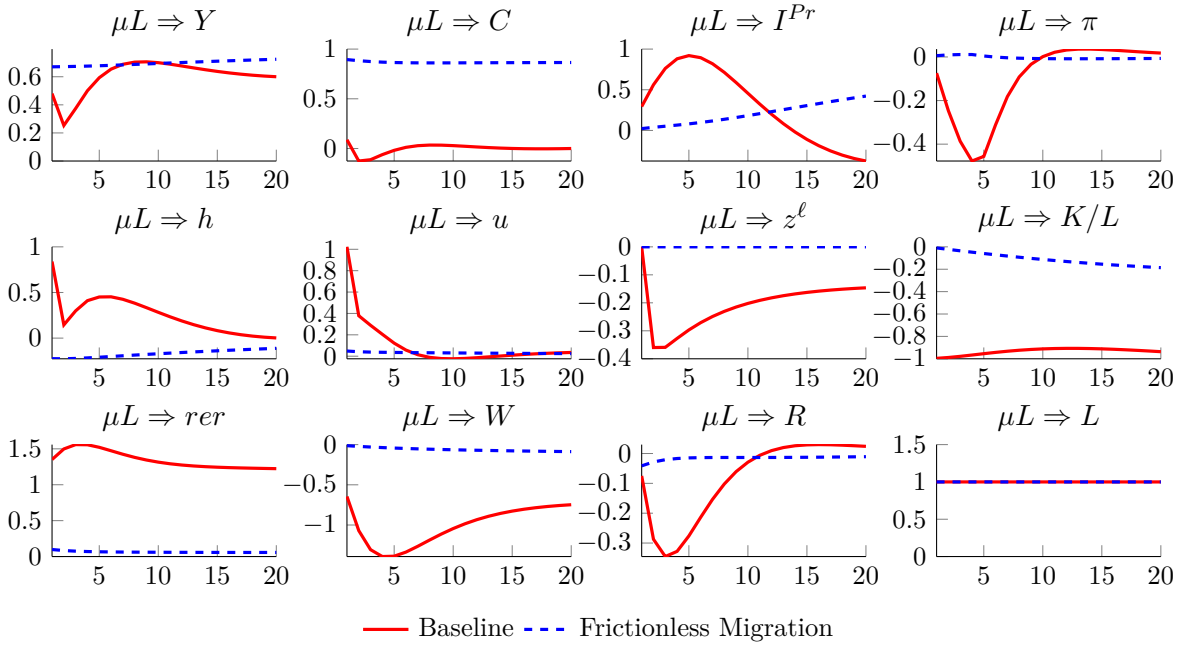
and all differences in characteristics and preferences between immigrants and natives. In this "frictionless migration" benchmark, immigrants are identical to natives, and the shock has no impact on inflation or the monetary policy rate. In the second step of the analysis, we study an immigration shock under our baseline parameterization, which includes all the features that differentiate immigrants from natives, in aspects such as human capital, consumption and labor supply preferences, and remittances, among others. The baseline parameterization is designed to deliver an inverse relation between immigration and inflation, as suggested by the empirical evidence. In the third and final step, we study the role of each of the differentiating characteristics of immigrants in driving the macroeconomic effects of an immigration shock.

5.1 Frictionless Migration Benchmark

Figure 7 shows, in dashed blue lines, the effect of an immigration shock (μL)—a permanent 1% increase in the labor force (L), under the frictionless migration parameterization. This benchmark considers that, compared to natives, immigrants have exactly the same human capital ($z^{M,\ell} = 1$, $\rho^{M,z} = \delta^{M,z} = 0$), obtain the same disutility from labor ($\lambda^{M,\kappa} = 1$), have the same consumption home bias and consumption habits ($\eta^{HB} = 0$, $\lambda^{M,C} = 1$), experience the same job finding rate ($\lambda^{M,m} = 1$), and arrive with the same unemployment rate and per-capita capital stock ($\lambda^{M,U} = u$, $\lambda^{M,K} = 1$). In this frictionless scenario we also assume that immigrants do not send remittances abroad ($\lambda^{M,R} = 0$), and that the GDP measure in the central bank's Taylor rule fully adjusts for the change in the labor force ($\lambda^{M,CB} = 1$). When immigrants are identical to natives, bring the same per-capita stock of physical capital, and integrate

seamlessly to the labor market, there are virtually no effects on the economy, other than an increase in its size. Both output (Y) and consumption (C) increase permanently on impact. Private investment (I^{Pr}), on the other hand, increases gradually due to adjustment costs. Importantly, neither inflation (π), nor the monetary policy rate (R) are materially affected by the immigration shock, since net inflationary pressures are negligible. The effects on the unemployment rate (u), average labor productivity (z^{ℓ}), the real exchange rate (rer), hours worked (h), and the real wage (W) are also negligible in this case.[37]

Figure 7: Effects of an Immigration Shock



Notes.— Impulse responses to an immigration shock (μL) that permanently increases the size of the labor force L (equivalent to the population) by 1%. Dashed blue lines show responses to a frictionless migration shock that features immigrants that have the same characteristics and preferences as natives. Solid red lines show responses under our baseline parameterization, which considers that immigrants have lower human capital than natives, have different preferences towards consumption and labor, that all immigrants arrive as unemployed and bring no physical capital, and send part of their income as remittances to their home countries. Responses of the following variables are expressed as percent deviations from steady state: output (Y), consumption (C), private investment (I^{Pr}), hours worked (h), average labor productivity (z^{ℓ}), the capital stock per capita (K/L), the real exchange rate (rer), and the real wage (W). π describes the response of annualized inflation, expressed in percentage points and in deviations from steady state; annualized inflation is proxied by the sum of the last four values of quarterly inflation. R denotes the monetary policy rate on an annual basis, and u the unemployment rate, both in percentage points and as deviations from steady state. Horizontal axes show quarters.

5.2 Baseline Parameterization

The solid red lines in figure 7 show the effects of an immigration shock under our baseline parameterization, which captures all the discussed characteristics that differentiate immigrants from natives, and is designed to deliver the inverse relation between immigration and inflation observed in the data. The key features of this simulation are:

- Immigrants have lower human capital than natives due to lower education quality, as shown in

[37] π denotes annualized inflation, which is proxied by the sum of the last four values of quarterly inflation. R denotes the monetary policy rate on an annual basis.

section 3.3. This is modeled as a reduction in the economy's average labor productivity, which generates upward pressure on inflation.[38]

- Immigrants obtain lower disutility from labor than natives, so that the shock generates a substantial increase in labor supply, putting downward pressure on inflation through its effect on wages. This feature leads to an increase in hours worked, which is consistent with the evidence on immigrants working longer hours than natives shown in section 3.3.

- Immigrants send part of their income as remittances to their home countries. This feature weakens the demand channel's inflationary pressure, since immigrants have lower disposable income. However, remittances are capital outflows that depreciate the exchange rate, which creates inflationary pressure. Under our parameterization, these forces nearly cancel each other, so remittances have a negligible net effect on inflation and, by extension, on the monetary policy rate.

- Immigrants' consumption preferences are relatively more biased toward foreign goods. This feature weakens the demand channel's inflationary pressure. However, more intense preferences over foreign goods depreciate the exchange rate, other things equal, which generates inflationary pressure. In this case, under our parameterization, the net effect of heterogeneous consumption preferences leads to mildly lower inflation and monetary policy rates.

- All immigrants arrive as unemployed workers that search for jobs. Search frictions delay the integration of immigrants to the labor market, mitigating the disinflationary effect from higher labor supply.[39]

- Immigrants have a higher job finding probability than natives, so their long-run unemployment rate is lower, as suggested by the evidence shown in section 3.3. This feature mitigates inflationary pressure from the immigration shock, since a higher job finding probability allows immigrants to integrate more quickly to the labor market, which in turn allows aggregate supply to respond more quickly to the expansion in demand induced by the shock. Immigrants also exhibit a higher job separation rate, as in the evidence for Europe offered by Battisti et al. (2017). However, heterogeneity in job separation rates has little effect on inflation.

The solid red lines in figure 7 show that the general equilibrium effect of the immigration shock under the baseline parameterization is mostly expansionary, as output and investment increase. Consumption increases only slightly, mainly due to the mitigating effect of remittances, as we show below. Inflation declines, reaching a trough of 0.5 percentage points (pp) below steady state a year after the shock hits the economy. The disinflationary force of immigration, mainly due to the pressure of higher labor supply, dominates the inflationary force, primarily originated in higher demand for consumption and investment, and in lower average labor productivity. The role of the labor supply channel is evident in the persistent

[38] As shown in section 3.3, the evidence also suggests that, in addition to lower human capital, immigrants experience a transitory underemployment or downgrading spell, a period during which they cannot fully exercise the productivity associated with their human capital. This spell would further reduce average labor productivity in the economy. Although this underemployment spell is not part of the baseline simulation, we consider its effects when we study the role of differences in the human capital of immigrants and natives in section 5.3.

[39] In the baseline parameterization, we further assume that immigrants bring no physical capital with them.

decline of one and a half percent in the real wage. In response to this shock, the Taylor rule generates a transitory decline in the monetary policy rate that reaches 35 basis points below steady state by the third quarter after the shock.

5.3 Characteristics that Differentiate Immigrants from Natives

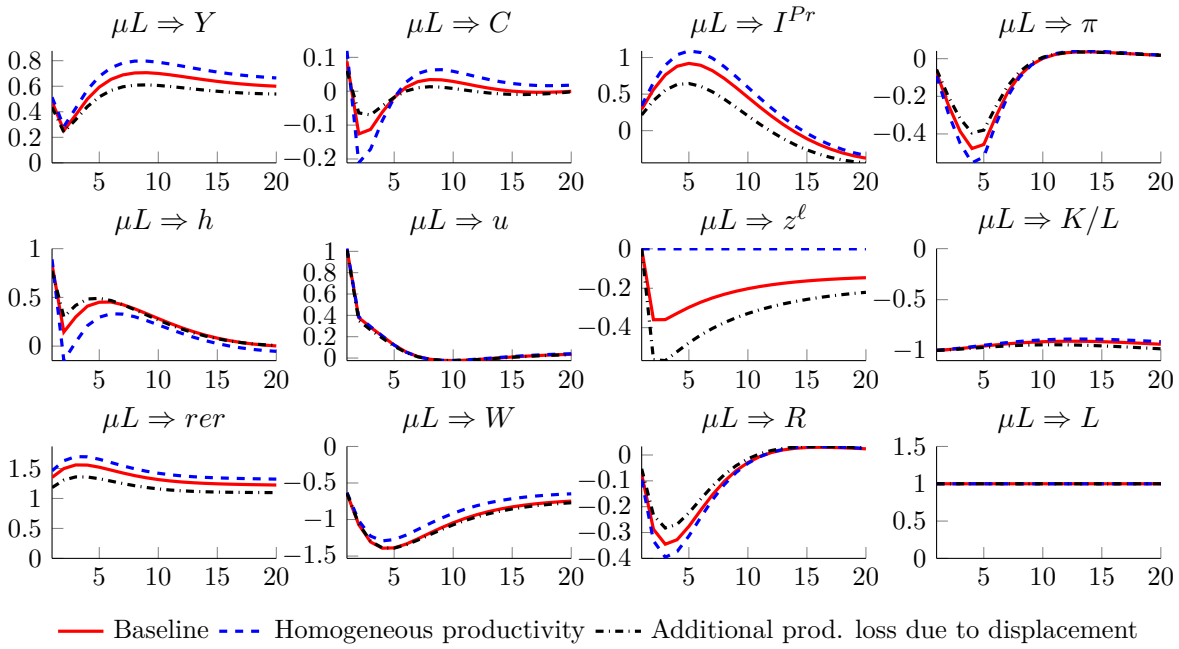
We now study the role that each of the characteristics that differentiate immigrants from natives plays in the baseline results: human capital, labor supply preferences, remittances, consumption preferences, employment status at arrival, and job finding and separation rates.

Human capital. In our baseline results, immigrants have lower human capital than natives, which lowers the economy's average labor productivity, creating inflationary pressure. To study the role of this feature, we consider an alternative case in which immigrants have the same level of human capital as natives, and the remaining features of the baseline simulation remain unchanged. The dashed blue lines of figure 8 show that in the case of "homogeneous productivity," the decline in inflation (π) induced by the immigration shock is larger, reaching a trough of about 0.55pp below the steady state, an additional 0.05pp lower than in the baseline simulation. Since average labor productivity (z^{ℓ}) does not decline in this case, the shock is more expansionary, with output, investment and consumption displaying larger increases. The monetary policy rate (R) is lower than in the baseline simulation, due to its response to inflation. At the trough, it reaches nearly 35 basis points below the steady state.

We also study how the baseline results change if, in addition to having lower human capital than natives, immigrants experienced a transitory underemployment or downgrading spell. As shown in section 3.3, the evidence suggests that it takes time for immigrants to find jobs that match their qualifications. The dash-and-dotted black lines in figure 8 show the effects of an immigration shock in which, in addition to all the features in the baseline results, including lower human capital, immigrants experience an underemployment spell. To calibrate this spell, we use the estimates of average wage losses due to displacement offered by Huckfeldt (2022).[40] The underemployment spell exacerbates the decline in average labor productivity, generating additional inflationary pressure. In general equilibrium, this feature mitigates the decline in inflation by about 0.1pp; inflation reaches a trough of roughly 0.4pp below steady state, compared to the decline of 0.5pp in the baseline case. The underemployment spell also mitigates the economy's expansion. In this case, the monetary policy rate falls less than in the baseline simulation.

[40] We calibrate the parameters that govern migrants' underemployment dynamics ($\delta^{M,x}$ and $\rho^{M,x}$; see equation (29)) based on a simple average from Huckfeldt's (2022) estimates of wage losses for switchers (a 20% wage loss, of which 5 percentage points are permanent, with a 3-year half-life for the remainder of the gap) and stayers (a 5% loss, which is entirely transitory, with a 5-year half-life). Further, we assume an elasticity from average labor productivity (z^{ℓ}) to wages of $(1-\alpha)$, where α represents the capital share in the Cobb-Douglas production function.

Figure 8: The Role of Human Capital



Notes.— Impulse responses to an immigration shock (μL) that permanently increases the size of the labor force L (equivalent to the population) by 1%. Solid red lines show responses under our baseline parameterization. Dashed blue lines show responses in a scenario in which immigrants and natives have the same level of human capital, so labor productivity is homogeneous. In the dash-and-dotted black lines, immigrants experience a transitory underemployment or downgrading spell due to the effects of job displacement on immigrants' country-specific and job-specific skills. Horizontal axes show quarters. For a definition of the variables, see the note to figure 7.

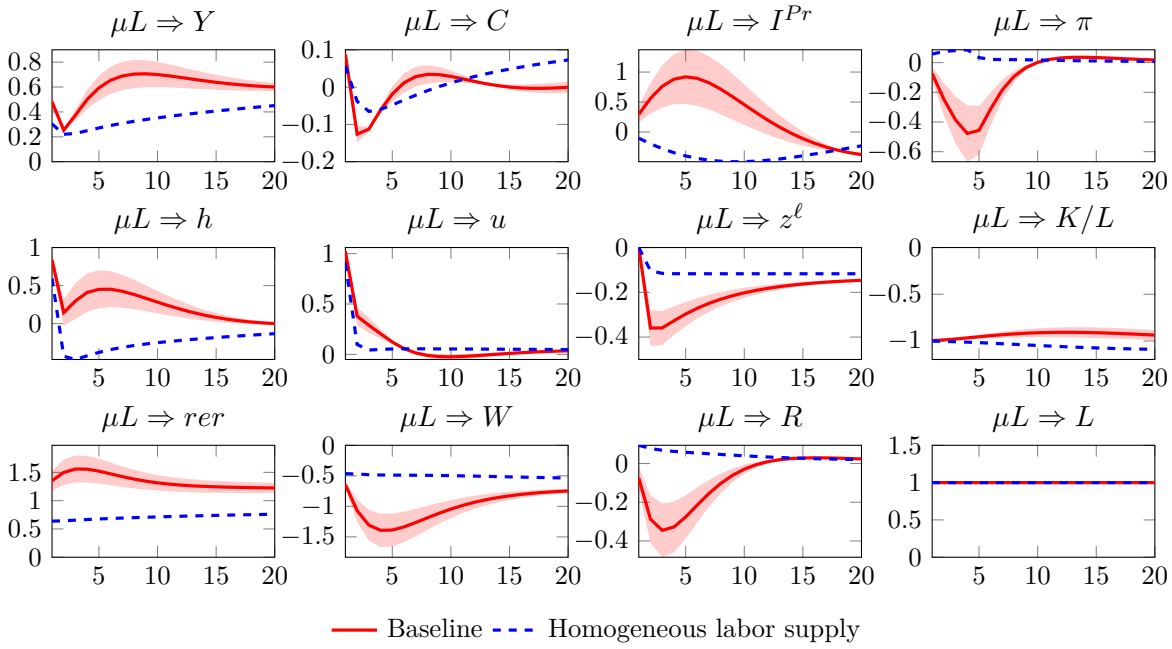
Labor supply preferences. For the baseline results to show the inverse relation between immigration and inflation observed in the data, it is crucial that immigrants obtain lower disutility from labor than natives. The additional supply of labor resulting from this feature generates substantial downward pressure on wages and, ultimately, inflation. Figure 9 compares the baseline results, in solid red lines, with the case in which immigrants and natives have the same preferences over labor supply, in dashed blue lines. Under "homogeneous labor supply," inflation does not decline at all, and actually increases slightly, which points to the inflationary forces of the shock roughly canceling its disinflationary forces in this case. With inflation virtually unchanged, the response of the monetary policy rate to the immigration shock is negligible. Note that in this case the wage (W) experiences a decline of one third to one half of its decline under the baseline parameterization and, importantly, that hours worked (h) do not increase. The behavior of hours worked when immigrants and natives have the same preferences over labor supply is at odds with the evidence, since we showed in section 3.3 that immigrants work substantially more hours than natives across all employment categories. An immigration shock, therefore, should push aggregate hours worked up. In the baseline results, with the additional channel of labor supply active, hours increase substantially.

Heterogeneity in labor supply preferences is also important for the expansionary effect of the immigration shock. Since hours worked do not increase at all when this heterogeneity is absent, output, consumption, and especially investment, do not expand nearly as much as in the baseline results.[41]

[41] Note that, under homogeneous labor supply preferences, average labor productivity (z^l) declines less than in the baseline.

Since heterogeneity in labor supply preferences is so important for the effect of immigration on inflation, we also study the sensitivity of the baseline results to different values of the parameter that governs the additional transitory decline in labor disutility—$\delta^{M,\kappa}$ in equation (4). The additional transitory decline in labor disutility is motivated by the time it takes immigrants to recover social capital as they adjust to their host country. For our baseline calibration, parameter $\delta^{M,kappa}$ takes a value of 3, which generates a maximum decline in the inflation rate of about 0.5%, close the midpoint of our benchmark empirical estimates discussed in section 4.7. The shaded areas around the baseline results in figure 9 show the effects of the immigration shock when parameter $\delta^{M,\kappa}$ takes values in the [2,4] range. This range for $\delta^{M,\kappa}$ generates a maximum decline in inflation between 0.3% and 0.7%, consistent with the lower and upper bounds of our empirical benchmarks.

Figure 9: The Role of Labor Supply Preferences



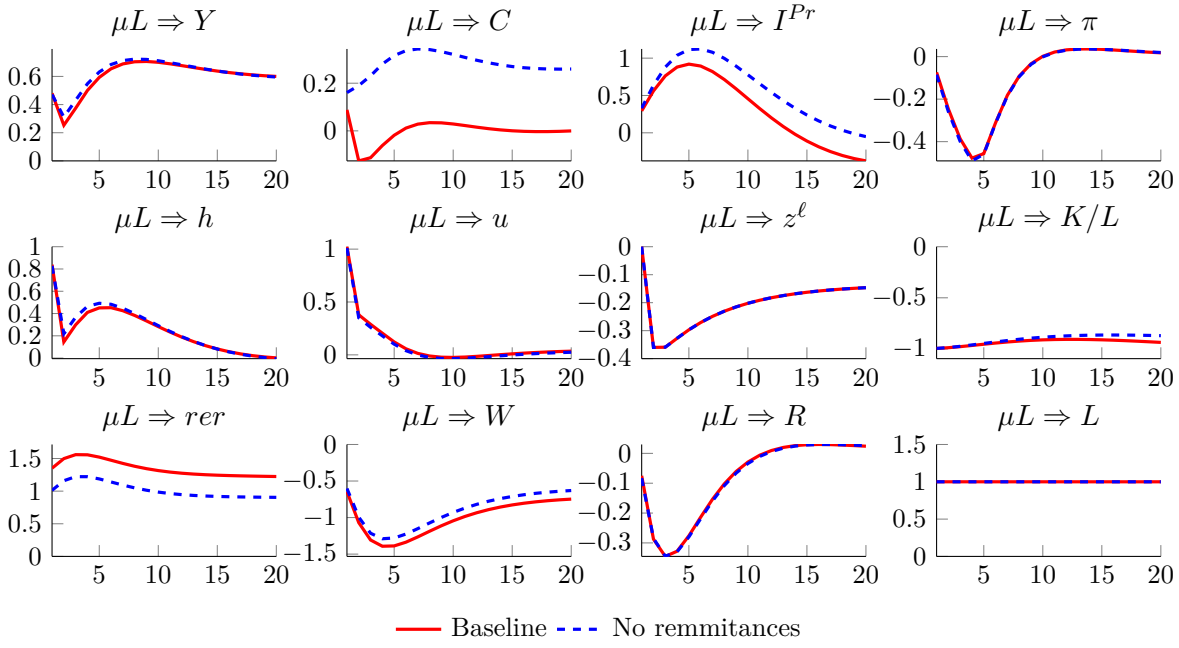
Notes.— Impulse responses to an immigration shock (μL) that permanently increases the size of the labor force L (equivalent to the population) by 1%. Solid red lines show responses under our baseline parameterization. Dashed blue lines show responses in a scenario in which immigrants and natives have the same preferences for labor supply, so immigrants do not obtain lower disutility from labor. The shaded area around the baseline specification shows its sensitivity to the magnitude of the parameter that governs the transitory loss of immigrants' social capital ($\delta^{M,\kappa}$). Horizontal axes show quarters. For a definition of the variables, see the note to figure 7.

Remittances. In our baseline specification, immigrants send a fraction of their income as remittances to their home countries. After an immigration shock, this feature produces ambiguous effects on inflation and the monetary policy rate. On one hand, remittances weaken the demand channel's inflationary pressures, since they lower newly arrived immigrants' disposable income. On the other hand, remittances are capital outflows that depreciate the exchange rate and, other things equal, put upward pressure on

This is because, as shown in equation (28), this variable is a weighted average of the productivity of natives and immigrants, where the weights are given by the share of immigrants in total hours worked ($N_t h_t$). Although the underlying labor productivity of immigrants and natives under homogeneous labor supply preferences is the same as in the baseline case, the weights change. In particular, since immigrants work fewer hours, their weight in average labor productivity declines, so the immigration shock induces a smaller decline in z^l.

inflation through its effect on the domestic-currency price of imported goods. Figure 10 shows in dashed blue lines the case in which immigrants do not send remittances, and compares it to the baseline simulation (solid red lines). Aggregate consumption expands substantially more than in the baseline simulation, since sending remittances reduces immigrants' disposable income. In the case of no remittances, the real exchange rate depreciates nearly 30% less than in the baseline simulation. Despite the substantial effect of remittances on aggregate consumption and the real exchange rate, the net effect of this feature on inflation is negligible, since, under our parameterization, both forces nearly cancel each other. It is worth mentioning that GDP is only slightly higher in the case of no remittances. This is because a relatively worsened trade balance, caused by the reduced depreciation, compensates the expansion in consumption.[42] With negligible differences in inflation and GDP, monetary policy is also unchanged with respect to the baseline case.

Figure 10: The Role of Remittances



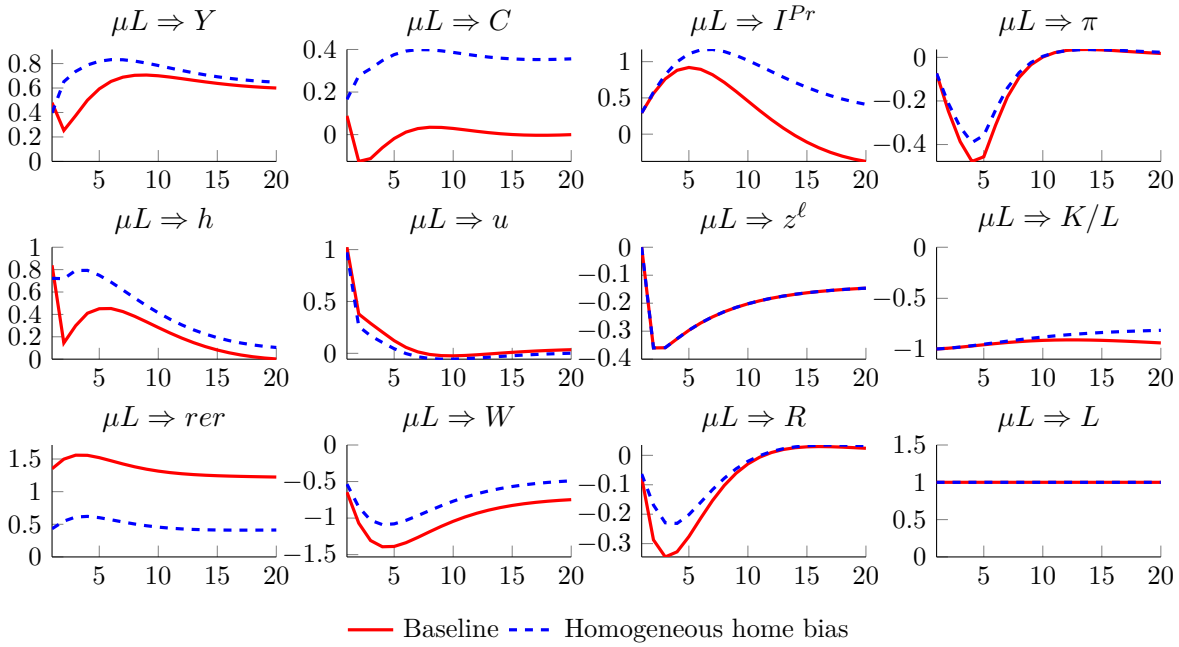
Notes.— Impulse responses to an immigration shock (μL) that permanently increases the size of the labor force L (equivalent to the population) by 1%. Solid red lines show responses under our baseline parameterization. Dashed blue lines show responses in a scenario in which immigrants do not send remittances to their home countries. Horizontal axes show quarters. For a definition of the variables, see the note to figure 7.

Consumption preferences. In our baseline results, immigrants' preferences are relatively more biased towards foreign goods. Figure 11 compares the baseline results with a case in which immigrants and natives have homogeneous consumption preferences (dashed blue lines). Heterogeneity in consumption preferences generates opposing forces on inflation. First, demand for domestic goods is lower than in the homogeneous case, which mitigates the demand channel's inflationary pressure. In the baseline case, a larger portion of the expansion in demand is diverted to foreign goods, which mitigates the expansion in labor demand and wages. This force contains consumption, wages, and ultimately inflation. The second

[42] Relatedly, in a study of 13 Latin American and Caribbean countries, Amuedo-Dorantes and Pozo (2004) find that the inflow of remittances can appreciate the exchange rate and worsen export competitiveness.

and opposing force acts through the real exchange rate. The higher preferences for foreign goods in the baseline case generate a depreciating force on the exchange rate. Note that exchange depreciation is more than two times larger than in the case of homogeneous consumption preferences. The additional exchange rate depreciation puts upward pressure on inflation through its effect on the domestic-currency price of imported goods. Under our calibration, however, the disinflationary force dominates slightly. In the baseline results, inflation is about 0.1pp lower than in the case of homogeneous consumption preferences.

Figure 11: The Role of Heterogeneous Consumption Preferences



Notes.— Impulse responses to an immigration shock (μL) that permanently increases the size of the labor force L (equivalent to the population) by 1%. Solid red lines show responses under our baseline parameterization. Dashed blue lines show responses in a scenario in which immigrants have the same consumption preferences as natives, i.e., do not exhibit more bias towards foreign goods. Horizontal axes show quarters. For a definition of the variables, see the note to figure 7.

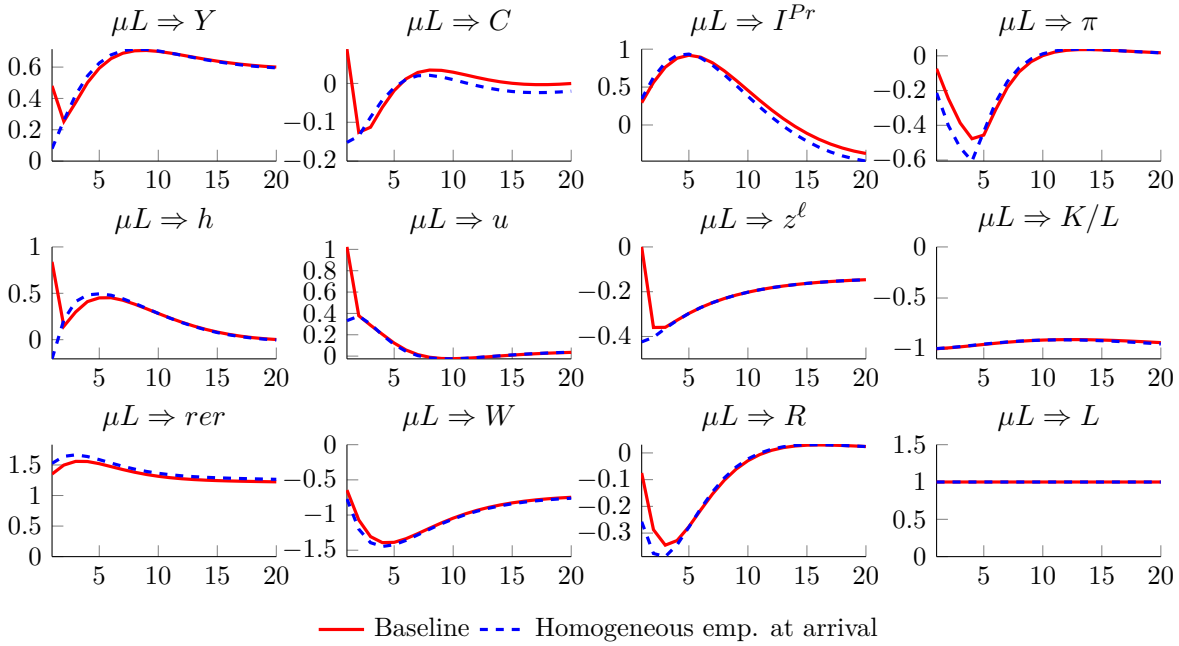
Employment status at arrival. In the baseline specification we assume that all immigrants arrive as unemployed workers that search for jobs, based on the evidence shown in section 3.3 that shows that recently arrived immigrants display substantially higher unemployment rates than both natives and immigrants that arrived some time ago. In Figure 12 we show the role of this assumption. Dashed blue lines show the effects of an immigration shock when the employment status of immigrants is identical to that of natives, i.e., the proportion of immigrants that arrive as unemployed searchers is equal to the economy's steady state unemployment rate, calibrated to 8%.[43] In this alternative case, most of the newly arrived immigrants work immediately, as if they had arrived with a contract.[44] When most immigrants need not go through the frictional search process upon arrival, employment expands more quickly, exacerbating the disinflationary effect of the labor supply channel. Consequently, inflation falls faster than in the baseline case, reaching a trough of 0.6pp below steady state, an additional -0.1pp with

[43]See García et al. (2019) for details on the calibration of the steady state unemployment rate.

[44]Notice that in this scenario, even if *at the beginning* of the period the unemployment rate is unaffected by the arrival of migrants, the endogenous separation mechanism described in section 4.2 still allows for changes in the unemployment rate *by the end* of the first period.

respect to the baseline case. In response to the lower inflation, the monetary policy rate is also lower than in the baseline case, reaching a trough of nearly 40 basis points below steady state.

Figure 12: The Role of Arrival Status



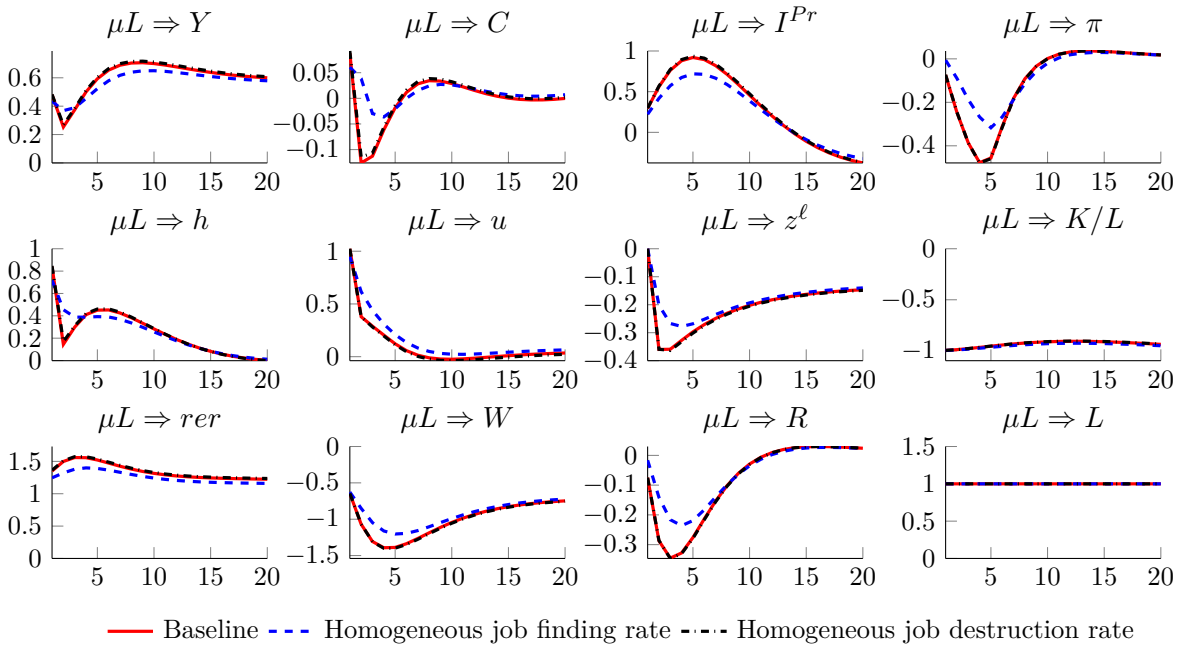
Notes.— Impulse responses to an immigration shock (μL) that permanently increases the size of the labor force L (equivalent to the population) by 1%. Solid red lines show responses under our baseline parameterization. Dashed blue lines show responses in a scenario in which immigrants' employment status upon arrival, i.e., the proportion that are employed and unemployed, is exactly the same as that of natives. Horizontal axes show quarters. For a definition of the variables, see the note to figure 7.

Job finding and destruction rates. The baseline simulation of an immigration shock considers that the long-run unemployment rate of immigrants is lower than that of natives, as shown in section 3.3 for the case of Chile. The international evidence on job flows of immigrants suggests that they may have higher job finding and job separation rates. We include these features in our baseline simulation, and calibrate parameter m^L, which governs the job finding probability of natives, to match the difference in the unemployment rate of immigrants and natives observed in the data. As previously mentioned, the literature finds that workers with higher mobility are more likely to find jobs, and that immigrants have higher mobility than natives, which motivates the introduction of higher job finding rates for immigrants.[45] We have also mentioned international evidence on higher separation rates for immigrants, which we also include in the model economy. Heterogeneity in job separation rates has negligible quantitative effects, so we focus our discussion on the role of heterogeneity in job finding rates. The dashed blue lines in figure 13 show responses to an immigration shock when immigrants and natives face the same job finding rates. In this case, inflation declines about 0.2pp less than in the baseline simulation. The higher job finding rate of immigrants, therefore, mitigates the inflationary force of the immigration shock. The reason is that, when immigrants are able to find jobs more quickly, the economy's aggregate supply can respond faster to the

[45] Basso et al. (2019) presents evidence of higher mobility of immigrants in the U.S. and the Euro area. Bentolila et al. (1990) shows a negative correlation between workers' mobility and equilibrium unemployment.

demand pressure induced by the arrival of immigrants. Since the higher job finding rate of immigrants mitigates inflationary pressure, the monetary policy rate is lower than in the case of homogeneous job finding rates.

Figure 13: The Role of Heterogeneous Job Finding Rates



Notes.— Impulse responses to an immigration shock (μL) that permanently increases the size of the labor force L (equivalent to the population) by 1%. Solid red lines show responses under our baseline parameterization. Dashed blue lines show responses in a scenario in which immigrants and natives face the same job finding rates, so the long-term unemployment rate is nearly the same for both groups. Horizontal axes show quarters. For a definition of the variables, see the note to figure 7.

6 Conclusion

An immigration shock can affect aggregate inflation through multiple channels that operate in both directions. The literature on this topic, and its implications for monetary policy, is however scarce. This paper contributes to the understanding of the aggregate effects of immigration using a general equilibrium model of a small open economy. We ground the analysis on motivating empirical evidence that points to immigration generating lower inflation. The labor supply channel, by which immigrants depress wages as they search for jobs and integrate to the labor market, is the main driver of the disinflationary effect of immigration. Differences in the characteristics and preferences of immigrants relative to natives are crucial for the way in which immigration affects the macroeconomy. We discipline the model with evidence on such differences for Chile, an emerging country that has experienced a substantial immigration shock in recent years. We consider that immigrants have lower human capital than natives due to the lower education quality in their home countries, that they send a fraction of their income as remittances, and that their consumption preferences are relatively more biased toward foreign goods, among other issues.

In future work, studying the optimal design of monetary policy in the presence of immigration shocks would be valuable. Our framework is well-suited for this task, as it incorporates several dimensions of heterogeneity between natives and immigrants and is flexible enough to accommodate different assump-

tions regarding the idiosyncratic characteristics of arriving migrants. Optimal policy would then take into account the many frictions associated with the integration of immigrants to the local economy.

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