

NBER WORKING PAPER SERIES

REMOTE WORK, FOREIGN RESIDENTS, AND THE FUTURE OF GLOBAL CITIES

Joao Guerreiro  
Sergio Rebelo  
Pedro Teles

Working Paper 31402  
<http://www.nber.org/papers/w31402>

NATIONAL BUREAU OF ECONOMIC RESEARCH  
1050 Massachusetts Avenue  
Cambridge, MA 02138  
June 2023

We thank Marios Angeletos and Paul Beaudry for their comments. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

At least one co-author has disclosed additional relationships of potential relevance for this research. Further information is available online at <http://www.nber.org/papers/w31402>

NBER working papers are circulated for discussion and comment purposes. They have not been peer-reviewed or been subject to the review by the NBER Board of Directors that accompanies official NBER publications.

© 2023 by Joao Guerreiro, Sergio Rebelo, and Pedro Teles. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

Remote Work, Foreign Residents, and the Future of Global Cities  
Joao Guerreiro, Sergio Rebelo, and Pedro Teles  
NBER Working Paper No. 31402  
June 2023  
JEL No. H00,J61,R3,R58

**ABSTRACT**

As remote work opportunities expand, more people are seeking residence in foreign destinations. The resulting surge in foreign residents generates capital gains for property owners but negatively impacts renters and creates potentially important production, congestion, and amenities externalities. We study the optimal policy toward foreign residents in a model with key features emphasized in policy discussions. Using this model, we provide sufficient statistics to evaluate the impact of an influx of foreign residents and to calculate the tax/transfer policies required to implement the optimal policy. This policy involves implementing transfers to internalize agglomeration, congestion, and other potential externalities. Importantly, we find that it is not optimal to restrict, tax, or subsidize home purchases by foreign residents.

Joao Guerreiro  
Department of Economics  
Northwestern University  
Evanston, IL 60208  
jguerreiro@u.northwestern.edu

Sergio Rebelo  
Northwestern University  
Kellogg School of Management  
Department of Finance  
Leverone Hall  
Evanston, IL 60208-2001  
and CEPR  
and also NBER  
s-rebelo@northwestern.edu

Pedro Teles  
Banco de Portugal  
R. Francisco Ribeiro 2  
1150 Lisboa  
Portugal  
and Univ Catolica Portuguesa and CEPR  
pteles@ucp.pt

# 1 Introduction

In 1917, the American composer Cole Porter moved to Paris and acquired an opulent residence built in 1777 for the brother of Louis XIV. There, he hosted luminaries like F. Scott Fitzgerald and Ernest Hemmingway and composed memorable tunes like “Night and Day” and “Anything Goes.”

Buying a home in a foreign country was unusual at the beginning of the 20th century but has become increasingly common in recent decades. As remote work opportunities expand (Dingel and Neiman, 2020 and Aksoy, Barrero, Bloom, Davis, Dolls, and Zarate, 2022), many more people are seeking residence in foreign destinations.<sup>1</sup>

The surge in the flow of foreign residents has transformed housing markets in many cities across the globe. These flows generate capital gains for property and land owners but negatively impact renters and create potentially important production, congestion, and amenities externalities.

Many countries have grappled with the question of how to deal with potentially large numbers of foreign residents. The policies adopted so far vary widely, ranging from laissez-faire approaches and incentive programs designed to attract foreign home buyers to special taxes and regulations designed to restrict home purchases by foreigners.<sup>2</sup>

Determining the optimal policy regarding foreign residents is important for three reasons. First, housing is the primary asset in most household portfolios (Cocco,

---

<sup>1</sup>At the same time, higher incomes and reduced air travel costs have greatly increased international tourism flows. According to data compiled by the United Nations World Tourism Organization, international tourist arrivals have grown at an average annual rate of 5.9 percent between 1950 and 2018.

<sup>2</sup>France and the United States impose no restrictions on foreign home buyers. Greece, Portugal, and Spain offer tax breaks and visa programs to attract foreign buyers. Australia, some Canadian provinces, Hong Kong, Israel, and Singapore levy special taxes on foreign property purchases. The city of Vancouver has imposed taxes on unoccupied homes. Switzerland enforces annual quotas on foreign home sales, and New Zealand has strict foreign real estate investment limitations. The Philippines and Thailand permit foreign home ownership but prohibit land ownership.

2005). Second, the availability of affordable housing near the workplace influences commuting times and job choices in ways that can significantly affect worker welfare. Third, most economic activity occurs in cities (Rossi-Hansberg and Wright (2007)).

We study the optimal policy toward foreign residents using a model that incorporates key factors emphasized in informal policy discussions. We find that it is optimal to use transfers to internalize externalities. However, it is not optimal to impose restrictions or taxes on home purchases by foreigners. Likewise, it is not optimal to implement programs that subsidize home purchases by foreign residents. We provide a set of sufficient statistics to evaluate the impact of an influx of foreign residents and to calculate the tax/transfer policies required to implement the optimal solution.

The model has two locations: the center area and the periphery. Each location has a stock of housing and offices that is fixed in the short run. Foreign residents prefer to live in the center and have an outside option: they can always stay in their home country.

Locals can live and work in different locations by incurring commuting costs. Taste shocks, location-specific amenities, and commuting times influence home and work location choices by the locals. In our benchmark model, we assume that the ownership of houses and office buildings is equally distributed in the population. We revisit this assumption in Section 6, where we consider a model in which property ownership is unequally distributed.

We begin by examining the competitive equilibrium and analyzing the impact of a marginal increase in the number of foreign residents on social welfare. We identify two effects of this increase. The first relates to the agglomeration or production externality emphasized by Jacobs (1969), Lucas (1988), Lucas (2001), and Lucas and Rossi-Hansberg (2002). This effect can be negative if the arrival of foreigners leads to the relocation of locals from high- to low-productivity locations. The second effect

pertains to the housing capital gains that accrue to the locals. We call this effect the foreign resident surplus, and it is always positive.

Next, we study the policy toward foreign residents that maximizes the social welfare of the local population. We assume that the planner operates within a Mirrleesian environment. In this environment, the planner faces an information constraint: it cannot observe taste shocks that influence the choice of where the locals choose to live and work. We characterize this second-best optimum.

We expand our model to incorporate three additional effects discussed in policy circles. First, we introduce congestion externalities by assuming that the cost of commuting increases with the number of commuters. In this case, the optimal policy requires three types of transfers to internalize the agglomeration externality, the congestion externality, and their interaction. This interaction arises because increased commuting time results in decreased agglomeration externalities.

Second, we consider the scenario where foreigners have a negative impact on the value that locals attach to amenities in the city center. It is optimal to correct these externalities by imposing a lump-sum tax on foreigners, similar to the per diem or per night tax levied by an increasing number of cities.

Third, we explore the case where foreigners place value on authenticity, deriving utility from having locals live and work in the city center. At first sight, we might think that this effect does not affect the social optimum. After all, the planner does not include the utility of foreigners in the social welfare function. However, it is optimal to internalize this externality by providing transfers to locals who live and work in the city center. The rationale for this policy is that the externality affects the participation constraint of foreigners and influences their decision to relocate.

Our model provides some insights into the implications of an inflow of foreign residents for optimal long-run city design. By the long run, we mean a timeframe where offices can be converted into houses and vice versa in both the city center and the periphery. In our model, it is optimal to convert offices into houses in the city

center to meet the increased demand for housing. However, the optimal solution for the periphery is ambiguous. On the one hand, more locals reside in the periphery, raising the marginal value of houses in that area. On the other hand, more people work in the periphery, increasing the value of offices.

Finally, we consider two important extensions of our model. In the first extension, property ownership is unequally distributed. In this situation, once externalities are corrected, it is feasible to implement transfers to redistribute the capital gains so that ex-ante (before taste shocks are realized) all locals benefit from the influx of foreigners. In the second extension, the local labor force can choose to work in the office or remotely. In this case, the optimal policy entails higher transfers for office workers compared to those working from home.

The structure of the paper is as follows. Section 2 introduces the model, characterizes the competitive equilibrium, and assesses the impact of a marginal increase in the number of foreign residents on social welfare. Section 3 outlines the optimal second-best policy. In Section 4, we explore three additional factors: traffic congestion, amenity effects, and the possibility of foreign residents valuing authenticity. Section 5 discusses how the influx of foreign residents affects long-run city design. Section 6 examines a variant of the model that incorporates unequal property holdings. Section 7 considers an economy where the local population can choose between working in an office or remotely. Section 8 concludes.

## 2 Competitive equilibrium

There are two locations in the model: the center and the periphery. Both locations produce a single tradable good by combining labor and a type of capital that we refer to as office buildings.

The index  $\ell$  takes the value  $c$  or  $p$  depending on whether a person chooses to live in the center or the periphery. Similarly, the index  $j$  takes the value  $c$  or  $p$  depending

on whether a person chooses to work in the center or the periphery.

Each local person  $i$  draws a taste shock,  $\zeta_{i,\ell,j}$ , with respect to living in location  $\ell$  and working in location  $j$ . Following [McFadden \(1973\)](#), we assume that this shock is governed by a Gumbel  $(0, \eta^{-1})$  distribution.<sup>3</sup> These shocks eliminate corner solutions with respect to location choices and make the analysis tractable because the maximum of  $n$  i.i.d. Gumbel variables follows a Gumbel distribution.

Locals who live in location  $\ell$  and work in location  $j$  derive utility from housing services ( $h_{\ell,j}$ ) and from consuming a single tradable good ( $c_{\ell,j}$ ). They supply exogenously one unit of labor, which they allocate to working and commuting.

In this version of the model, local people have an equal endowment of houses and office buildings. We relax this assumption in [Section 6](#).

**Location choices** The utility that local person  $i$  derives from living in location  $\ell$  and working in location  $j$  has two components:

$$\zeta_{i,\ell,j} + u_{\ell,j}.$$

The first is the taste shock,  $\zeta_{i,\ell,j}$ . The second is given by

$$u_{\ell,j} = \bar{u}_\ell + c_{\ell,j} + v(h_{\ell,j}).$$

We refer to  $u_{\ell,j}$  as "common utility" because it is common to all who live in location  $\ell$  and work in location  $j$ . The variable  $c_{\ell,j}$  denotes consumption,  $h_{\ell,j}$  housing services, and  $\bar{u}_\ell$  the utility that locals derive from the amenities in location  $\ell$ .

Person  $i$  maximizes utility subject to the budget constraint

$$c_{\ell,j} + r_\ell h_{\ell,j} = w_j (1 - t_{\ell,j}) + T.$$

The variable  $t_{\ell,j}$  denotes the time it takes to commute from a home in location  $\ell$  to work at an office in location  $j$ . For those who live and work in the same location,

---

<sup>3</sup>The mean of this distribution is not zero, but this value does not influence the comparative evaluations individuals make between different locations.

commuting costs are zero ( $t_{\ell,\ell} = 0$ ). The variable  $r_\ell$  denotes the cost of renting a unit of housing in location  $\ell$  and  $T$  denotes the housing and office rents, which are given by

$$T = \sum_{\ell} r_{\ell} \bar{H}_{\ell} + \sum_{\ell} r_{\ell}^K \bar{K}_{\ell}.$$

The variable  $r_{\ell}^K$  denotes the rental rate of office buildings in location  $\ell$ . In Section 6, we consider a version of the model in which people are heterogeneous with respect to their ownership of offices and houses.

The first-order conditions for this problem are

$$v'(h_{\ell,j}) = r_{\ell},$$

$$c_{\ell,j} = w_j (1 - t_{\ell,j}) + T - r_{\ell} h_{\ell,j}.$$

Note that all locals living in locatio  $\ell$  have the same housing consumption, i.e.,  $h_{\ell,j} = h_{\ell}$  for all  $j$ . The resulting common utility is

$$u_{\ell,j} = \bar{u}_{\ell} + w_j (1 - t_{\ell,j}) + T - r_{\ell} h_{\ell,j} + v(h_{\ell,j}).$$

A person lives in  $\ell$  and works in  $j$  if

$$u_{\ell,j} + \xi_{i,\ell,j} = \max_{\ell',j'} \{u_{\ell',j'} + \xi_{i,\ell',j'}\}.$$

The share of people who live in  $\ell$  and work in  $j$  is

$$\pi_{\ell,j} = \mathbb{P} \left[ u_{\ell,j} + \xi_{\ell,j} = \max_{\ell',j'} \{u_{\ell',j'} + \xi_{\ell',j'}\} \right] = \mathbb{P} \left[ x_{\ell,j} \geq x_{\ell',j'} \forall \{\ell',j'\} \right],$$

where  $x_{\ell,j} = u_{\ell,j} + \xi_{i,\ell,j}$  for  $\ell, j = c, p$ . The cdf of  $x_{\ell,j}$ , is

$$G_{\ell,j}(x) = \mathbb{P} [x_{\ell,j} < x] = \mathbb{P} [\xi_{\ell,j} < x - u_{\ell,j}] = F(x - u_{\ell,j}) = e^{-e^{-\eta(x - u_{\ell,j})}}.$$

The corresponding pdf is

$$g_{\ell,j}(x) = \eta e^{-\eta(x - u_{\ell,j})} e^{-e^{-\eta(x - u_{\ell,j})}}$$



The share of local people living in  $\ell$  and working in  $j$  is given by

$$\pi_{\ell,j} = \int_{-\infty}^{\infty} g_{\ell,j}(x) \prod_{\{\ell',j'\} \neq \{\ell,j\}} G_{\ell',j'}(x) dx$$

Here,  $g_{\ell,j}(x)$  denotes the mass of people with valuation  $x$  for the pair of location choices  $(\ell, j)$  and  $G_{\ell',j'}(x)$  is the fraction of people with valuations lower than  $x$  for  $(\ell', j')$ . This expression can be rewritten as:

$$\pi_{\ell,j} = \frac{e^{\eta u_{\ell,j}}}{\sum_{\ell',j'} e^{\eta u_{\ell',j'}}$$

**Foreign residents** To simplify, we assume that foreign residents are not subject to taste shocks and prefer to live in the city center. Their problem is to choose consumption ( $c_f$ ) and housing in the center ( $h_f$ ) so as to maximize their utility,

$$\bar{u}_f + c_f + v(h_f),$$

where  $\bar{u}_f$  is the value attached by foreign residents to the amenities in the center. Foreigners bring a fixed endowment of the tradable good ( $y_f$ ) that they use to pay for consumption, housing services, and any potential taxes. We assume that these taxes are zero in the competitive equilibrium. The foreign residents' budget constraint is:

$$c_f + r_c h_f = y_f.$$

The first-order conditions for this problem are

$$v'(h_f) = r_c,$$

$$c_f = y_f - r_c h_f.$$

These conditions imply that foreign residents choose the same housing consumption as locals who live in the center.

Foreigners can stay in their own country and receive utility  $u_f^*$ . They only migrate if their participation constraint is satisfied:

$$\bar{u}_f + c_f + v(h_f) \geq u_f^*.$$

**Firms' problem** Each location has a measure one of identical firms. Firms in location  $j$  produce output ( $y_j$ ) by combining offices ( $k_j$ ) and labor ( $l_j$ ) according to a Cobb-Douglas production function:

$$y_j = A(L_j) k_j^\alpha l_j^{1-\alpha}.$$

The function  $A(L_j)$  represents an agglomeration or production externality. Locations with more workers tend to be more productive because there are more opportunities for workers to learn from each other. We assume that the function  $A(L_j)$  takes the form:

$$A(L_j) = L_j^\gamma$$

The problem of a representative firm in location  $j$  is to maximize its profits ( $\pi_j$ ):

$$\pi_j = A(L_j) k_j^\alpha l_j^{1-\alpha} - w_j l_j - r_j^K k_j.$$

The first-order condition for the firms' problem are:

$$w_j = (1 - \alpha) A(L_j) \left( \frac{k_j}{l_j} \right)^\alpha,$$

$$r_j^K = \alpha A(L_j) \left( \frac{k_j}{l_j} \right)^{\alpha-1}.$$

**Equilibrium conditions** The goods market clearing condition is:

$$\sum_{\ell,j} \pi_{\ell,j} c_{\ell,j} + N_f c_f = \sum_j A(L_j) L_j^{1-\alpha} \bar{K}_j^\alpha + N_f y_f.$$

On the right-hand side of this equation we have the sum of the locals' consumption across all living and working locations ( $\sum_{\ell,j} \pi_{\ell,j} c_{\ell,j}$ ) and the total consumption by foreign residents,  $N_f c_f$ , where  $N_f$  denotes the total amount of foreign residents. On the left-hand side we have the production in the center and periphery ( $\sum_j A(L_j) L_j^{1-\alpha} \bar{K}_j^\alpha$ ) and the endowment of goods brought by the foreigners  $N_f y_f$ .

The labor market clearing condition is

$$l_j = L_j,$$

where  $L_j$ , the amount of labor available in location  $j$ . This variable is equal to the time supplied by all the people who work at location  $j$  net of commuting costs

$$L_j = \sum_{\ell} \pi_{\ell,j} (1 - t_{\ell,j}).$$

The market clearing condition for office buildings in location  $j$  is

$$k_j = \bar{K}_j.$$

Finally, the housing market clearing conditions for the center and the periphery are

$$(\pi_{c,c} + \pi_{c,p})h_c + N_f h_f = \bar{H}_c,$$

$$(\pi_{p,c} + \pi_{p,p})h_p = \bar{H}_p.$$

**The welfare impact of a marginal increase in the number of foreign residents** We define social welfare as the sum of the utility of all local people.

$$\mathcal{W} = \int_0^1 \max \{u_{\ell,j} + \xi_{i,\ell,j}\} di$$

In the appendix, we show that social welfare is given by:

$$\mathcal{W} = \frac{\log \left( \sum_{\ell,j} e^{\eta u_{\ell,j}} \right)}{\eta} + \frac{1}{\eta} \int_0^{\infty} [-\log(y) e^{-y}] dy,$$

where  $\int_0^{\infty} [-\log(y) e^{-y}] dy$  is the Euler-Mascheroni constant.

We assume that the foreign residents' participation constraint is satisfied:

$$\bar{u}_f + c_f + v(h_f) \geq u_f^*,$$

and that the function  $v(h)$  takes the form

$$v(h) = \chi h^{1-\sigma} / (1 - \sigma).$$

The following proposition provides sufficient statistics to evaluate the impact of an influx of foreign residents on social welfare.

**Proposition 1.** *The change in social welfare from a marginal increase in the number of foreign residents is*

$$d\mathcal{W} = \sum_{\ell,j} \pi_{\ell,j} du_{\ell,j}.$$

This welfare change has two components,  $d\mathcal{W} = \mathcal{PE} + \mathcal{FS}$ . The production or agglomeration externality,  $\mathcal{PE}$ , is given by

$$\mathcal{PE} \equiv \frac{\gamma}{1-\alpha} \cdot \mathbf{COV} \left( w_j (1 - t_{\ell,j}), \frac{d\pi_{\ell,j}}{\pi_{\ell,j}} \right),$$

with

$$\mathbf{COV} \left( w_j (1 - t_{\ell,j}), \frac{d\pi_{\ell,j}}{\pi_{\ell,j}} \right) = \sum_{\ell} \sum_j \pi_{\ell,j} w_j (1 - t_{\ell,j}) d\pi_{\ell,j} / \pi_{\ell,j}.$$

The foreign residents surplus,  $\mathcal{FS}$ , is given by

$$\mathcal{FS} \equiv \sigma \frac{N_f}{\pi_c + N_f} r c h_f (d\Pi_c + dN_f).$$

where  $\Pi_c \equiv \pi_{c,c} + \pi_{c,p}$

See appendix [A.3](#) for the proof.

The interpretation of the production or agglomeration externality,  $\mathcal{PE}$ , is as follows. If, on average, people leave higher productivity locations,  $\mathbf{COV}$  is negative, and there is a welfare loss. Three pertinent comments about this component of the change in welfare are as follows. If foreigners choose the same distribution of locations as locals and  $\sigma = 1$ , then  $d\pi_{j,\ell} = 0$  and  $\mathbf{COV} = 0$ . So there is no welfare loss from the production externality. Second, the production externalities would be more

important in a model with multiple peripheries because workers who move from the center would scatter across different peripheries. Third, the ability of locals to work from home reduces production externalities. We discuss the issue of working from home in Section 7.

The foreign resident surplus is equal to the capital gains realized on the houses sold to foreigners. Foreigners replace some of the locals who live in the center ( $d\Pi_c < 0, dN_f > 0$ ). In addition, people in the center reduce housing consumption, making space for additional foreign residents. As a result, the number of people who live in the center increases ( $d\Pi_c + dN_f > 0$ ). Since everybody who lives in the center consumes the same amount of housing, per capita housing consumption falls. Rents rise, resulting in an increase in rental income obtained from foreigners. This effect is the foreign resident surplus.

The foreign resident surplus is similar to the immigration surplus discussed in the immigration literature (e.g., [Borjas, 1995](#) and [Guerreiro, Rebelo, and Teles, 2020](#)). This surplus is the net benefit of immigration that results from increases in income to non-labor factors such as land.

### 3 Optimal policy

It is natural to assume that the planner does not observe taste shocks but has information about individuals' residential and work locations. We compute a second-best optimal solution in which the planner can only choose utilities and allocations that are contingent on location choices.

Our analysis of the impact of foreign residents on the competitive equilibrium suggests two questions. First, when the foreign resident surplus is lower than the production externality, is it optimal to restrict home purchases by foreigners? Second, when  $\text{COW} < 0$ , is it optimal to tax home purchases by foreigners to internalize the production externality? We will show that the answer to both of these questions

is no.

Location decisions must be privately optimal given the allocations chosen by the planner. In other words, incentive compatibility requires that two local people who live in the same location and work in the same location have the same common utility,  $u_{\ell,j}$ . It follows that person  $i$  chooses to live in location  $\ell$  and work in location  $j$  if

$$u_{\ell,j} + \xi_{i,\ell,j} = \max\{u_{\ell',j'} + \xi_{i,\ell',j'}\}.$$

We can show that the incentive compatibility constraints imply that

$$\pi_{\ell,j} = \frac{e^{\eta u_{\ell,j}}}{\sum_{\ell',j'} e^{\eta u_{\ell',j'}}}.$$

The planner maximizes

$$\mathcal{W} = \frac{\log\left(\sum_{\ell,j} e^{\eta u_{\ell,j}}\right)}{\eta}$$

subject to the resource constraints for goods,

$$\sum_{\ell,j} \pi_{\ell,j} c_{\ell,j} + N_f c_f \leq \sum_j A(L_j) L_j^{+1-\alpha} \bar{K}_j^\alpha + N_f y_f,$$

the adding-up constraints for housing in the center and in the periphery,

$$\sum_j \pi_{c,j} h_{c,j} + N_f h_f \leq \bar{H}_c,$$

$$\sum_j \pi_{p,j} h_{p,j} \leq \bar{H}_p,$$

the location-decisions constraints,

$$\pi_{\ell,j} = \frac{e^{\eta u_{\ell,j}}}{\sum_{\ell',j'} e^{\eta u_{\ell',j'}}$$

and the foreign resident participation constraints,

$$\bar{u}_f + c_f + v(h_f) \geq u_f^*.$$

We write the Lagrangean for this optimization problem as follows,

$$\begin{aligned}
\mathcal{L} = & \frac{\log \left( \sum_{\ell,j} e^{\eta u_{\ell,j}} \right)}{\eta} \\
& + \lambda_c \left( L_c^{\gamma+1-\alpha} \bar{K}_c^\alpha + N_f (y_f - c_f) + L_p^{\gamma+1-\alpha} \bar{K}_p^\alpha - \sum_{\ell,j} \pi_{\ell,j} c_{\ell,j} \right) \\
& + \lambda_{h,c} \left( \bar{H}_c - \sum_j \pi_{c,j} h_{c,j} - N_f h_f \right) + \lambda_{h,p} \left( \bar{H}_p - \sum_j \pi_{p,j} h_{p,j} \right) \\
& + \sum_{\ell,j} \lambda_{\ell,j}^{\text{loc}} \left( \pi_{\ell,j} - \frac{e^{\eta u_{\ell,j}}}{\sum_{\ell',j'} e^{\eta u_{\ell',j'}}} \right) \\
& + N_f \lambda_f \left( \bar{u}_f + c_f + v(h_f) - u_f^* \right)
\end{aligned}$$

The first-order conditions for this problem can be written as

$$\begin{aligned}
1 - \eta \lambda_{\ell,j}^{\text{loc}} + \eta \sum_{\ell',j'} \lambda_{\ell',j'}^{\text{loc}} \pi_{\ell',j'} &= \lambda_c \\
v'(h_{\ell,j}) \left( 1 - \eta \lambda_{\ell,j}^{\text{loc}} + \eta \sum_{\ell',j'} \lambda_{\ell',j'}^{\text{loc}} \pi_{\ell',j'} \right) &= \lambda_{h,\ell} \\
\lambda_f &= \lambda_c \\
\lambda_f v'(h_f) &= \lambda_{h,c} \\
\lambda_c (y_f - c_f) - \lambda_{h,c} h_f &= 0 \\
\lambda_c \left\{ (1 + \gamma - \alpha) \frac{Y_j}{L_j} (1 - t_{\ell,j}) - c_{\ell,j} \right\} - \lambda_{h,\ell} h_{\ell,j} &= \lambda_{\ell,j}^{\text{loc}}
\end{aligned}$$

Combining the first-order conditions for  $c_{\ell,j}$  we find  $\lambda_c = 1$ . Because utility is quasi-linear, the social marginal value of consumption goods is equal to one.

In addition,

$$\lambda_{c,c}^{\text{loc}} = \lambda_{c,p}^{\text{loc}} = \lambda_{p,c}^{\text{loc}} = \lambda_{p,p}^{\text{loc}}.$$

The planner equalizes the marginal value of people across all locations.

With quasi-linear preferences, welfare is independent of the distribution of consumption. Only aggregate consumption matters. The planner can engineer any distribution of consumption to provide incentives without affecting aggregate consumption. Second-best aggregates coincide with first-best ones, and social welfare is the same in the two solutions.

The following proposition provides sufficient statistics to calculate the tax/transfer policies required to implement the optimal solution.

**Proposition 2.** *The optimal solution has three key features. First, foreigners pay no taxes. Second, absent externalities, rents on houses and offices are equally distributed among locals. Third, the planner corrects the production externality by giving transfers to pairs  $(\ell, j)$  with labor income  $w_j (1 - t_{\ell,j})$  higher than average labor income  $\sum_{\ell,j} \pi_{\ell,j} \times w_j (1 - t_{\ell,j})$ . The total transfers implemented by the planner are:*

$$T_{\ell,j} = \underbrace{\alpha \sum_j Y_j + \sum_{\ell} r_{\ell} \bar{H}_{\ell}}_{\text{Rents on houses and offices}} + \underbrace{\frac{\gamma}{1 - \alpha} \left\{ w_j (1 - t_{\ell,j}) - \sum_{\ell,j} \pi_{\ell,j} \times w_j (1 - t_{\ell,j}) \right\}}_{\text{Externality correction}}.$$

To see that it is not optimal to tax home purchases by foreign residents, consider the first-order condition for  $N_f$

$$\lambda_c (y_f - c_f) = \lambda_{h,c} h_f$$

The term  $\lambda_c (y_f - c_f)$  represents the benefit of the goods paid by foreign residents. The term  $\lambda_{h,c} h_f$  represents the cost of providing homes to foreigners. This equation can be rewritten as:

$$y_f = c_f + \frac{\lambda_{h,c}}{\lambda_c} h_f.$$

Since

$$v'(h_f) = \frac{\lambda_{h,c}}{\lambda_c} = r_c.$$



There are no taxes in the foreign resident's budget constraint,

$$y_f = c_f + r_c h_f.$$

This result continues to hold when preferences are not quasi-linear.

## 4 Congestion, amenity, and authenticity effects

In this section, we add three additional effects that are often mentioned in policy discussions: traffic congestion, negative externalities exerted by foreign residents on the value that the locals place on amenities, and the possibility that foreign residents derive utility from authenticity effects created by the presence of the locals.

**Congestion effects** Suppose that commuting time is an increasing function of the number of commuters:

$$t_{\ell,j} = \mathcal{T}_{\ell,j}(\pi_{\ell,j}),$$

with  $\mathcal{T}_{\ell,\ell}(\pi_{\ell,\ell}) = 0$ .

Assume that

$$\frac{\mathcal{T}'_{\ell,j}(\pi_{\ell,j}) \pi_{\ell,j}}{\mathcal{T}_{\ell,j}(\pi_{\ell,j})} = \psi.$$

Consider the effect on social welfare of a marginal increase in the number of foreign residents:

$$d\mathcal{W} = \mathcal{F}\mathcal{S} + \mathcal{P}\mathcal{E} + \mathcal{C}\mathcal{E} + \mathcal{P}\mathcal{C}\mathcal{E}.$$

The first two effects, the production externality and the foreign resident surplus, are the same as before. In addition, there are two new effects. The first is the commuting externality

$$\mathcal{C}\mathcal{E} \equiv -\psi \cdot \text{COV} \left( w_j t_{\ell,j}, \frac{d\pi_{\ell,j}}{\pi_{\ell,j}} \right).$$

The second is the interaction between the production and congestion externalities,

$$\mathcal{PCE} \equiv -\frac{\gamma}{1-\alpha} \cdot \psi \cdot \text{COV} \left( w_j t_{\ell,j}, \frac{d\pi_{\ell,j}}{\pi_{\ell,j}} \right).$$

This interaction arises because the more time people spend commuting, the weaker is the agglomeration/production externality. The transfers that the planner needs to make to implement the second-best optimal solution are given by

$$\begin{aligned} T_{\ell,j} = & \underbrace{\sum_j \alpha Y_j + \sum_\ell r_\ell \bar{H}_\ell}_{\text{Rents on houses and offices}} + \frac{\gamma}{1-\alpha} \underbrace{\left\{ w_j (1-t_{\ell,j}) - \sum_{\ell,j} \pi_{\ell,j} \times w_j (1-t_{\ell,j}) \right\}}_{\text{Production externality correction}} \\ & - \underbrace{\psi \left\{ w_j t_{\ell,j} - \sum \pi_{\ell,j} w_j t_{\ell,j} \right\}}_{\text{Congestion externality correction}} - \underbrace{\frac{\gamma}{1-\alpha} \psi \left\{ w_j t_{\ell,j} - \sum \pi_{\ell,j} w_j t_{\ell,j} \right\}}_{\text{Externality complementarity correction}} \end{aligned}$$

**Amenity effects** There is a growing literature on the impact of changes in resident composition on amenities. Important contributions include [Guerrieri, Hartley, and Hurst \(2013\)](#), [Diamond \(2016\)](#), and [Almagro and Dominguez-lino \(2022\)](#).

To study these effects in our model, suppose that foreign residents affect the value attributed by locals to amenities in the city center:

$$\bar{u}_c = \mathcal{U}(N_f).$$

Assume that

$$\frac{\mathcal{U}'(N_f) N_f}{\mathcal{U}(N_f)} = -\phi_{\bar{u}}.$$

The impact of a marginal increase in the number of foreign residents is the same as before plus an additional effect ( $\mathcal{AE}$ ) which results from the amenity externalities. Same effects as before plus an additional effect

$$dW = \mathcal{FS} + \mathcal{PE} + \mathcal{CE} + \mathcal{PCE} + \mathcal{AE}.$$

The new term  $\mathcal{AE}$  is given by

$$\mathcal{AE} \equiv -\phi_{\bar{u}} \Pi_c \bar{u}_c \frac{dN_f}{N_f}.$$

To examine the optimal taxation of foreign residents, consider the first-order condition for  $N_f$

$$\underbrace{\lambda_c (y_f - c_f)}_{\text{Benefit of goods paid by foreigners}} = \underbrace{\lambda_{h,c} h_f + \phi_{\bar{u}} \frac{\Pi_c}{N_f} \bar{u}_c}_{\text{Cost of providing homes to foreigners}}$$

This condition can be rewritten as

$$y_f = c_f + \lambda_{h,c} h_f + \phi_{\bar{u}} \frac{\Pi_c}{N_f} \bar{u}_c.$$

This equation implies that it is not optimal to tax house purchases by foreigners:  $v'(h_f) = \lambda_{h,c} = r_c$ . However, it is optimal to charge foreigners a lump-sum tax that corrects the amenity externality

$$T_f = \phi_{\bar{u}} \frac{\Pi_c}{N_f} \bar{u}_c.$$

**Authenticity effects** Finally, suppose that foreign residents derive utility from authenticity and that this authenticity is fostered by having more locals live and work in the city center. In this case, we can write the foreign resident utility as

$$\bar{u}_f (\pi_{c,c}, \pi_{c,p}, \pi_{p,c}) + c_f + v(h_f).$$

The welfare consequences in the competitive equilibrium are the same as in the previous case. However, in the second-best optimum, the planner has a new reason to subsidize living/working in the city center.

The following proposition provides sufficient statistics to implement the optimal transfers.

**Proposition 3.** *In a model with congestion, amenity, and authenticity effects the optimal transfers are given by:*

$$\begin{aligned}
T_{\ell,j} = & \underbrace{\sum_j \alpha Y_j + \sum_\ell r_\ell \bar{H}_\ell}_{\text{Rents on houses and offices}} + \underbrace{\frac{\gamma}{1-\alpha} \left\{ w_j (1 - t_{\ell,j}) - \sum_{\ell,j} \pi_{\ell,j} \times w_j (1 - t_{\ell,j}) \right\}}_{\text{Production externality correction}} \\
& - \underbrace{\psi \left\{ w_j t_{\ell,j} - \sum_{\ell,j} \pi_{\ell,j} w_j t_{\ell,j} \right\}}_{\text{Congestion externality correction}} - \underbrace{\frac{\gamma}{1-\alpha} \psi \left\{ w_j t_{\ell,j} - \sum_{\ell,j} \pi_{\ell,j} w_j t_{\ell,j} \right\}}_{\text{Externality complementarity correction}} \\
& + N_f \underbrace{\left\{ \frac{\partial \bar{u}_f}{\partial \pi_{\ell,j}} - \sum_{\ell,j} \pi_{\ell,j} \frac{\partial \bar{u}_f}{\partial \pi_{\ell,j}} \right\}}_{\text{Foreign-resident externality correction}}.
\end{aligned}$$

## 5 Long run: the future of global cities

In this section, we study how an influx of foreign residents affects the optimal long-run city design. To study these effects, we consider the possibility that offices can be converted into homes and vice versa.

Consider first the marginal social welfare effect of converting offices into houses in the city center.

$$d\mathcal{W} = v' \left( \frac{\bar{H}_c}{\Pi_c + N_f} \right) - \alpha \frac{L_c^{1+\gamma-\alpha}}{\bar{K}_c^{1-\alpha}}.$$

Suppose that before the influx of foreign residents, the rental rates of houses and offices are equalized in the center and in the periphery:  $r_c = r_c^K$  and  $r_p = r_p^K$ . The condition  $r_c = r_c^K$  can be rewritten as:

$$v'(\bar{H}_c / \Pi_c) - \alpha \frac{L_c^{1+\gamma-\alpha}}{\bar{K}_c^{1-\alpha}} = 0.$$

Foreign home purchases reduce housing consumption in the center ( $\frac{\bar{H}_c}{\Pi_c + N_f}$ ), increasing the utility of additional homes. At the same time, locals move away from the

center, reducing labor supply  $L_c$  and the rents of office buildings. It is optimal to increase home supply in the city center, decreasing office supply:  $d\mathcal{W} > 0$ .

Consider now the effect on social welfare of converting houses into offices in the periphery,

$$d\mathcal{W} = \alpha \frac{L_p^{1+\gamma-\alpha}}{\bar{K}_p^{1-\alpha}} - v' \left( \frac{\bar{H}_p}{\bar{\Pi}_p} \right).$$

Locals move to the periphery, reducing per-capita housing consumption  $\left(\frac{\bar{H}_p}{\bar{\Pi}_p}\right)$ . At the same time, the labor supply increases in the periphery. As a result, the total marginal effect on social welfare is ambiguous:  $d\mathcal{W} \leq 0$ .

**Proposition 4.** *In response to an influx of foreign residents, it is optimal to convert offices into houses in the city center. In contrast, the welfare effect of converting offices into houses in the periphery is ambiguous.*

## 6 Heterogeneous property ownership

In this section, we extend the model to allow for heterogeneous ownership of houses and office buildings. We assume that each individual  $i$  belongs to one of a finite number of groups:  $g \in \{1, \dots, G\}$ . This formulation allows us to use the law of large numbers in computing the welfare of each group.

The mass of group  $g$  is given by  $\chi_g \geq 0$ , which satisfies the adding-up condition  $\sum_g \chi_g = 1$ . Each member of group  $g$  is endowed with a share  $s_g \geq 0$  of houses and  $s_g^k \geq 0$  of office buildings. These shares are defined as the housing (office buildings) holdings of a person in group  $g$  divided by the per capita housing stock (office building stock). In groups whose members own more houses than the per capita housing stock,  $s_g \geq 1$ .

The non-labor income of a person in group  $g$  is

$$T_g = s_g \sum_j r_j \bar{H}_j + s_g^k \sum_j r_j^k \bar{K}_j,$$

where  $\sum_g \chi_g s_g = 1$  and  $\sum_g \chi_g s_g^K = 1$ . The equilibrium conditions are given by

$$\begin{aligned} h_{g,\ell,j} &= h_\ell \equiv [v']^{-1}(r_\ell) \\ c_{\ell,j} &= w_j(1 - t_{\ell,j}) + T_g - r_\ell h_\ell \\ u_{g,\ell,j} &= \bar{u}_{\ell,j} + w_j(1 - t_{\ell,j}) + T_g - r_\ell h_\ell + v(h_\ell) \\ \pi_{g,\ell,j} &= \frac{e^{\eta u_{g,\ell,j}}}{\sum_{\ell',j'} e^{\eta u_{g,\ell',j'}}} = \pi_{\ell,j}. \end{aligned}$$

Because preferences are quasi-linear, heterogeneity in property holdings does not affect housing purchases or location choices.

We define the welfare of group  $g$  as the average utility across group members. We can write the welfare of group  $g$  as:

$$\mathcal{W}_g = \frac{\log \left( \sum_{\ell,j} e^{\eta u_{g,\ell,j}} \right)}{\eta} + \frac{\text{Euler-Mascheroni constant}}{\eta}.$$

We investigate the impact of home purchases by foreigners on individuals with different holdings of houses and office buildings.

**Proposition 5.** *The change in group- $g$  welfare is given by*

$$d\mathcal{W}_g = \mathcal{P}\mathcal{E} + \left( s_g^K - 1 \right) \mathcal{C}\mathcal{G}^K + s_g \mathcal{F}\mathcal{S} + (s_g - 1) \mathcal{C}\mathcal{G}^{H,L},$$

where

$$\mathcal{C}\mathcal{G}^{H,L} \equiv \sigma r_c \frac{\bar{H}_c - N_f h_f}{\Pi_c + N_f} (d\Pi_c + dN_f) + \sigma r_p \frac{\bar{H}_p}{\Pi_p} d\Pi_p,$$

denotes the capital gains on houses purchased by locals and

$$\mathcal{C}\mathcal{G}^K \equiv \sum_j \alpha \Upsilon_j \{ \gamma + (1 - \alpha) \} \frac{dL_j}{L_j}.$$

denotes the capital gains on office buildings.

To understand the expression for the change in welfare in Proposition 5, note that people in group  $g$  benefit from the foreign-resident surplus in proportion to the

share of houses they own,  $s_g$ . To the extent that  $s_g \neq 1$ , they may also gain or lose from the fact that houses purchased by locals become more expensive,  $\mathcal{CG}^{H,L}$ .

People with  $s_g = 0$  have to pay higher rents but do not benefit from housing capital gains. More generally, if  $s_g < 1$ , their capital gains are lower than the increase in housing costs. People who own more shares than average,  $s_g > 1$ , receive capital gains that exceed the rise in housing costs.

The change in wage income of people in group  $g$  is given by

$$\sum_j (\gamma - \alpha) (1 - \alpha) Y_j \frac{dL_j}{L_j},$$

and the change in their capital income is given by

$$s_g^K \sum_j \alpha Y_j \{ \gamma + (1 - \alpha) \} \frac{dL_j}{L_j}.$$

Adding these two effects, we obtain

$$\gamma \sum_j \frac{dL_j}{L_j} Y_j + (s_g^K - 1) \sum_j \alpha Y_j \{ \gamma + (1 - \alpha) \} \frac{dL_j}{L_j} = \mathcal{PE} + (s_g^K - 1) \mathcal{CG}^K.$$

So,  $\mathcal{PE}$  has two components: the change in wages and the changes in rents to office buildings. Implicitly,  $\mathcal{PE}$  is defined as if offices are equally distributed among the population. The term  $(s_g^K - 1) \mathcal{CG}^K$  corrects  $\mathcal{PE}$  for the fact that the change in office rents are unequally distributed among the population. When  $s_g^K = 0$ , people in group  $g$  receive no capital income. So, the production externality effect must be subtracted by the change in office rents in order to obtain only the change in wage income.

## 6.1 Optimal policy

We compute the second-best optimal allocation in which the planner cannot observe taste shocks. The planner has information about people's residential and workplace

choices as well as their holdings of houses and office buildings, so it can make allocations contingent on these factors.

The planner chooses the share of people in each location,  $\pi_{g,\ell,j}$ . These shares must satisfy

$$\pi_{g,\ell,j} = \frac{e^{\eta u_{g,\ell,j}}}{\sum_{\ell',j'} e^{\eta u_{g,\ell',j'}}}.$$

In order to characterize the welfare possibilities frontier, the planner maximizes the welfare of group 1,

$$\max \mathcal{W}_1 = \frac{\log \left( \sum_{1,\ell,j} e^{\eta u_{1,\ell,j}} \right)}{\eta},$$

subject to achieving specific welfare levels for other groups

$$\frac{\log \left( \sum_{\ell,j} e^{\eta u_{g,\ell,j}} \right)}{\eta} \geq \bar{u}_g^p,$$

the resource constraints for goods,

$$\sum_g \chi_g \sum_{\ell,j} \pi_{g,\ell,j} c_{\ell,j} + N_f c_f \leq L_c^{\gamma+1-\alpha} \bar{K}_c^\alpha + L_p^{\gamma+1-\alpha} \bar{K}_p^\alpha + N_f y_f,$$

the adding-up constraints for housing in the center and in the periphery,

$$\sum_g \chi_g \sum_j \pi_{g,c,j} h_{g,c,j} + N_f h_f \leq \bar{H}_c,$$

$$\sum_g \chi_g \sum_j \pi_{g,p,j} h_{g,p,j} \leq \bar{H}_p,$$

the incentive compatibility constraints,

$$\pi_{g,\ell,j} = \frac{e^{\eta u_{g,\ell,j}}}{\sum_{\ell',j'} e^{\eta u_{g,\ell',j'}}},$$

and the foreign resident participation constraints,

$$\bar{u}_f + c_f + v(h_f) \geq u_f^*.$$



By varying the parameters  $\bar{u}_g^p$  we can trace out the full group welfare frontier.

The first-order conditions for the planner's problem are given by

$$\begin{aligned} \lambda_g^u - \eta \lambda_{g,\ell,j}^{\text{loc}} + \eta \sum_{g,\ell',j'} \lambda_{g,\ell',j'}^{\text{loc}} \pi_{g,\ell',j'} &= \lambda_c \\ v'(h_{g,\ell,j}) \left( 1 - \eta \lambda_{g,\ell,j}^{\text{loc}} + \eta \sum_{g,\ell',j'} \lambda_{g,\ell',j'}^{\text{loc}} \pi_{g,\ell',j'} \right) &= \lambda_{h,\ell}, \\ \lambda_f &= \lambda_c, \\ \lambda_f v'(h_f) &= \lambda_{h,c}, \\ \lambda_c (y_f - c_f) - \lambda_{h,c} h_f &= 0, \\ \lambda_c \left\{ (1 + \gamma - \alpha) \frac{Y_j}{L_j} (1 - t_{\ell,j}) - c_{g,\ell,j} \right\} - \lambda_{h,\ell} h_{g,\ell,j} &= \lambda_{g,\ell,j}^{\text{loc}}, \end{aligned}$$

where  $\lambda_1^u \equiv 1$ . The first-order conditions with respect to consumption imply that  $\lambda_c = \lambda_g^u = \lambda_1^u = 1$ . In addition,  $\lambda_{g,\ell,j}^{\text{loc}} = \lambda_g^{\text{loc}}$ . These results imply that housing purchases are equal for all individuals in a given location independently of group membership or work location

$$v'(h_{g,\ell,j}) = \lambda_{h,\ell} \Rightarrow h_{g,\ell,j} \equiv h_\ell = [v']^{-1}(\lambda_{h,\ell}).$$

Optimal location choices  $\pi_{g,\ell,j}$  are constant across groups. The transfers to individuals in group  $g$  who live in location  $\ell$  and work in location  $j$  are given by

$$T_{g,\ell,j} = T_g + \frac{\gamma}{1 - \alpha} \left\{ \frac{w_j}{L_j} (1 - t_{\ell,j}) - \sum_{\ell,j} \pi_{\ell,j} \frac{w_j}{L_j} (1 - t_{\ell,j}) \right\},$$

where  $T_g$  are group-specific transfers which are a function of the parameters  $\bar{u}_g^p$  and satisfy

$$\sum_g \chi_g T_g = \alpha \sum_j Y_j + \sum_\ell r_\ell \bar{H}_\ell \equiv T.$$

By varying the elements of the vector that comprises the welfare of the different groups,  $\{\bar{u}_g\}$ , we can calculate the set of transfers for each group that satisfies this equation. It is always possible to find a distribution of welfare across groups  $\{\bar{u}_\ell^p\}$  such that the second-best solution does not involve redistributing the rental income received by different groups in the competitive equilibrium.

The key result in this section is summarized by the following proposition.

**Proposition 6.** *Given an initial distribution of property ownership, it is possible to implement a transfer and tax policy such that, ex ante, before taste shocks materialize, all groups gain from the influx of foreign residents.*

In the model, capital gains can be redistributed through lump-sum taxes and transfers. In practice, this redistribution can be implemented by taxing capital gains on housing and making transfers to those with property holdings below average. In a static model like ours, this tax does not distort the decisions of individuals. In a dynamic setting, capital gain taxes are also not distorting as long as investment expenses can be deducted from the tax base (see [Abel, 2007](#)).

## 7 Remote work

In this section, we consider a version of our model in which local workers can either work onsite at an office, or at home. The production function of the representative firm in location  $j$  is given by

$$y_j = A(L_{j,o}) \left( l_{j,o}^{1-\alpha} k_j^\alpha + A_h l_{j,h} \right),$$

where  $l_{j,o}$  and  $l_{j,h}$  denote the number of people working for the firm in the office and at home, respectively. The agglomeration or production externality,  $A(L_{j,o})$ , depends on the total number of people who work in offices in location  $j$ ,  $L_{j,o}$ . This externality benefits the productivity of all the workers. We assume that

$$A(L_{j,o}) = L_{j,o}^\gamma.$$

**Location choices** People's choices are influenced by Gumbel-distributed taste shocks,  $\xi_{\ell,j,e}$ , about the location of their residence, workplace, and remote versus onsite work.

The subscript  $e$  indexes labor arrangements. It takes the value  $o$  and  $h$  depending on whether the individual works onsite or at home, respectively. Consider a local individual who chooses to live in location  $\ell$ , work in location  $j$ , and use work arrangement  $e$ . The optimal consumption and housing services for this individual are those that maximize common utility, that is, the utility net of taste shocks

$$\bar{u}_\ell + c_{\ell,j,e} + v(h_{\ell,j,e}),$$

subject to the budget constraint

$$c_{\ell,j,e} + r_\ell h_{\ell,j,e} = w_{j,e} (1 - t_{\ell,j,e}) + T.$$

Here  $t_{\ell,j,e}$  is the cost of commuting from  $\ell$  to  $j$  for someone working at  $e$  (home or office). This commuting cost is zero for those who work in an office in the same location as their residence,  $t_{\ell,\ell,e} = 0$ , and for those who work from home,  $t_{\ell,j,h} = 0$  for all  $\ell, j$ .

The first-order conditions for this problem are,

$$v'(h_{\ell,j,e}) = r_\ell,$$

$$c_{\ell,j,e} = w_{j,e} (1 - t_{\ell,j,e}) + T - r_\ell h_{\ell,j,e},$$

$$u_{\ell,j,e} = \bar{u}_\ell + w_{j,e} (1 - t_{\ell,j,e}) + T - r_\ell h_{\ell,j,e} + v(h_{\ell,j,e}),$$

All individuals residing in  $\ell$  choose the same housing consumption.

$$h_{\ell,j,e} = h_\ell.$$

Optimal location and work arrangement choices are given by

$$\{\ell, j, e\} = \arg \max \{u_{\ell,j,e} + \xi_{\ell,j,e}\}.$$

The share of individuals living in  $\ell$  and working in  $j$  with employment type  $e$  is

$$\pi_{\ell,j,e} = \frac{e^{\eta u_{\ell,j,e}}}{\sum_{\ell',j',e'} e^{\eta u_{\ell',j',e'}}}.$$

Even when the wage for remote work is low, there are always people who choose this option because of their taste shock. Note that individuals who live and work in different places are relatively more likely to work remotely, since,

$$\frac{\pi_{j,j,o}}{\pi_{j,j,h}} = e^{\eta(w_{j,o}-w_{j,h})} > e^{\eta(w_{j,o}(1-t_{\ell,j})-w_{j,h})} = \frac{\pi_{\ell,j,o}}{\pi_{\ell,j,h}},$$

for  $\ell \neq j$ . This result suggests that the influx of foreign home buyers may increase telecommuting within the city by relocating local workers to the periphery.

**Foreign resident problem** The foreign resident problem is the same as in the benchmark model.

**Firms' problem** A firm in location  $j$  maximizes profits, given by

$$\pi_j = A (L_{j,o}) \left( l_{j,o}^{1-\alpha} k_j^\alpha + A_h l_{j,h} \right) - w_{j,o} l_{j,o} - w_{j,h} l_{j,h} - r_j k_j.$$

The first-order conditions for this problem are,

$$\begin{aligned} w_{j,h} &= A (L_{j,o}) A_h, \\ w_{j,o} &= (1 - \alpha) A (L_{j,o}) l_{j,o}^{-\alpha} k_j^\alpha, \\ r_j &= \alpha A (L_{j,o}) l_{j,o}^{1-\alpha} k_j^{\alpha-1}. \end{aligned}$$

**Equilibrium conditions** There are two labor market clearing conditions. The first is for office workers in location  $j$ :

$$l_{j,o} = L_{j,o} = \sum_{\ell} \pi_{\ell,j,o} (1 - t_{\ell,j,o}).$$

The second is for remote workers employed by firms in location  $j$  is

$$l_{j,h} = L_{j,h} = \sum_{\ell} \pi_{\ell,j,h}.$$

The market clearing conditions for office buildings in location  $j$  is

$$k_j = \bar{K}_j.$$

The goods market clearing condition is

$$\sum_{\ell,j,e} \pi_{\ell,j,e} c_{\ell,j,e} + N_f c_f = \sum_j A(L_{j,o}) \left( L_{j,o}^\alpha \bar{K}_j^{1-\alpha} + A_h L_{j,h} \right) + N_f y_f.$$

The housing market clearing conditions for the center and the periphery are

$$\Pi_c h_c + N_f h_f = \bar{H}_c,$$

$$\Pi_p h_p = \bar{H}_p,$$

where

$$\Pi_c \equiv \sum_{j,e} \pi_{c,j,e},$$

$$\Pi_p \equiv \sum_{j,e} \pi_{p,j,e}.$$

Rents on housing and office buildings are distributed equally across locals. These rents are given by

$$T = \sum_{\ell} r_{\ell} \bar{H}_{\ell} + \sum_j r_j^K \bar{K}_j.$$

**Social welfare** Social welfare is the average utility across the local population,

$$\mathcal{W} = \frac{\log \left( \sum_{\ell,j,e} e^{\eta u_{\ell,j,e}} \right)}{\eta} + \frac{\text{Euler-Mascheroni constant}}{\eta}.$$

**The welfare impact of a marginal increase in the number of foreign residents** We assume that the foreign residents' participation constraint is satisfied. The marginal change in social welfare from an influx of foreign residents is

$$d\mathcal{W} = \sum_{\ell,j,e} \pi_{\ell,j,e} du_{\ell,j,e}.$$

The change in common utility is

$$u_{\ell,j,e} = \bar{u}_\ell + w_{j,e} (1 - t_{\ell,j,e}) + T - r_\ell h_{\ell,j,e} + v(h_{\ell,j,e}),$$

$$du_{\ell,j,e} = dw_{j,e} (1 - t_{\ell,j,e}) + dT + \beta v'(h_\ell) dh_\ell.$$

The change in the wages paid to onsite and remote workers are

$$\frac{dw_{j,o}}{w_{j,o}} = (\gamma - \alpha) \frac{dL_{j,o}}{L_{j,o}},$$

$$\frac{dw_{j,h}}{w_{j,h}} = \gamma \frac{dL_{j,o}}{L_{j,o}},$$

where the change in the number of office workers in location j is

$$\frac{dL_{j,o}}{L_{j,o}} = \sum_j \frac{\pi_{j,\ell,o}}{L_{j,o}} (1 - t_{j,\ell,o}) \frac{d\pi_{j,\ell,o}}{\pi_{j,\ell,o}}.$$

The changes in housing consumption are

$$\frac{dh_p}{h_p} = -\frac{d\Pi_p}{\Pi_p},$$

and

$$\frac{dh_c}{h_c} = -\left( \frac{\Pi_c}{\Pi_c + N_f} \frac{d\Pi_c}{\Pi_c} + \frac{N_f}{\pi_c + N_f} \frac{dN_f}{N_f} \right),$$

where  $\Pi_\ell = \sum_{j,e} \pi_{\ell,j,e}$ . The change in the rents on houses and office buildings are:

$$\begin{aligned} dT &= - \sum_{\ell} \beta \bar{H}_\ell v'(h_\ell) \frac{dh_\ell}{h_\ell} + \sum_{\ell} \alpha Y_\ell \{ \gamma + (1 - \alpha) \} \frac{dL_\ell}{L_\ell} \\ &= \beta \bar{H}_c v'(h_c) \left( \frac{\Pi_c}{\Pi_c + N_f} \frac{d\Pi_c}{\Pi_c} + \frac{N_f}{\pi_c + N_f} \frac{dN_f}{N_f} \right) \\ &\quad + \beta \bar{H}_p v'(h_p) \frac{d\Pi_p}{\Pi_p} + \sum_{\ell} \alpha Y_{\ell,o} \{ \gamma + (1 - \alpha) \} \frac{dL_\ell}{L_\ell}. \end{aligned}$$

Using these expressions, we can compute the change in utility for those who live in the center and the periphery and add them to compute the change in social welfare. The result is the following expression

$$\begin{aligned} d\mathcal{W} &= \frac{\gamma}{1 - \alpha} \sum_{j,\ell} \pi_{\ell,j,o} w_{j,o} (1 - t_{\ell,j,o}) \frac{d\pi_{\ell,j,o}}{\pi_{\ell,j,o}} \\ &\quad + \gamma \sum_{j,\ell} \pi_{\ell,j,o} w_{j,h} (1 - t_{\ell,j,o}) \frac{d\pi_{\ell,j,o}}{\pi_{\ell,j,o}} \\ &\quad + \beta v'(h_c) N_f h_f \left( \frac{\Pi_c}{\Pi_c + N_f} \frac{d\Pi_c}{\Pi_c} + \frac{N_f}{\pi_c + N_f} \frac{dN_f}{N_f} \right). \end{aligned}$$

**Proposition 7.** *The change in social welfare caused by a marginal increase in the number of foreign residents has two components. The first is the foreign resident surplus,*

$$\mathcal{FS} \equiv \beta \frac{N_f}{\pi_c + N_f} r_c h_f (d\Pi_c + dN_f).$$

*The second is the production externality*

$$\mathcal{PE} = \gamma \mathbf{COV} \left( (Y_{j,o} + Y_{j,h}) \frac{1 - t_{\ell,j,o}}{L_{j,o}}, \frac{d\pi_{\ell,j,o}}{\pi_{\ell,j,o}} \right) + \gamma \left( \sum_j Y_{j,h} \right) d\Pi_o^e.$$

The production externality includes the impact of an increase in foreign residents on the productivity of onsite and remote workers. This impact operates through two channels. The first is changes in the spatial distribution of office workers. If office

workers move to locations where they contribute less to the externality, then the covariance in  $\mathcal{PE}$  is negative because overall productivity falls. The second channel is changes in the overall number of people working onsite. If people move to the periphery but work remotely in the center, the number of office workers falls, reducing the external effect.

**Second-best solution** In the second best, we have that the planner assigns utilities for each triplet comprised of residence location, work location, and work arrangement. The share of agents that chooses the triplet  $(\ell, j, e)$  is given by

$$\pi_{\ell,j} = \frac{e^{\eta u_{\ell,j,e}}}{\sum_{\ell',j',e'} e^{\eta u_{\ell',j',e'}}$$

and so welfare is

$$\mathcal{W} = \frac{\log\left(\sum_{\ell,j,e} e^{\eta u_{\ell,j,e}}\right)}{\eta}.$$

It is useful to define  $u_{\ell,j,e} = \bar{u}_{\ell,j,e} + c_{\ell,j,e} + v(h_{\ell,j,e})$  and  $L_{j,e} = \sum_{\ell} \pi_{\ell,j,e} (1 - t_{\ell,j,e})$ .

The second-best problem is to maximize

$$\frac{\log\left(\sum_{\ell,j} e^{\eta u_{\ell,j}}\right)}{\eta},$$

subject to

$$\sum_{\ell,j,e} \pi_{\ell,j,e} c_{\ell,j,e} + \pi_p c_p + N_f c_f = \sum_j A(L_{j,o}) \left( L_{j,o}^\alpha \bar{K}_j^{1-\alpha} + A_h L_{j,h} \right) + N_f y_f,$$

$$\sum_{j,e} \pi_{c,j,e} h_{c,j,e} + N_f h_f \leq \bar{H}_c,$$

$$\sum_{j,e} \pi_{p,j,e} h_{p,j,e} \leq \bar{H}_p,$$

$$\pi_{\ell,j,e} = \frac{e^{\eta u_{\ell,j,e}}}{\sum_{\ell',j',e'} e^{\eta u_{\ell',j',e'}}$$



$$c_f + v(h_f) \geq \bar{u}_f.$$

The Lagrangean for this problem is

$$\begin{aligned} \mathcal{L} = & \frac{\log\left(\sum_{\ell,j} e^{\eta u_{\ell,j,e}}\right)}{\eta} + \lambda_c \left( \sum_j A(L_{j,o}) \left( L_{j,o}^\alpha \bar{K}_j^{1-\alpha} + A_h L_{j,h} \right) + N_f (y_f - c_f) - \sum_{\ell,j,e} \pi_{\ell,j,e} c_{\ell,j,e} \right) \\ & + \lambda_{h,c} \left( \bar{H}_c - \sum_{j,e} \pi_{c,j,e} h_{c,j,e} - N_f h_f \right) + \lambda_{h,p} \left( \bar{H}_p - \sum_{j,e} \pi_{p,j,e} h_{p,j,e} \right) \\ & + \sum_{\ell,j,e} \lambda_{\ell,j,e}^{\text{loc}} \left( \pi_{\ell,j,e} - \frac{e^{\eta u_{\ell,j,e}}}{\sum_{\ell',j',e'} e^{\eta u_{\ell',j',e'}}} \right) \\ & + N_f \lambda_f (c_f + v(h_f) - \bar{u}_f). \end{aligned}$$

The first-order conditions for consumption and housing services of locals and foreign residents can be written as

$$\begin{aligned} 1 + \eta \left( \sum_{\ell',j',e'} \lambda_{\ell',j',e'}^{\text{loc}} \pi_{\ell',j',e'} - \lambda_{\ell,j,e}^{\text{loc}} \right) &= \lambda_c, \\ v'(h_{\ell,j}) \left\{ 1 + \eta \left( \sum_{\ell',j',e'} \lambda_{\ell',j',e'}^{\text{loc}} \pi_{\ell',j',e'} - \lambda_{\ell,j,e}^{\text{loc}} \right) \right\} &= \pi_{\ell,j} \lambda_{\ell,h}, \\ \lambda_f &= \lambda_c, \\ \lambda_f v'(h_f) &= \lambda_{h,c}. \end{aligned}$$

Summing the first equation over  $\ell, j$  we conclude that  $\lambda_c = 1$  and  $\lambda_{\ell,j,e}^{\text{loc}} = \lambda^{\text{loc}}$  for all  $\ell, j$ . These results imply that the multipliers on the location-decision constraints take on the same value. This property means that the social welfare in the second-best allocation is the same as in the first-best allocation. Because utility is linear in consumption, social welfare depends only on the aggregate level of consumption. Since the distribution of consumption does not affect social welfare, the planner can always redistribute consumption without impacting social welfare to incentivize individuals to choose a certain residential and working location or working arrangement.

The first-order conditions also imply that  $\lambda_f = 1$ . Combining these results, we obtain

$$\begin{aligned} v'(h_{c,j,e}) &= v'(h_f) = v'\left(\frac{\bar{H}_c}{\sum_{j,e} \pi_{c,j,e} + N_f}\right), \\ v'(h_{p,j,e}) &= v'\left(\frac{\bar{H}_p}{\sum_{j,e} \pi_{p,j,e}}\right). \end{aligned}$$

These equations imply that all individuals who live in the same location consume the same housing services,

The first-order condition for  $N_f$  is

$$\lambda_c (y_f - c_f) - \lambda_{h,c} h_f = 0 \Leftrightarrow y_f = c_f + v'(h_f) h_f.$$

This equation implies that it is not optimal to tax foreign residents or restrict in any way their home purchases.

The first-order conditions for the optimal shares of people in offices can be written as:

$$(1 + \gamma - \alpha) \frac{Y_{j,o}}{L_j} (1 - t_{\ell,j}) + \gamma \frac{Y_{j,h}}{L_{j,o}} (1 - t_{\ell,j}) - c_{\ell,j,o} - \lambda_{h,\ell} h_{\ell,j,o} = -\lambda^{\text{loc}}.$$

The first-order conditions for the shares of people working from home are

$$A(L_{j,o}) A_h - c_{\ell,j,h} - \lambda_{h,\ell} h_{\ell,j,h} = -\lambda^{\text{loc}}.$$

The key results are summarized in the following proposition.

**Proposition 8.** *The optimal solution involves transfers to office and remote workers. The optimal transfer to office workers is*

$$T_{\ell,j,o} = \alpha \sum_j Y_{j,o} + \sum_\ell \lambda_{h,\ell} \bar{H}_\ell + \gamma \left\{ \frac{Y_{j,o} + Y_{j,h}}{L_{j,o}} (1 - t_{\ell,j}) - \sum_{\ell,j} \pi_{\ell,j,o} \frac{Y_{j,o} + Y_{j,h}}{L_{j,o}} (1 - t_{\ell,j}) \right\}.$$

The optimal transfer to remote workers is

$$T_{\ell,j,h} = \alpha \sum_j Y_{j,o} + \sum_\ell \lambda_{h,\ell} \bar{H}_\ell - \gamma \sum_j (Y_{j,o} + Y_{j,h}).$$

The optimal transfer to office workers has two components. The first is the rent from houses and office buildings. These rents are equally distributed among locals. The second is transfers that internalize the production externality. Office workers receive higher transfers if they work in a location where productivity is higher than average.

The two components of the optimal transfer to remote workers are as follows. The first, which is positive, is the rental income from houses and office buildings. The second, which is negative, reflects the fact that remote workers do not contribute to the production externality.

## 8 Conclusion

Many nations and urban areas are grappling with the challenge of devising policies to ensure that the local population benefits from a potentially large influx of foreign residents.

We show that an optimal approach involves internalizing externalities through the implementation of transfers to local individuals based on their residential and occupational locations. Once these externalities are internalized, the marginal impact of additional foreign residents is positive. There is no marginal impact of foreign residents on external effects, and there exists a positive surplus resulting from capital gains on housing. Consequently, restricting property purchases by foreigners or imposing taxes on those purchases is not optimal.

In situations where there is an unequal distribution of housing and office buildings ownership in the population, it can be optimal to implement transfers that redistribute the capital gains produced by the influx of foreign residents.

In scenarios where the local population can choose whether to work from home or at the office, it is optimal to implement transfers targeted toward office workers to internalize production or agglomeration externalities.

Looking toward the future, it is optimal in the long-run to convert office spaces in the city center into residential units and relocate production facilities to the periphery. This urban design mirrors the one adopted in Paris. In the 19th century, Napoleon III granted Baron Hausmann broad powers to remodel Paris. The result was the monumental city we know today, with wide boulevards, impressive squares, and views of the Eiffel Tower that are not obstructed by towering skyscrapers. Office buildings, production structures, and residential complexes, where a majority of the local population resides, were shifted to La Defense and other peripheral areas. The ability of Paris to accommodate foreign residents impressed Ernest Hemingway who wrote that “There are only two places in the world where we can live happy—at home and in Paris.”

## References

- ABEL, A. B. (2007): "Optimal capital income taxation," .
- AKSOY, C. G., J. M. BARRERO, N. BLOOM, S. J. DAVIS, M. DOLLS, AND P. ZARATE (2022): "Working from Home Around the World," Working Paper 30446, National Bureau of Economic Research.
- ALMAGRO, M. AND T. DOMINGUEZ-IINO (2022): "Location Sorting and Endogenous Amenities: Evidence from Amsterdam," .
- BORJAS, G. J. (1995): "The Economic Benefits from Immigration," *Journal of Economic Perspectives*, 9, 3–22.
- COCCO, J. F. (2005): "Portfolio Choice in the Presence of Housing," *The Review of Financial Studies*, 18, 535–567.
- DIAMOND, R. (2016): "The Determinants and Welfare Implications of US Workers' Diverging Location Choices by Skill: 1980–2000," *American Economic Review*, 106, 479–524.
- DINGEL, J. I. AND B. NEIMAN (2020): "How Many Jobs Can Be Done at Home?" *Journal of Public Economics*, 189, 104235.
- GUERREIRO, J., S. REBELO, AND P. TELES (2020): "What is the Optimal Immigration Policy? Migration, Jobs, and Welfare," *Journal of Monetary Economics*, 113, 61–87.
- GUERRIERI, V., D. HARTLEY, AND E. HURST (2013): "Endogenous Gentrification and Housing Price Dynamics," *Journal of Public Economics*, 100, 45–60.
- JACOBS, J. (1969): "The Economy of Cities," .
- LUCAS, R. E. (1988): "On the Mechanics of Economic Development," *Journal of Monetary Economics*, 22, 3–42.

——— (2001): “Externalities and Cities,” *Review of Economic Dynamics*, 4, 245–274.

LUCAS, R. E. AND E. ROSSI-HANSBERG (2002): “On the Internal Structure of Cities,” *Econometrica*, 70, 1445–1476.

McFADDEN, D. (1973): “Conditional Logit Analysis of Qualitative Choice Behavior,” .

ROSSI-HANSBERG, E. AND M. L. WRIGHT (2007): “Urban structure and growth,” *The Review of Economic Studies*, 74, 597–624.

## A Appendix to Section 2

### A.1 Location shares

Define  $x_{i,\ell,j} = u_{\ell,j} + \xi_{i,\ell,j}$  for  $\ell, j = c, p$ . The cross-sectional cumulative density function of  $x_{i,\ell,j}$  is given by

$$G_{\ell,j}(x) = \mathbb{P}[x_{i,\ell,j} \leq x] = F(x - u_{\ell,j}) = e^{-e^{-\eta(x-u_{\ell,j})}},$$

and the associated probability density function is given by

$$g_{\ell,j}(x) = \eta e^{-\eta(x-u_{\ell,j})} e^{-e^{-\eta(x-u_{\ell,j})}}$$

Then, by the law of large numbers

$$\begin{aligned} \pi_{\ell,j} &= \mathbb{P}\left[x_{i,\ell,j} = \max_{\ell',j'} x_{i,\ell',j'}\right] = \int_{-\infty}^{\infty} g_{\ell,j}(x) \prod_{(\ell',j') \neq (\ell,j)} G_{\ell',j'}(x) dx \\ &= \int_{-\infty}^{\infty} \eta e^{-\eta(x-u_{\ell,j})} e^{-e^{-\eta(x-u_{\ell,j})}} \prod_{(\ell',j') \neq (\ell,j)} e^{-e^{-\eta(x-u_{\ell',j'})}} dx \\ &= \frac{e^{\eta u_{\ell,j}}}{\sum_{\ell',j'} e^{\eta u_{\ell',j'}}} \int_{-\infty}^{\infty} \eta e^{-\eta x} \left( \sum_{\ell',j'} e^{\eta u_{\ell',j'}} \right) e^{-e^{-\eta x} \left( \sum_{\ell',j'} e^{\eta u_{\ell',j'}} \right)} dx \\ &= \frac{e^{\eta u_{\ell,j}}}{\sum_{\ell',j'} e^{\eta u_{\ell',j'}}}. \end{aligned}$$

### A.2 Social welfare

By the law of large numbers

$$\mathcal{W} \equiv \int_0^1 \max\{u_{\ell,j} + \xi_{i,\ell,j}\} di = \mathbb{E}\left[\max_{\ell,j}\{u_{\ell,j} + \xi_{i,\ell,j}\}\right].$$

Let  $x^* \equiv \max_{\ell,j}\{u_{\ell,j} + \xi_{i,\ell,j}\}$ . The cumulative distribution function of  $x^*$  is given by:

$$F^*(x) = \mathbb{P}[x^* \leq x] = \mathbb{P}[\xi_{\ell} \leq x - u_{\ell}, \quad \forall \ell] = \prod_{\ell} e^{-e^{-\eta(x-u_{\ell})}} = e^{-e^{-\eta x} \sum_{\ell} e^{\eta u_{\ell}}}$$

and the probability density function is given by:

$$f^*(x) = \eta e^{-\eta x} \left( \sum_{\ell} e^{\eta u_{\ell}} \right) e^{-e^{-\eta x} \sum_{\ell} e^{\eta u_{\ell}}}$$

So, social welfare is give by

$$\mathcal{W} = \mathbb{E} [\max \{u_{\ell} + \xi_{\ell}\}] = \int_{-\infty}^{\infty} x \eta e^{-\eta x} \left( \sum_{\ell} e^{\eta u_{\ell}} \right) e^{-e^{-\eta x} \sum_{\ell} e^{\eta u_{\ell}}} dx$$

It is useful to do a change of variables:  $y = e^{-\eta x} \sum_{\ell} e^{\eta u_{\ell}}$ . Then,

$$x = -\frac{1}{\eta} \log \left( \frac{y}{\sum_{\ell} e^{\eta u_{\ell}}} \right),$$

$dx = -\frac{1}{\eta} \frac{dy}{y}$ ,  $\lim_{x \rightarrow \infty} y = 0$  and  $\lim_{x \rightarrow -\infty} y = \infty$ . We can rewrite social welfare as follows:

$$\begin{aligned} \mathcal{W} &= \int_{\infty}^0 \left( -\log \left( \frac{y}{\sum_{\ell} e^{\eta u_{\ell}}} \right) \right) y e^{-y} \left( -\frac{1}{\eta} \frac{dy}{y} \right) \\ &= \frac{1}{\eta} \int_0^{\infty} \left( \log \left( \sum_{\ell} e^{\eta u_{\ell}} \right) - \log(y) \right) e^{-y} dy \\ &= \frac{\log(\sum_{\ell} e^{\eta u_{\ell}})}{\eta} + \frac{1}{\eta} \underbrace{\int_0^{\infty} [-\log(y)] e^{-y} dy}_{\text{Euler-Mascheroni Constant}} \end{aligned}$$

### A.3 The welfare impact of increasing foreign residents

Using the fact that  $r_{\ell} = v'(h_{\ell})$ , we can write common utility as

$$u_{\ell,j} = \bar{u}_{\ell,j} + w_j \cdot (1 - t_{\ell,j}) + T - v'(h_{\ell}) \cdot h_{\ell} + v(h_{\ell}),$$

where  $h_{\ell}$  denote the quantity of housing purchased by people who live in location  $\ell$ .

Then,

$$du_{\ell,j} = dw_j \cdot (1 - t_{\ell,j}) + dT - v''(h_{\ell}) \cdot h_{\ell} \cdot dh_{\ell}$$



Assuming that  $v(h) = h^{1-\sigma}/(1-\sigma)$  we can write

$$du_{\ell,j} = dw_j \cdot (1 - t_{\ell,j}) + dT + \sigma \cdot r_\ell \cdot dh_\ell.$$

Note that, because

$$h_c = \frac{\bar{H}_c}{\Pi_c + N_f} \Rightarrow \frac{dh_c}{h_c} = - \left( \frac{\Pi_c}{\Pi_c + N_f} \frac{d\Pi_c}{\Pi_c} + \frac{N_f}{\pi_c + N_f} \frac{dN_f}{N_f} \right),$$

$$h_p = \frac{\bar{H}_p}{\Pi_p} \Rightarrow \frac{dh_p}{h_p} = - \frac{d\Pi_p}{\Pi_p}.$$

Furthermore, since  $w_j = L_j^\gamma \left( \frac{\bar{K}_j}{L_j} \right)^\alpha (1 - \alpha)$  and  $L_j = \sum_\ell \pi_{\ell,j} (1 - t_{\ell,j})$  then

$$\frac{dw_j}{w_j} = (\gamma - \alpha) \frac{dL_j}{L_j} = (\gamma - \alpha) \sum_\ell \frac{\pi_{\ell,j}}{L_j} (1 - t_{\ell,j}) \frac{d\pi_{\ell,j}}{\pi_{\ell,j}}.$$

Finally, the change in total rents is given by

$$\begin{aligned} dT &= d \left( \sum_\ell v'(h_\ell) \bar{H}_\ell + \sum_\ell \alpha A(L_\ell) L_\ell^{1-\alpha} \bar{K}_\ell^\alpha \right) \\ &= \sum_\ell v''(h_\ell) \bar{H}_\ell dh_\ell + \sum_\ell \alpha A(L_\ell) L_\ell^{1-\alpha} \bar{K}_\ell^\alpha \left\{ \frac{A'(L_\ell)}{A(L_\ell)} L_\ell + (1 - \alpha) \right\} \frac{dL_\ell}{L_\ell} \\ &= - \sum_\ell \sigma \bar{H}_\ell v'(h_\ell) \frac{dh_\ell}{h_\ell} + \sum_\ell \alpha Y_\ell \{ \gamma + (1 - \alpha) \} \frac{dL_\ell}{L_\ell} \\ &= \sigma \bar{H}_c v'(h_c) \left( \frac{\Pi_c}{\Pi_c + N_f} \frac{d\Pi_c}{\Pi_c} + \frac{N_f}{\pi_c + N_f} \frac{dN_f}{N_f} \right) + \sigma \bar{H}_p v'(h_p) \frac{d\Pi_p}{\Pi_p} \\ &\quad + \sum_\ell \alpha Y_\ell \{ \gamma + (1 - \alpha) \} \frac{dL_\ell}{L_\ell}. \end{aligned}$$

Putting everything together, we find that

$$\begin{aligned}
d\mathcal{W} &= (\gamma - \alpha) L_c w_c \frac{dL_c}{L_c} + (\gamma - \alpha) L_p w_p \frac{dL_p}{L_p} \\
&\quad + \sigma v'(h_c) (\bar{H}_c - \Pi_c h_c) \left( \frac{\Pi_c}{\Pi_c + N_f} \frac{d\Pi_c}{\Pi_c} + \frac{N_f}{\pi_c + N_f} \frac{dN_f}{N_f} \right) \\
&\quad + \sigma v'(h_p) (\bar{H}_p - \Pi_p h_p) \frac{d\Pi_p}{\Pi_p} \\
&\quad + \sum_j \alpha Y_j \{ \gamma + (1 - \alpha) \} \frac{dL_j}{L_j}.
\end{aligned}$$

Using the fact that  $\bar{H}_c = \Pi_c h_c + N_f h_f$ ,  $\bar{H}_p = \Pi_p h_p$ , and  $w_j = (1 - \alpha) \frac{Y_j}{L_j}$ , we can write

$$d\mathcal{W} = \gamma \sum_{\ell,j} \pi_{\ell,j} \frac{Y_j}{L_j} (1 - t_{\ell,j}) \frac{d\pi_{\ell,j}}{\pi_{\ell,j}} + \sigma \frac{N_f}{\Pi_c + N_f} r_c h_f (d\Pi_c + dN_f),$$

or, equivalently,

$$d\mathcal{W} = \frac{\gamma}{1 - \alpha} \sum_{\ell,j} \pi_{\ell,j} w_j (1 - t_{\ell,j}) \frac{d\pi_{\ell,j}}{\pi_{\ell,j}} + \sigma \frac{N_f}{\Pi_c + N_f} r_c h_f (d\Pi_c + dN_f),$$

## B Appendix to Section 3

### B.1 Second-best problem and incentive compatibility

Let  $c(\xi)$ ,  $h(\xi)$ ,  $\ell(\xi)$  and  $j(\xi)$  denote, respectively, the consumption, housing, living location, and working location of person with idiosyncratic location preferences  $\xi = [\xi_{c,c}, \xi_{c,p}, \xi_{p,c}, \xi_{p,p}]$ .

The utility net of taste shocks of this person is given by

$$U(\xi) \equiv \bar{u}_{\ell(\xi),j(\xi)} + c(\xi) + v(h(\xi))$$

The incentive compatibility constraints of the direct revelation mechanism can be written as

$$U(\xi) + \xi_{\ell(\xi),j(\xi)} \geq U(\xi') + \xi_{\ell(\xi'),j(\xi')} \quad (1)$$

for all  $\xi$  and  $\xi'$ .

It follows from (1) that if two people have the same location choices then they must have the same level of common utility, i.e., assuming  $(\ell(\xi), j(\xi)) = (\ell(\xi'), j(\xi'))$ , then

$$U(\xi) = U(\xi'). \quad (2)$$

Let  $u_{\ell,j}$  denote the level of common utility attained by individuals with location choices  $\ell, j$ .

Note that now incentive compatibility can now be equivalently written as

$$\{\ell(\xi), j(\xi)\} = \arg \max \{u_{\ell,j} + \xi_{\ell,j}\}, \quad (3)$$

and  $U(\xi) = u_{\ell(\xi), j(\xi)}$ .

Using the properties of the Gumbel distribution, these equations imply that the share of individuals with location choices  $\ell, j$  is given by

$$\pi_{\ell,j} = \frac{e^{\eta u_{\ell,j}}}{\sum_{\ell',j'} e^{\eta u_{\ell',j'}}}, \quad (4)$$

and, furthermore, the social welfare function is

$$\mathcal{W} = \frac{\log \left( \sum_{\ell,j} e^{\eta u_{\ell,j}} \right)}{\eta} + \frac{\text{Euler-Mascheroni Constant}}{\eta}. \quad (5)$$

Note that these are the only restrictions on the aggregate shares and social welfare implied by incentive compatibility. This means that if the planner chooses common utility levels  $u_{\ell,j}$ , location shares  $\pi_{\ell,j}$ , and welfare  $\mathcal{W}$  which satisfy (4) and (5), then we can always find individual location choices which are consistent with incentive compatibility.

Note, furthermore, that because utility is concave in housing and all attain the same level of common utility then the optimal plan must always feature equal housing consumption for all people with the same location choices. It also follows that consumption is the same for all individuals with the same location choices.

## Second-best solution

We write the Lagrangean for this optimization problem as follows,

$$\begin{aligned} \mathcal{L} = & \frac{\log\left(\sum_{\ell,j} e^{\eta u_{\ell,j}}\right)}{\eta} + \lambda_c \left( L_c^{\gamma+1-\alpha} \bar{K}_c^\alpha + N_f (y_f - c_f) + L_p^{\gamma+1-\alpha} \bar{K}_p^\alpha - \sum_{\ell,j} \pi_{\ell,j} c_{\ell,j} \right) \\ & + \lambda_{h,c} \left( \bar{H}_c - \sum_j \pi_{c,j} h_{c,j} - N_f h_f \right) + \lambda_{h,p} \left( \bar{H}_p - \sum_j \pi_{p,j} h_{p,j} \right) \\ & + \sum_{\ell,j} \lambda_{\ell,j}^{\text{loc}} \left( \pi_{\ell,j} - \frac{e^{\eta u_{\ell,j}}}{\sum_{\ell',j'} e^{\eta u_{\ell',j'}}} \right) + N_f \lambda_f \left( \bar{u}_f + c_f + v(h_f) - u_f^* \right) \end{aligned}$$

The first-order conditions for this problem can be written as

$$[c_{\ell,j}] \quad 1 - \eta \lambda_{\ell,j}^{\text{loc}} + \eta \sum_{\ell',j'} \lambda_{\ell',j'}^{\text{loc}} \pi_{\ell',j'} = \lambda_c \quad (6)$$

$$[h_{\ell,j}] \quad v'(h_{\ell,j}) \left( 1 - \eta \lambda_{\ell,j}^{\text{loc}} + \eta \sum_{\ell',j'} \lambda_{\ell',j'}^{\text{loc}} \pi_{\ell',j'} \right) = \lambda_{h,\ell} \quad (7)$$

$$[c_f] \quad \lambda_f = \lambda_c \quad (8)$$

$$[h_f] \quad \lambda_f v'(h_f) = \lambda_{h,c} \quad (9)$$

$$[N_f] \quad \lambda_c (y_f - c_f) - \lambda_{h,c} h_f = 0 \quad (10)$$

$$[\pi_{\ell,j}] \quad \lambda_c \left\{ (1 + \gamma - \alpha) \frac{Y_j}{L_j} (1 - t_{\ell,j}) - c_{\ell,j} \right\} - \lambda_{h,\ell} h_{\ell,j} = \lambda_{\ell,j}^{\text{loc}} \quad (11)$$

and all constraints bind with equality.

Note that averaging across (6) for different  $\ell, j$  we obtain

$$\begin{aligned} \sum_{\ell,j} \pi_{\ell,j} [1 - \eta \lambda_{\ell,j}^{\text{loc}} + \eta \sum_{\ell',j'} \lambda_{\ell',j'}^{\text{loc}} \pi_{\ell',j'}] &= \sum_{\ell,j} \pi_{\ell,j} \lambda_c \\ \Leftrightarrow 1 - \eta \sum_{\ell,j} \pi_{\ell,j} \lambda_{\ell,j}^{\text{loc}} + \eta \sum_{\ell',j'} \lambda_{\ell',j'}^{\text{loc}} \pi_{\ell',j'} &= \lambda_c \Leftrightarrow 1 = \lambda_c. \end{aligned}$$

Using this finding back in (6) we find that

$$\lambda_{\ell,j}^{\text{loc}} = \sum_{\ell',j'} \lambda_{\ell',j'}^{\text{loc}} \pi_{\ell',j'} = \lambda^{\text{loc}}$$

is constant across location choices and where  $Y_j = A(L_j)\bar{K}_j^\alpha L_j^{1-\alpha}$ .

Then, note that these first order conditions can be simplified to

$$[c_{\ell,j}] \quad 1 = \lambda_c \quad (12)$$

$$[h_{\ell,j}] \quad v'(h_{\ell,j}) = \lambda_{h,\ell} \quad (13)$$

$$[c_f] \quad \lambda_f = 1 \quad (14)$$

$$[h_f] \quad \lambda_f v'(h_f) = \lambda_{h,c} \quad (15)$$

$$[N_f] \quad (y_f - c_f) - \lambda_{h,c} h_f = 0 \quad (16)$$

$$[\pi_{\ell,j}] \quad \left\{ (1 + \gamma - \alpha) \frac{Y_j}{L_j} (1 - t_{\ell,j}) - c_{\ell,j} \right\} - \lambda_{h,\ell} h_{\ell,j} = \lambda^{\text{loc}} \quad (17)$$

Note that these imply that

$$v'(h_{c,c}) = v'(h_{c,p}) = v'(h_f)$$

and

$$v'(h_{p,c}) = v'(h_{p,p}).$$

Note that these also imply that there are no marginal distortions in house purchases by foreigners. Furthermore, equation (16) shows that

$$y_f = c_f + v'(h_f) h_f,$$

which also shows that, in the optimum, foreigner spending is equal to their income, i.e., there should be no taxes on foreigners.

Now, averaging equation (17) across  $\ell, j$  we find that

$$(1 + \gamma - \alpha) \sum_j Y_j - \sum_{\ell,j} \pi_{\ell,j} c_{\ell,j} - \sum_{\ell,j} \pi_{\ell,j} \lambda_{h,\ell} h_{\ell,j} = \lambda^{\text{loc}}$$

Using the fact that  $\sum_{\ell,j} \pi_{\ell,j} c_{\ell,j} = \sum Y_j + N_f (y_f - c_f) = \sum Y_j + N_f \lambda_{h,c} h_f$  we can rewrite that equation as

$$(\gamma - \alpha) \sum_j Y_j - \sum_{\ell} \lambda_{h,\ell} \bar{H}_{\ell} = \lambda^{\text{loc}}$$

Replacing  $\lambda^{\text{loc}}$  in equation (17), we find

$$c_j + \lambda_{\ell,j} = (1 - \alpha) \frac{Y_j}{L_j} (1 - t_{\ell,j}) + \gamma \frac{Y_j}{L_j} (1 - t_{\ell,j}) + (\alpha - \gamma) \sum_j Y_j + \sum_{\ell} \lambda_{h,\ell} \bar{H}_{\ell}$$

$$c_j + \lambda_{\ell,j} h_{\ell,j} = (1 - \alpha) \frac{Y_j}{L_j} (1 - t_{\ell,j}) + \gamma \left[ \frac{Y_j}{L_j} (1 - t_{\ell,j}) - \sum_{\ell',j'} \frac{Y_{j'}}{L_{j'}} (1 - t_{\ell',j'}) \right] + \sum_j \alpha Y_j + \sum_{\ell} \lambda_{h,\ell} \bar{H}_{\ell}.$$

The decentralized equilibrium features the price of housing  $r_{\ell} = \lambda_{h,\ell}$ , the wage  $w_j = (1 - \alpha) Y_j / L_j$  and the rent of capital  $r_j^K = \alpha Y_j / \bar{K}_j$ . It follows that the transfer to individuals with location choices  $\ell, j$  is given by

$$T_{\ell,j} = \gamma \left[ \frac{Y_j}{L_j} (1 - t_{\ell,j}) - \sum_{\ell',j'} \frac{Y_{j'}}{L_{j'}} (1 - t_{\ell',j'}) \right] + \sum_j r_j^K \bar{K}_j + \sum_{\ell} r_{\ell} \bar{H}_{\ell}. \quad (18)$$