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## Where Should the Elderly Live and Who Should Pay for their Care? A Study in Demographics and Geographical Economics

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*Department of Economics*

# Where Should the Elderly Live and Who Should Pay for their Care? A Study in Demographics and Geographical Economics

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WHERE SHOULD THE ELDERLY LIVE AND WHO SHOULD PAY FOR THEIR CARE?  
A STUDY IN DEMOGRAPHICS AND GEOGRAPHICAL ECONOMICS

THOMAS ARONSSON, SÖREN BLOMQUIST AND LUCA MICHELETTO

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# Where Should the Elderly Live and Who Should Pay for their Care? A Study in Demographics and Geographical Economics\*

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## Abstract

There is a rich literature analyzing the problems that will arise as the share of elderly and retired in the population increases in the near future. However, the locational decisions among the elderly as well as their implications in terms of taxes/transfers and of allocation of responsibilities for elderly care between the federal and local levels have not received much attention. In this paper we aim at investigating these issues. For this purpose we explore a model where there is a big city and a set of small villages, and where congestion effects and agglomeration forces are at work at the level of the big city. We also assume that the population is divided between two groups of agents, workers and retired, which differ with respect to the degree of mobility. In the first part of the paper we study and characterize the inefficiencies that arise because of individuals' free location choice in the context of a unitary government. In the second part of the paper we consider a fiscal federalism structure and we investigate the suitable instruments that are needed in order to decentralize the optimal allocation obtained under full centralization.

Keywords: agglomeration effects, congestion, elderly care, fiscal federalism.

JEL Classification: D62, H42, H55, H77, J10.

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# 1 Introduction

In many developed countries, the share of elderly and retired in the population will rise considerably in the near future. This aging of the population poses several problems, and there is a rich literature analyzing them. However, the locational decisions among the elderly, as well as their implications in terms of taxes/transfers and the allocation of responsibilities for elderly care between the federal and local levels of government, have not received much attention so far. In this paper, we aim at investigating these issues.

A basic observation in several countries is the tendency towards a geographically unbalanced demographic structure, with the “villages” being populated mainly by elderly people, and the “big cities” to a greater extent populated by people in working ages. A possible explanation to this phenomenon is given by a life-cycle pattern of mobility behavior. For instance, people may live in the small communities, where they were born, until they have finished high school. Then, they move to the “big cities” and work for many years. When becoming old, quite a few return back to the region from where they came or to a region where they consider the living conditions (climate) to be pleasurable. Another possibility is that the mobility pattern is part of a long-term transition process, which has been going on for at least a hundred years, where the country-side is depopulated and the big cities increase in size. Those who move away from the country-side typically do so when young. This also contributes to a geographically unbalanced demographic structure.

Clearly, a geographically unbalanced demographic structure may be perfectly consistent with the notion of efficiency. The basic argument is that it may be cheaper to provide elderly care in the country-side than in the big city. Elderly living in the big city contribute to congestion, higher land prices, etc., without adding to the production capacity. We will elaborate on this in more detail below. Depending on how the grant system is designed, especially in countries with publicly provided elderly care, as in the Nordic countries, this unbalanced demographic structure can lead to financial problems for small villages, since the local taxable income might be too small to finance high quality care for the elderly.<sup>1</sup>

Transfers to the poor parts of a country are often motivated by income redistribution arguments, and individuals living in the big cities sometimes complain about these transfers. However, given that elderly care is publicly provided, and if it is cheaper to provide elderly care in the country-side than in the big city, it may be better for those working in the big cities to transfer money to the country-side, allowing good care for the elderly there, instead of having the elderly living in the big cities, in which case they would still

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<sup>1</sup>Korpi (2003) describes a very unbalanced demographic structure in Sweden, where the population in the country-side largely consists of elderly people, while Stockholm has a population with a larger share of people in working ages.

have to pay for their care via taxes. One can, therefore, provide efficiency arguments for transfers from the big city to the country-side.

Throughout the paper, we assume that elderly care is publicly provided. Without going into a detailed argument of why this might be a desirable policy, we want to point to three motivations for considering publicly provided care for the elderly. First, it is a common phenomenon in many countries that some form of basic elderly care is publicly provided, often at the local level. Second, the same type of tax base arguments as those proposed in Bergstrom and Blomquist (1996) for public subsidies to day care are also valid for elderly care, as are the arguments put forward by Boadway and Marchand (1995), Blomquist and Christiansen (1995) and Cremer and Gahvari (1997) that public provision of certain private goods can mitigate self-selection constraints and thereby help income redistribution. Third, without public pensions, some individuals may want to free ride, i.e. not saving for their old age, by counting on being helped out by others when old (see e.g. Buchanan (1975), Kotlikoff (1987) and Lindbeck and Weibull (1988)). To avoid this free riding, a society could use a public pension scheme forcing everyone to save for their old age. This type of argument is also valid for public provision of elderly care.

There are two salient differences between the big city and the country-side that we want to capture in our model. First, there is congestion in the big city, while there is no congestion in the country-side. Congestion can take several forms like bad air quality and/or scarce land resources leading to high costs for housing and long times for commuting. Retired and earners contribute in the same way towards the congestion. Second, there are agglomeration effects in the big city, in the sense that the marginal and average products of workers increase with the number of people working in the consumption goods industry.<sup>2</sup> Workers contribute to the agglomeration effects, whereas the retired do not.

Our paper relates to a large, and growing, literature on fiscal federalism dealing with the interactions within the public sector, as well as how a federal government must act in order to implement efficiency aspects of a unitary resource allocation. Several earlier studies concentrate on fiscal external effects, and a distinction is commonly made between horizontal<sup>3</sup> and vertical<sup>4</sup> external effects. Our paper, on the other hand, focuses on redistri-

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<sup>2</sup>For an evaluation of the relevance of such agglomeration effects, see the analyses by Ciccone and Hall (1996) and Glaeser and Mare (2001).

<sup>3</sup>A standard reference here is Oates (1972). Wildasin (1991) shows how horizontal external effects associated with mobility can be internalized by means of a system of matching grants from the central to the local governments.

<sup>4</sup>Vertical external effects may arise from co-occupancy of a common tax base. Typically, the local authorities do not recognize that their policies affect the central authority's tax base. This was pointed out by Hansson and Stuart (1987) and Johnson (1988). Methods to internalize vertical fiscal external effects have been discussed by e.g. Boadway and Keen (1996), Dahlby (1996), Boadway et al. (1998), Sato (2000) and Aronsson and Wikström

bution and population mobility. An important reference here is Boadway et al. (2003) dealing with redistribution and equalization in the context of an economic federation.<sup>5</sup> They assume that individuals differ in ability, and all ability-types are mobile across local jurisdictions. Their main contribution is to characterize the behavior of the local and central governments in the context of a federal decision-structure as well as studying how a unitary optimum can be decentralized. Our study differs from Boadway et al. (2003) in several respects. For example, in Boadway et al. the public sector provides a local public good whereas in our model it provides the private good elderly care to the population subgroup given by the elderly. It is true that regions can differ in productivity conditions in the Boadway et al. model. However, the basic structure of all the regions is the same. In our model, due to the fact that we incorporate agglomeration effects and congestion in the big city, there is a fundamental asymmetry between the two types of regions. This has important implications for the structure of incentives underlying the public policy in the economic federation.

The rest of the paper is organized as follows. In Section 2, we present the basic assumptions of our model and how individuals make their locational decisions. The basic model could be used to study how an inadequate choice of instruments leads to the kind of difficulties described in the introduction, with severe problems for small villages to finance elderly care. However, to save space we begin our analysis considering how an optimal tax/transfer system should be designed. Thus, as a benchmark, we describe the first best in Section 3, where the policy maker is assumed to decide upon each individual's consumption, the quality of elderly care as well as each person's location. As one of the starting points for the literature on the effects of mobility, Tiebout (1956) made strong claims that free mobility leads to an efficient allocation. Within our framework we obtain the opposite result, namely that free mobility leads to inefficiencies. Given the popular view that free mobility is efficiency-enhancing, we believe it is of interest to see how free mobility hampers the possibilities to achieve the first best, and how the incentives of the individuals differ from those of the social planner (due to the congestion and agglomeration effects). Thus, in Section 4, we consider how the results are affected, if the policy maker is free to set all variables except those associated with the individuals' locations. In Section 5, we consider a federation structure with local governments (deciding about local income taxation and elderly care quality) and a federal government (deciding about pensions and intergovernmental transfers). Our analysis explains why the lower level governments may have incentives to deviate from the second best, and identifies the policy instruments needed by the federal government in order to decentralize the second best resource allocation discussed in Section

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(2001).

<sup>5</sup>See also Boadway et al. (1998).

4. Section 6 concludes and discusses the policy implications of our analysis.

## 2 General model and individuals' location decisions

There is one big city and a given number, normalized to one, of small identical villages. There are two types of individuals:<sup>6</sup> productive people ( $e$ ) that work and earn an income and retired people ( $r$ ) who need care. Within each type, everyone is identical. Individuals can either live in the city or in the country-side and earners are assumed to work in the place where they choose to live. We use the notations  $N_b^r$ ,  $N_b^e$ ,  $N_v^r$  and  $N_v^e$  to represent the number of retired living in the big city, the number of earners living in the big city, the number of retired living in a village and the number of earners living in a village, respectively. In addition, we define  $N_b \equiv N_b^r + N_b^e$  and  $N_v \equiv N_v^r + N_v^e$ .

To keep the model tractable, we disregard the labor supply decision; each earner supplies one unit of labor inelastically. The utility of earners only depends on consumption and is represented by  $u(c)$ , where  $c$  denotes private consumption. The only decision made by each earner is where to live. On the other hand, the retired both consume the consumption good and elderly care. Their utility is given by  $u(c) + \phi(q)$ , where  $q$  denotes the quality of the care. The quality of elderly care is assumed to be directly proportional to the number of earners used to take care of each retired person. Also for them the only decision variable is the place where they reside.

In the city, which has a fixed area, there is a given number of (many) firms, each with a constant returns to scale production function. However, due to agglomeration effects, the marginal and average products of labor are increasing in the total number of individuals working in the consumption goods industry, i.e. the average and marginal product is given by  $w = F(N_b^e - qN_b^r)$  with  $F' > 0$ .<sup>7</sup> Here,  $qN_b^r$  denotes the number of earners that is needed to take care of the elderly living in the big city for a given level,  $q$ , of the quality of the service provided. Thus, the elderly and those taking care of the elderly do not contribute to the agglomeration effects. In the big city, there is also congestion; this is represented by the function  $m(N_b)$ , with properties  $m(\cdot) < 0$  and  $m'(\cdot) < 0$ , which gives the congestion imposed on each city-dweller.

In the villages, there is neither congestion nor agglomeration effects. The labor required to take care of  $N_v^r$  retired people is  $qN_v^r$ . The production of

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<sup>6</sup>To have three or more types would only complicate matters without adding any new qualitative insights.

<sup>7</sup>With a fixed area the density of workers will increase with the number of workers in the big city. See Ciccone and Hall (1996) both for a model of how productivity depends on population density of workers as well as for empirical evidence.



the consumption good is given by the constant returns to scale technology  $Q_v = (N_v^e - qN_v^r)\theta$ , where  $\theta$  is a constant. Since there is no congestion, providing elderly care in the country-side is cheaper than in the big city.

Much of the focus in this paper will be on the individuals' location decisions. To reflect the circumstance that the cost of mobility seems to vary over the life-cycle, we assume that earners are perfectly mobile across jurisdictions, whereas elderly people are imperfectly mobile.<sup>8</sup> For earners, the utility difference between living in a village and living in the big city is given by

$$\Delta^e = u(c_v^e) - u(c_b^e) - m(N_b). \quad (1)$$

Therefore, if  $\Delta^e > 0$ , an earner prefers to live in a village; if  $\Delta^e = 0$ , he/she is indifferent; and if  $\Delta^e < 0$ , he/she prefers to live in the big city.

Regarding the elderly, we assume that they are characterized by an attachment to home element, and that the attachment varies in strength among the retired. This is accomplished by following the approach of Wellisch (1994). Ranking the retired according to the strength of their attachment to a village in such a way that the individual with strongest attachment is numbered  $N_1^r$ , we obtain for individual  $j$ :

$$\Delta_j^r = u(c_v^r) + \phi(q_v) + h[N^r - N_j^r] - u(c_b^r) - \phi(q_b) - hN_j^r - m(N_b). \quad (2)$$

If  $\Delta_j^r > 0$ , the individual prefers to live in a village; if  $\Delta_j^r = 0$ , he/she is indifferent; and if  $\Delta_j^r < 0$ , he/she prefers to live in the big city.

### 3 First best analysis

The policy maker maximizes a utilitarian social welfare function. To facilitate comparisons with the second best analysis of Section 4, we use region specific lump-sum taxes to control the consumptions among the earners in the village and the big city, respectively, i.e.  $c_v^e = \theta - T_v^e$  and  $c_b^e = F(\cdot) - T_b^e$ .

The first and second best analyses are quite similar. The only difference is that, in the second best, we must consider two migration constraints that do not appear in the first best problem. To save on space, we start by presenting the policy maker's second best problem. Formally, this can be represented as:

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<sup>8</sup>See Topel (1986) for an empirical analysis showing that the degree of mobility among young agents is larger than among the old; for a theoretical model incorporating the assumption that agents' propensity to move declines with age see also Wildasin and Wilson (1996).

$$\begin{aligned}
& \max_{c_v^r, c_b^r, T_v^e, T_b^e, q_v, q_b, N_v^r, N_b^e} N_v^r [u(c_v^r) + \phi(q_v)] + N_b^r [u(c_b^r) + \phi(q_b)] \\
& + N_v^e u(\theta - T_v^e) + N_b^e u(F(N_b^e - q_b N_b^r) - T_b^e) \\
& + h \sum_{n=1}^{N_v^r} (N^r - n) + h \sum_{n=1+N_v^r}^{N^r} n + (N_b^e + N_b^r) m (N_b^e + N_b^r)
\end{aligned}$$

subject to

$$N_b^e T_b^e + N_v^e T_v^e - N_b^r [c_b^r + q_b F(N_b^e - q_b N_b^r)] - N_v^r (c_v^r + \theta q_v) \geq 0 \quad (\mu)$$

$$N_v^e - q_v N_v^r \geq 0 \quad (\gamma)$$

$$u(F(N_b^e - q_b N_b^r) - T_b^e) + m(N_b^e + N_b^r) - u(\theta - T_v^e) = 0 \quad (\lambda_1)$$

$$u(c_b^r) + \phi(q_b) + m(N_b^e + N_b^r) - u(c_v^r) - \phi(q_v) - 2hN_b^r + hN^r = 0 \quad (\lambda_2),$$

as well as subject to  $N_b^e = N^e - N_v^e$  and  $N_b^r = N^r - N_v^r$ .

The first constraint is the government's budget constraint. The second constraint states that the number of earners in the village must at least be sufficient to take care of the elderly living there. The last two constraints are migration constraints that we do not need to consider in the first best. The labels  $(\mu)$ ,  $(\gamma)$ ,  $(\lambda_1)$  and  $(\lambda_2)$  refer to the Lagrange multipliers attached to the constraints.

We assume there exists an interior solution to the problem above in the sense that there will be a nonzero population of earners and retired both in the representative village and in the big city. The first order conditions are presented in the Appendix. Setting  $\lambda_1$  and  $\lambda_2$  to zero we obtain the conditions that define the first best.

Here, we summarize the main results characterizing the first best and give the basic intuition behind them.

**Proposition 1** *The first best resource allocation is characterized by*

$$u'(c_b^r) = u'(c_v^r) = u'(c_b^e) = u'(c_v^e) = \mu, \quad (3)$$

$$\phi'(q_v) = \mu\theta + \gamma, \quad (4)$$

$$\phi'(q_b) = \mu [F + (N_b^e - q_b N_b^r) F'] , \quad (5)$$

as well as by the following conditions for  $N_v^e$  and  $N_v^r$ , respectively:

$$\gamma - (N_b m' + m) = \mu [F + (N_b^e - q_b N_b^r) F' - \theta] , \quad (6)$$

$$\begin{aligned} & \phi(q_v) - \phi(q_b) + h[N^r - 2N_v^r] - \gamma q_v - (N_b m' + m) \\ &= \mu \{ q_v \theta - q_b [F + (N_b^e - q_b N_b^r) F'] \} . \end{aligned} \quad (7)$$

**Proof.** With  $\lambda_1 = \lambda_2 = 0$ , eqs. (18-21) in the Appendix reduce to (3), while eqs. (22) and (23) reduce to (4) and (5). Using the identities  $c_b^e = F(\cdot) - T_b^e$  and  $c_v^e = \theta - T_v^e$ , and since (3) implies equalization of agents' consumption, we can rewrite (24) and (25) as (6) and (7). ■

The consumption good is perfectly transferable. Hence, it is no surprise that the first best is characterized by the equalization of the marginal utility of consumption for all agents (see eq. (3)). Given the assumption of additive separability, it also follows that the consumption is equal across all individuals. This means, in turn, that the lump-sum tax paid by the earners in the big city should exceed the lump-sum tax paid by the earners in the village, and that pensions should not be differentiated across space. However, elderly care is instead not transferable; what is produced in the village cannot be transferred to the big city and vice versa. Equations (4) and (5) imply that the quality of elderly care should be set so that its marginal utility (the left hand side) equals its marginal cost (the right hand side). From equation (6), it follows that  $\mu [F + (N_b^e - q_b N_b^r) F'] > \mu \theta + \gamma$ , meaning that at an optimum the marginal cost of elderly care is higher in the big city than in the village. Therefore, equations (4) and (5) require that the quality level of elderly care in the country-side should be higher than in the big city:  $q_v > q_b$ .

Equations (6) and (7) give the conditions for an optimal population distribution. From eq. (6), we see that the policy maker sets the number of earners in the village in such a way that the sum of the Lagrange multiplier  $\gamma$  and the welfare-enhancing effect of lowering congestion in the big city exactly balances the value of the net reduction in production (given by both a direct decrease  $F - \theta$  but also by a loss  $(N_b^e - q_b N_b^r) F'$  due to a weakening of the agglomeration effects). This implies that an individual earner and the policy maker evaluate the locational benefits and costs differently.

Since at a first best resource allocation the consumption of earners is equalized across localities, the only remaining term in (1) is the congestion term. Therefore, earners would strictly prefer to live in a village.<sup>9</sup> By

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<sup>9</sup>This result requiring an unequal treatment of equals is reminiscent of similar findings emphasized by Mirrlees (1972) and Hartwick (1980).

combining eqs. (1) and (6), we see that the policy maker values the village versus the big city according to

$$\Delta_e^p = \Delta^e - N_b m' + \gamma - \mu [F + (N_b^e - q_b N_b^r) F' - \theta]. \quad (8)$$

From the point of view of the policy maker, therefore, there are three additional effects in comparison with the decision rule facing the earner. First, the policy maker also recognizes that an extra person in the village reduces congestion in the big city,  $N_b m'$ . This effect works in the direction of allocating more earners to the villages. Second, if the number of earners in the country-side is just sufficient to take care of the elderly, and no production of the consumption good takes place locally, an additional earner is valuable also because he/she relaxes the binding  $\gamma$ -constraint. Third, an increase in the number of earners living in a village reduces output, which is captured by the term  $F + (N_b^e - q_b N_b^r) F' - \theta$ .

According to (7), the benefit of moving an additional retiree from the big city to the village (the left hand side of the equation) should exactly balance the cost (represented by the right hand side of the equation) of such a reallocation. The first group of terms  $(\phi(q_v) - \phi(q_b) + h[N^r - 2N_v^r])$  on the left hand side represents the net welfare gain in terms of increased utility of elderly care and attachment to home. The second term,  $-\gamma q_v$ , reflects the cost due to a tightening of the  $\gamma$ -constraint when an additional retired is moved to the country-side; if some production of the consumption good takes place also in the country-side, the  $\gamma$ -constraint is not binding and this term vanishes. Finally, there is the gain in terms of reduced congestion in the city which is given by  $-(N_b m' + m)$ . On the right hand side we have the net budget cost of moving an additional retired to the country-side. This can be decomposed into two components; (i) a direct effect due to the difference between the per-retired expenditure on elderly care in the village and in the big city,  $q_v \theta - q_b F$ , and (ii) an indirect cost saving effect due to the presence of agglomeration forces,  $-q_b [(N_b^e - q_b N_b^r) F']$ .

It may be of interest to compare the policy maker's valuation of the marginal retired person moving from the big city to a village with the valuation made by the marginal individual himself/herself. We can write the policy maker's valuation as

$$\Delta_r^p = \Delta^r - N_b m' - \gamma q_v + \underbrace{\mu [q_b F + q_b (N_b^e - q_b N_b^r) F' - q_v \theta]}_{\Xi}. \quad (9)$$

In comparison with the valuation made by the marginal individual himself/herself, the policy maker recognizes also in this case three additional effects. First, the congestion effect  $-N_b m'$  (which contributes to reduce the population in the big city). Second, the cost  $-\gamma q_v$  related to the need of

moving additional earners to the country-side, or lowering the quality of elderly care provided there, if the  $\gamma$ -constraint is binding. Third, the term  $\Xi$  shows how output changes as a retired is moved from the big city to a village. There is a direct increase in output by the amount  $q_b F$  in the big city and a corresponding decrease by  $q_v \theta$  in the village. However, since there now are  $q_b$  more workers in the consumption industry in the big city, an additional increase in output by  $q_b(N_b^e - q_b N_b^r)F'$  is due to the agglomeration forces. Depending on the relative size of  $q_b$  and  $q_v$  the term  $\Xi$  can be either positive or negative. Therefore, we cannot in general sign  $\Delta^r$ ; this would require additional assumptions. For instance, for sufficiently strong increases in the congestion effect,  $\Delta^r$  would be negative and the marginal retiree would like to move from a village to the big city. However, it is in general possible that  $\Delta^r$  is positive, implying that the marginal retired would like to move from the big city to a village.

To sum up, in the results corresponding to the first best the marginal utility of consumption should be equal across individuals. Due to congestion in the big city the marginal cost of elderly care will be lower in the village and for this reason the quality of elderly care will be higher in the village than in the big city. The allocation of individuals will be such that earners would like to move to a village. In general there would be retired wishing to move, but we cannot tell whether there would be retired in the big city that would like to move to a village or vice versa.

## 4 Second best analysis

We have seen that the first best is characterized by an allocation of individuals such that at least part of the population would like to move. Such an outcome is, of course, not sustainable in a setting where agents can freely choose where to live. It is therefore appropriate that we now consider the consequences of free mobility of individuals for the optimal policy chosen by the government. However, we still assume that the policy maker has instruments which allow him/her to perfectly control consumption and elderly care quality. Thus, the only choice left to people is the choice of residence. To deal with this case, we continue to treat  $N_v^r$  and  $N_v^e$  as the government's control variables while adding the migration equilibrium conditions as constraints in its optimization problem.<sup>10</sup> The problem is the one presented on p. 6 and including the  $\lambda_1$  and  $\lambda_2$  constraints. Proposition 2 provides a characterization of the second best optimum.

**Proposition 2** *The second best resource allocation is characterized by the following conditions:*

$$u'(c_v^r) = \frac{\mu N_v^r}{(N_v^r - \lambda_2)}, \quad (10)$$

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<sup>10</sup>This is also the approach followed by Sato (2000) and Boadway et al. (2003).

$$u'(c_b^r) = \frac{\mu N_b^r}{(N_b^r + \lambda_2)}, \quad (11)$$

$$u'(c_v^e) = \frac{\mu N_v^e}{(N_v^e - \lambda_1)}, \quad (12)$$

$$u'(c_b^e) = \frac{\mu N_b^e}{(N_b^e + \lambda_1)}, \quad (13)$$

$$\phi'(q_v) = \frac{(\mu\theta + \gamma)N_v^r}{(N_v^r - \lambda_2)}, \quad (14)$$

$$\phi'(q_b) = \frac{\mu N_b^r(F - q_b N_b^r F') + N_b^r(N_b^e + \lambda_1)u'(c_b^e)F'}{(N_b^r + \lambda_2)}, \quad (15)$$

$$\gamma - (N_b + \lambda_1)m' - \lambda_2 m' = \mu [F + (N_b^e - q_b N_b^r)F' - \theta + c_v^e - c_b^e], \quad (16)$$

$$-(N_b + \lambda_1)m' - \gamma q_v - \lambda_2(m' - 2h) = \mu [c_v^e + \theta q_v - c_b^e - q_b F - q_b(N_b^e - q_b N_b^r)F']. \quad (17)$$

**Proof.** See the Appendix. ■

Eqs. (10)-(13) show that at a second best solution the migration equilibrium constraints prevent in general the attainment of the result that the marginal utility of consumption is equalized across agents. In fact, since the first best solution was characterized by an unequal treatment of earners, with the welfare of workers in the big city being lower than the welfare of workers in the country-side, the migration equilibrium constraint  $\lambda_1$  is binding at the second best solution. Moreover, it can be easily shown that the Lagrange multiplier  $\lambda_1$  is positive.<sup>11</sup> Thus, according to (12) and (13) the marginal utility of consumption for earners should be higher in the village than in the big city. Therefore, in contrast to the first best where earners' disposable income is equal in the big city and the village, in the second best the disposable income of earners should be higher in the big city than in the village. With regards to the elderly, note that whereas the migration equilibrium constraint is in general binding, it is not possible to sign unambiguously the corresponding Lagrange multiplier  $\lambda_2$ .<sup>12</sup> In other words, although the consumption (i.e. pensions) for the elderly should be differentiated between big city and country-side, whether it should be higher in the former or in the latter depends respectively on whether  $\lambda_2$  turns out to be positive or negative.

<sup>11</sup>Combining the first order conditions of the government's problem with respect to  $T_v^e$  and  $T_b^e$  (eqs. (20) and (21) in the Appendix) it can be shown that  $\lambda_1 = N_b^e N_v^e [u'(c_v^e) - u'(c_b^e)] / N^e$ . In order to satisfy the equilibrium migration constraint for earners it must hold that  $c_v^e < c_b^e$ . Therefore, we have  $u'(c_v^e) > u'(c_b^e)$  and  $\lambda_1 > 0$ .

<sup>12</sup>From the first order conditions of the government's problem it can be shown that  $\lambda_2 = \frac{N_b^r N_v^r [u'(c_v^r) - u'(c_b^r)]}{N_v^r u'(c_b^r) + N_b^r u'(c_v^r)} (> 0)$ . If at an optimum  $\lambda_2 < (>) 0$ , then the amount of pension granted to a retiree in the country side is larger than the amount of pension granted to a retiree in the big city.

From equation (14), we see that the marginal utility of elderly care is no longer equal to its marginal cost. In the village the marginal utility is equal to the marginal cost scaled by the factor  $N_v^r / (N_v^r - \lambda_2)$ . According to equation (15), there is a similar scaling of the marginal cost in the big city, although the equilibrium condition also contains a term showing how the consumption of earners and, consequently, the constraint  $\lambda_1$  are affected as  $q_b$  is increased.

Eqs. (16) and (17) are the two conditions characterizing the optimal population distribution. Starting with (16), the right hand side reflects the net budget cost of inducing an additional earner to move to the country-side. It can be decomposed into two components. The first depends on the difference between the lump-sum tax levied on an earner in the big city and the lump-sum tax levied on an earner in the village,  $F - \theta + c_v^e - c_b^e$ . The second reflects the cost increasing effect due to reduced benefits associated with agglomeration in the big city,  $(N_b^e - q_b N_b^r) F'$ . On the left hand side, the first two terms are nonnegative. The first one measures the benefit associated with relaxing the  $\gamma$ -constraint, whereas the term  $-(N_b + \lambda_1) m'$  reflects part of the welfare effects following from reduced congestion in the big city when an additional earner moves to the country-side. It is unambiguously positive, since it can be shown that  $\lambda_1 > 0$ . The last term on the left side of (16) accounts for the remaining welfare effect due to reduced congestion costs in the big city. However, its sign is ambiguous since, as we have seen above, it is not in general possible to sign  $\lambda_2$ . A positive value of  $\lambda_2$  would imply an additional benefit associated with a marginal increase in the number of earners living in the village, whereas a negative value would imply an additional cost.

Turning to equation (17), the right hand side reflects the difference between the value of the resources absorbed by a retired person in the village and in the big city together with the value of the change in the benefits associated with agglomeration. The latter provides an evaluation of the benefit for the government's budget following from a marginal relocation of elderly from the big city to the village. On the left hand side, the term  $-(N_b + \lambda_1) m'$  is positive since  $\lambda_1 > 0$ . The second term,  $-\gamma q_v$ , is less than or equal to zero depending on whether or not the  $\gamma$ -constraint is binding. It measures the cost of a tightening of the  $\gamma$ -constraint due to an increase in the number of retired in the village. Finally, the sign of the third term on the left hand side is ambiguous; given that  $m' - 2h$  is negative, a marginal increase in the number of elderly living in the village would entail an additional benefit (cost) from the government's perspective if  $\lambda_2 > (<) 0$ .

## 5 The federal case

In this Section, we abandon the assumption of full centralization and assume the existence of local policy makers that are responsible for the provision of elderly care and, at least partly, for the funding of it. We assume that each local government decides upon the level of the local tax paid by the earners and the expenditures on elderly care subject to its budget constraint and the migration responses by the employed and elderly, respectively. The budget balance of other governments is, however, ignored: from the local perspective, the public revenues and expenditures of other localities are taken as given. Pensions are directly decided upon by the federal government; an assumption which is realistic from a practical perspective. To be more specific, the policy instruments decided upon by the federal government are the pensions facing the residents of the big city and the village, respectively, i.e.  $c_b^r$  and  $c_v^r$ , a set of subsidies proportional to the population of earners and retirees in the big city and the village, respectively, with the subsidy rates being denoted  $s_b^e$ ,  $s_b^r$ ,  $s_v^e$  and  $s_v^r$ , and redistributive lump-sum taxes/transfers,  $G_b$  and  $G_v$ . The last pair of instruments is standard and means that the federal government can redistribute resources lump-sum between the two levels of government. The idea behind the subsidies proportional to the number of earners and elderly in each locality is discussed below.

The order of decision making is as follows. In the first stage, the federal government chooses  $c_b^r$ ,  $c_v^r$ ,  $s_b^e$ ,  $s_b^r$ ,  $s_v^e$ ,  $s_v^r$ ,  $G_b$  and  $G_v$  anticipating the behavioral responses of the local governments and the private sector. In the second stage, the local government in locality  $j$  ( $j = b, v$ ) chooses the lump-sum tax to be paid by the earners,  $\tau_j^e$ , and the public expenditures on elderly care quality,  $q_j$ , taking as given the federal government's policy instruments while anticipating the behavioral responses of the private sector. Each local government treats the other local government as a Nash competitor in the sense of regarding the variables decided upon by the government in the other locality as exogenous. Finally, in the third stage, the private agents choose their place of residence treating the public decision variables (decided upon by both levels of government) as exogenous.

### 5.1 The Local Policy Problem

Each local government uses income taxation together with transfer payments from the federal government to finance the expenditures on elderly care. Let us start by briefly characterizing each such decision-problem. The problem solved by the policy maker in the big city can be written as

$$\max_{\tau_b^e, q_b, N_v^r, N_v^e} N_b^r [u(c_b^r) + \phi(q_b)] + N_b^e u(c_b^e) + h \sum_{n=1+N_v^r}^{N^r} n + N_b m(N_b)$$



subject to

$$N_b^e \tau_b^e + N_b^e s_b^e + N_b^r s_b^r - G_b - q_b N_b^r F(N_b^e - q_b N_b^r) \geq 0 \quad (\mu_b)$$

$$u(F(N_b^e - q_b N_b^r) - \tau_b^e) + m(N_b) - u(\theta - \tau_v^e) = 0 \quad (\lambda_b^e)$$

$$u(c_b^r) + \phi(q_b) + m(N_b) - u(c_v^r) - \phi(q_v) - 2hN_b^r + hN^r = 0, \quad (\lambda_b^r)$$

as well as subject to  $N_b^e = N^e - N_v^e$ ,  $N_b^r = N^r - N_v^r$ ,  $N_b = N^e - N_v^e + N^r - N_v^r$  and  $c_b^e = F(N_b^e - q_b N_b^r) - \tau_b^e$ . The Lagrange multiplier associated with each constraint is given in parenthesis.

In a similar way, the problem solved by the policy maker in the village becomes

$$\max_{\tau_v^e, q_v, N_v^r, N_v^e} N_v^r [u(c_v^r) + \phi(q_v)] + N_v^e u(c_v^e) + h \sum_{n=1}^{N_v^r} (N^r - n)$$

subject to

$$N_v^e \tau_v^e + N_v^e s_v^e + N_v^r s_v^r - G_v - N_v^r \theta q_v \geq 0 \quad (\mu_v)$$

$$N_v^e - q_v N_v^r \geq 0 \quad (\gamma_v)$$

$$u(F(N_b^e - q_b N_b^r) - \tau_b^e) + m(N_b) - u(\theta - \tau_v^e) = 0 \quad (\lambda_v^e)$$

$$u(c_b^r) + \phi(q_b) + m(N_b) - u(c_v^r) - \phi(q_v) - 2hN_b^r + hN^r = 0. \quad (\lambda_v^r)$$

as well as subject to  $N_b^e = N^e - N_v^e$ ,  $N_b^r = N^r - N_v^r$ ,  $N_b = N^e - N_v^e + N^r - N_v^r$  and  $c_v^e = \theta - \tau_v^e$ . The first order conditions for both problems are presented in the Appendix.

## 5.2 The federal government

It is apparent that, without proper incentives for the local governments, the population purchase choice would be suboptimal, since the lump-sum transfers alone are not sufficient to accomplish the same incentives as those underlying the second best resource allocation. Therefore, in order to implement the second best population distribution in the context of a federal decision-structure, the federal government must have access to policy instruments that independently affect the first order conditions for  $N_v^e$  and  $N_v^r$  characterizing each local government. This is the reason for introducing the subsidies  $s_b^e$ ,  $s_b^r$ ,  $s_v^e$  and  $s_v^r$ .

Given the framework described above, the decision variables facing the federal government are  $c_b^r$ ,  $c_v^r$ ,  $G_b$ ,  $G_v$ ,  $s_b^e$ ,  $s_b^r$ ,  $s_v^e$  and  $s_v^r$ , and the decision-problem will be to maximize

$$\begin{aligned} & N_b^r[u(c_b^r) + \phi(q_b)] + N_b^e u(c_b^e) + N_v^r[u(c_v^r) + \phi(q_v)] + N_v^e u(c_v^e) \\ & + h \sum_{n=1+N_v^r}^{N^r} n + N_b m(N_b) + h \sum_{n=1}^{N_v^r} (N^r - n) \end{aligned}$$

subject to

$$G_v + G_b - s_v^r N_v^r - s_v^e N_v^e - s_b^r N_b^r - s_b^e N_b^e - N_b^r c_b^r - N_v^r c_v^r \geq 0,$$

as well as subject to  $N_b^e = N^e - N_v^e$ ,  $N_b^r = N^r - N_v^r$ ,  $N_b = N^e - N_v^e + N^r - N_v^r$ ,  $c_b^e = F(N_b^e - q_b N_b^r) - \tau_b^e$  and  $c_v^e = \theta - \tau_v^e$ . Note also that the federal government anticipates how the local governments and the private sector responds to the public policy decided upon by the federal government. Therefore, the private and local public budget constraints as well as the first order conditions for the local public decision-problems are also part of the constraints facing the federal government.

We can now derive the following result:

**Proposition 3** *Given the set of policy instruments described above, the federal government can implement the second best resource allocation.*

**Proof.** See the Appendix. ■

The intuition behind Proposition 4 is straightforward. If the federal government uses the subsidies proportional to the number of earners and elderly, respectively, in each locality in order to correct for the external effects associated with mobility as well as uses the lump-sum taxes/transfers to reproduce the resource distribution in the second best, the population distribution preferred by each local government will correspond to the population distribution in the second best. What then remains for the federal

government is to choose  $c_b^r$  and  $c_v^r$  to replicate the choices made by the social planner in the previous Section. The second best levels for the consumption among the employed and the expenditures on elderly care, respectively, will then follow from the decisions made by the local governments (choices which are not themselves distorted by comparison with the second best model).

The exact formulas for  $s_b^e$ ,  $s_b^r$ ,  $s_v^e$  and  $s_v^r$  required to implement the second best are given in the Appendix. It is, nevertheless, worthwhile to discuss three aspects of the solution. The first is that, although  $s_b^r$ ,  $s_v^e$  and  $s_v^r$  can be either positive or negative, the optimal  $s_b^e$  is unambiguously negative. The latter means that the federal government imposes a tax proportional to the number of earners in the big city (see eq. (36) in the Appendix). This is so because the local policy maker in the big city tends to over-attract productive agents disregarding three effects that the corrective tax aims to internalize. These effects are (i) a pure welfare cost due to the fact that the utility added to the big city by an additional earner is offset by the utility lost in the village, (ii) a correction term associated with the  $\gamma$ -constraint (if it is binding) which recognizes that, if we were to attract an additional earner from the village to the big city, then this will lower the quality of the elderly care in the village, and (iii) a correction term due to that the policy maker in the big city neglects the reduction of the tax base facing the village, if an additional earner moves from the village to the big city.

The second aspect is that the instruments intended to affect the incentives facing the policy maker in the village, i.e.  $s_v^e$  and  $s_v^r$ , are designed to internalize marginal congestion and agglomeration effects. The intuition is, of course, that the policy maker in the village fails to recognize the welfare effects of its policy in terms of congestion and agglomeration in the big city. Note first that, in the absence of policy intervention by the federal government, the local policy maker in the village would not consider the benefit of reduced congestion in the big city. From this perspective, therefore, the policy maker in the village would choose an inefficiently low number of agents of each type, which is what  $s_v^e$  and  $s_v^r$  (in part) serve to correct. The contribution of agglomeration effects to the formulas for  $s_v^e$  and  $s_v^r$  are more complex, since a reallocation of earners and retired between the village and the big city will influence both the wage rate paid to earners and the cost of elderly care in the big city.

The third aspect that we would like to emphasize is that  $s_b^r$  and  $s_v^r$ , in part, serve to correct for a particular type of vertical external effect. This is so because, when choosing the values of their policy variables, the local governments ignore that a reallocation of elderly between the village and the big city influences the budget constraint of the federal government, which is due to our assumption that the federal government decides upon the pensions paid to the retired.<sup>13</sup> Therefore, an additional elderly in the

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<sup>13</sup>Note that the federal government is free to differentiate the value of the pension given

village will imply a negative (positive) vertical externality, if the pension granted to the elderly living in the village is higher (lower) than the pension granted to the elderly living in the big city.

## 6 Summary

The starting point of this paper is the observation that there is a tendency towards a geographically unbalanced demographic structure in many countries, with the “villages” being mainly populated by non-productive agents, while the “big cities” to a greater extent are populated by people in working ages. This unbalance poses a serious threat to the ability of many small jurisdictions to resort to taxation of local bases in order to finance a satisfactory level of public expenditures. At the same time, there are arguments suggesting that such a segmented spatial population distribution is not necessarily inefficient. To study these issues in more details, and to address the welfare and efficiency consequences of locational decisions among different agents, we examine a model that incorporates agglomeration forces and congestion effects in the metropolitan areas, and we make the (realistic) assumption that the degree of mobility of productive agents is in general higher than the degree of mobility among elderly people. The types of public expenditures we consider throughout the paper are pensions and publicly provided elderly care.

The first part of the analysis characterizes the first best resource allocation; namely, the allocation that would be chosen by a social planner empowered with the authority to freely decide upon the location of each agent. This resource allocation is not consistent with the underlying preferences for residential location, meaning that it is not sustainable in a framework where each consumer makes his/her own locational choice. Therefore, we also examine a second best regime, where a unitary government decides upon the public policy (taxation, pensions and elderly care quality) subject to a set of migration constraints, one for each type of agent. In the final part of the paper, we consider a federal structure, where the responsibility for the publicly provided elderly care is delegated to the local governments along with the power to tax the labor income facing the local residents. Our analysis explains why the lower level governments may have incentives to deviate from the second best, and identifies the policy instruments needed by the federal government in order to decentralize the second best resource allocation.

In the introduction, we discussed potential future problems descending from an unbalanced demographic structure for the sustainability of a proper level of publicly provided elderly care under the present system of grants. However, our analysis shows that with a proper widening of the set of instru-

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to the elderly according to the place where they live.

ments, the allocation of individuals can be controlled such that the second best resource allocation is obtained. Although perfectly feasible, as far as we know the kind of instruments considered in our analysis have not been used in actual policy making. The instruments needed are subsidies/taxes that are proportional to the number of earners and retired living in the big city and the village respectively. These subsidies/taxes should be payable by the local governments. For example, if there is a subsidy per elderly person given to the local regions, this subsidy should in general be region-specific. An interesting result is that there should be a per unit tax on earners in the big city. Such a tax might raise protests from earners in the big city, even though it really will benefit them in terms of less congestion and less expenditures for elderly care in the big city.

There are several possible extensions of our analysis. The most obvious is, perhaps, the introduction of a labor/leisure choice for the productive agents in combination with the abandonment of lump-sum taxation. Other possibilities would be to explicitly consider the functioning of the land market and/or introduce mobile capital. We leave these and other extensions for future research.

## 7 Appendix

### 7.1 First order conditions

The first order conditions for the problem on page 6 are

$$(N_v^r - \lambda_2) u' (c_v^r) = \mu N_v^r \quad (c_v^r) \quad (18)$$

$$(N_b^r + \lambda_2) u' (c_b^r) = \mu N_b^r \quad (c_b^r) \quad (19)$$

$$(N_v^e - \lambda_1) u' (c_v^e) = \mu N_v^e \quad (T_v^e) \quad (20)$$

$$(N_b^e + \lambda_1) u' (c_b^e) = \mu N_b^e \quad (T_b^e) \quad (21)$$

$$(N_v^r - \lambda_2) \phi' (q_v) = (\mu\theta + \gamma) N_v^r \quad (q_v) \quad (22)$$

$$\begin{aligned} (N_b^r + \lambda_2) \phi' (q_b) &= N_b^r (N_b^e + \lambda_1) u' (c_b^e) F' \\ &+ \mu N_b^r [F - q_b N_b^r F'] \quad (q_b) \end{aligned} \quad (23)$$

The first order conditions with respect to  $N_v^r$  and  $N_v^e$ , respectively, are given by

$$\begin{aligned}
& u(c_v^r) + \phi(q_v) - [u(c_b^r) + \phi(q_b)] - m + hN_b^r - hN_v^r \\
& + N_b^e u'(c_b^e) q_b F' - N_b m' - \gamma q_v - \mu N_b^r (q_b)^2 F' \\
& + \lambda_1 [u'(c_b^e) q_b F' - m'] - \lambda_2 (m' - 2h) \\
= & -\mu (c_b^r + q_b F - c_v^r - \theta q_v)
\end{aligned} \tag{24}$$

$$\begin{aligned}
& u(\theta - T_v^e) - u(F(N_b^e - q_b N_b^r) - T_b^e) - m \\
& - N_b^e u'(c_b^e) F' - N_b m' + \gamma + \mu (T_v^e - T_b^e + N_b^r q_b F') \\
& - \lambda_1 [u'(c_b^e) F' + m'] - \lambda_2 m' \\
= & 0
\end{aligned} \tag{25}$$

## 7.2 Proof of Proposition 2

To get (10), divide (18) by (19). For (14), first use (21) to rewrite (23) as

$$(N_b^r + \lambda_2) \phi'(q_b) = \mu N_b^r [F + (N_b^e - q_b N_b^r) F']. \tag{26}$$

Then divide (22) by (26) to get

$$\frac{(N_v^r - \lambda_2) \phi'(q_v)}{(N_b^r + \lambda_2) \phi'(q_b)} = \frac{\mu \theta + \gamma}{\mu [F + (N_b^e - q_b N_b^r) F']} \frac{N_v^r}{N_b^r}. \tag{27}$$

To get (14) multiply both sides of (27) by  $(N_b^r + \lambda_2)/(N_v^r - \lambda_2)$ .

Using the equilibrium migration condition  $u(c_b^r) + \phi(q_b) + m(N_b) = u(c_v^r) + \phi(q_v) + 2hN_b^r - hN^r$ , eq. (24) can be simplified to

$$\begin{aligned}
& N_b^e u'(c_b^e) q_b F' - \mu N_b^r (q_b)^2 F' - N_b m' - \gamma q_v \\
& + \lambda_1 [u'(c_b^e) q_b F' - m'] - \lambda_2 (m' - 2h) \\
= & \mu (c_v^r + \theta q_v - c_b^r - q_b F).
\end{aligned}$$

Dividing by  $\mu$  and using (21) gives (17).

Then, by using the equilibrium migration condition  $u(F(N_b^e - q_b N_b^r) - T_b^e) + m(N_b) = u(\theta - T_v^e)$ , eq. (25) can be simplified to

$$\begin{aligned}
& -N_b^e u'(c_b^e) F' - N_b m' + \gamma + \mu N_b^r q_b F' - \lambda_1 [u'(c_b^e) F' + m'] - \lambda_2 m' \\
= & \mu (T_b^e - T_v^e).
\end{aligned}$$

Dividing by  $\mu$  and using (21) gives (16).

### 7.3 Proof of Proposition 3

The first order conditions for the local policy problem in the big city are

$$\begin{aligned} N_b^r \phi'(q_b) - N_b^e N_b^r u'(c_b^e) F' - \mu_b (F - q_b N_b^r F') N_b^r \\ - \lambda_b^e N_b^r u'(c_b^e) F' + \lambda_b^r \phi'(q_b) = 0 \end{aligned} \quad (q_b) \quad (28)$$

$$(N_b^e + \lambda_b^e) u'(c_b^e) - \mu_b N_b^e = 0 \quad (\tau_b^e) \quad (29)$$

$$\begin{aligned} -[u(c_b^r) + \phi(q_b)] + N_b^e u'(c_b^e) q_b F' - h N_v^r \\ - N_b m' - m + \mu_b [-s_b^r + q_b F - N_b^r (q_b)^2 F'] \\ + \lambda_b^e [u'(c_b^e) q_b F' - m'] + \lambda_b^r (2h - m') = 0 \end{aligned} \quad (N_v^e) \quad (30)$$

$$\begin{aligned} -u(c_b^e) - N_b^e u'(c_b^e) F' - N_b m' - m + \mu_b (-s_b^e - \tau_b^e + N_b^r q_b F') \\ - \lambda_b^e [u'(c_b^e) F' + m'] - \lambda_b^r m' = 0. \end{aligned} \quad (N_v^e) \quad (31)$$

The first order conditions for the local policy problem in the village are

$$(N_v^r - \lambda_v^r) \phi'(q_v) - \mu_v \theta N_v^r - \gamma_v N_v^r = 0 \quad (q_v) \quad (32)$$

$$(N_v^e - \lambda_v^e) u'(c_v^e) - \mu_v N_v^e = 0 \quad (\tau_v^e) \quad (33)$$

$$\begin{aligned} u(c_v^r) + \phi(q_v) + h(N_v^r - N_v^e) + \mu_v (s_v^r - \theta q_v) - \gamma_v q_v \\ + \lambda_v^e [u'(c_v^e) q_v F' - m'] + \lambda_v^r (2h - m') = 0 \end{aligned} \quad (N_v^r) \quad (34)$$

$$u(c_v^e) + \mu_v (s_v^e + \tau_v^e) + \gamma_v - \lambda_v^e [u'(c_v^e) F' + m'] - \lambda_v^r m' = 0. \quad (N_v^e) \quad (35)$$

Let  $c_b^{e,*}$ ,  $c_b^{r,*}$ ,  $c_v^{e,*}$ ,  $c_v^{r,*}$ ,  $q_b^*$ ,  $q_v^*$ ,  $N_b^{e,*}$  and  $N_v^{r,*}$  denote the second best resource allocation derived in Section 4, whereas  $\mu^*$  and  $\gamma^*$  are associated Lagrange multipliers. Moreover, define  $N_b^*$  as  $N_b^* = N^e - N_v^{e,*} + N^r - N_v^{r,*}$ . Suppose the federal government solves the hypothetical second best problem and then chooses  $c_b^r = c_b^{r,*}$ ,  $c_v^r = c_v^{r,*}$  and

$$s_b^e = -\frac{1}{\mu^*} [u(c_v^{e,*}) + \gamma^*] - \theta + c_v^{e,*} < 0, \quad (36)$$

$$s_b^r = -\frac{1}{\mu^*}[u(c_v^{r,*}) + \phi(q_v^*) + hN_b^{r,*} + \gamma^*q_v^*] - c_b^{r,*} + c_v^{r,*} + \theta q_v^*, \quad (37)$$

$$\begin{aligned} s_v^e &= -\frac{1}{\mu^*}[u(c_b^{e,*}) + N_b^{e,*}u'(c_b^{e,*})F'(\omega^*) + m^* + N_b^*m'(N_b^*)] \\ &\quad -F(\omega^*) + c_b^{e,*} + N_b^{r,*}q_b^*F'(\omega^*), \end{aligned} \quad (38)$$

$$\begin{aligned} s_v^r &= -\frac{1}{\mu^*}[u(c_b^{r,*}) + \phi(q_b^*) - N_b^{e,*}u'(c_b^{e,*})F'(\omega^*)q_b^* + hN_v^{r,*} + m^* + N_b^*m'(N_b^*)] \\ &\quad + c_b^{r,*} + q_b^*F(\omega^*) - c_v^{r,*} - N_b^{r,*}(q_b^*)^2F'(\omega^*), \end{aligned} \quad (39)$$

where  $N_b^{e,*} = N^e - N_v^{e,*}$ ,  $N_b^{r,*} = N^r - N_v^{r,*}$  and  $\omega^* = N_b^{e,*} - q_b^*N_b^{r,*}$ . Then, if the lump-sum taxes/transfers are chosen such as to obtain the distribution of resources across localities implicit in the second best resource allocation, it follows that the second best resource allocation solves equations (28)-(35). Note also that, by combining the budget constraints of the federal and local governments, we obtain the resource constraint for the economy as a whole, which was used in the second best problem in Section 4.

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