Beine, M., Bertoli, S. and Fernández-Huertas, J. (2016). A Practitioners' Guide to Gravity Models of International Migration. The World Economy, v. 39, n. 4, pp. 496-512. Available in : https://doi.org/10.1111/twec.12265

A Practitioners' Guide to Gravity Models of International Migration

Michel Beine[1,2], *Simone Bertoli*[3,4] *and Jesús Fernández-Huertas Moraga*[5,6]
[1]*CREA, University of Luxembourg, Luxembourg, Luxembourg,* [2]*CES Ifo, Munich, Germany,* [3]*CERDI, University of Auvergne, Clermont Ferrand, France,* [4]*CNRS, Paris, France,* [5]*Department of Economic Analysis, Universidad Autónoma de Madrid, Madrid, Spain, and* [6]*IAE, CSIC, Bellaterra (Barcelona), Spain*

1. INTRODUCTION

THE review of the gravity model by Anderson (2011) credits Ravenstein (1885, 1889), for pioneering the use of gravity to model migration patterns,[1] long before the seminal contribution of Tinbergen (1962) who estimated a gravity equation of international trade flows. Trade economists have explored since then, albeit in a discontinuous way (Head and Mayer, 2015), the theoretical foundations of gravity models of trade, while the interest towards gravity models of migration has only recently regained momentum because of an enhanced availability of migration data, particularly of dyadic (origin–destination) nature.

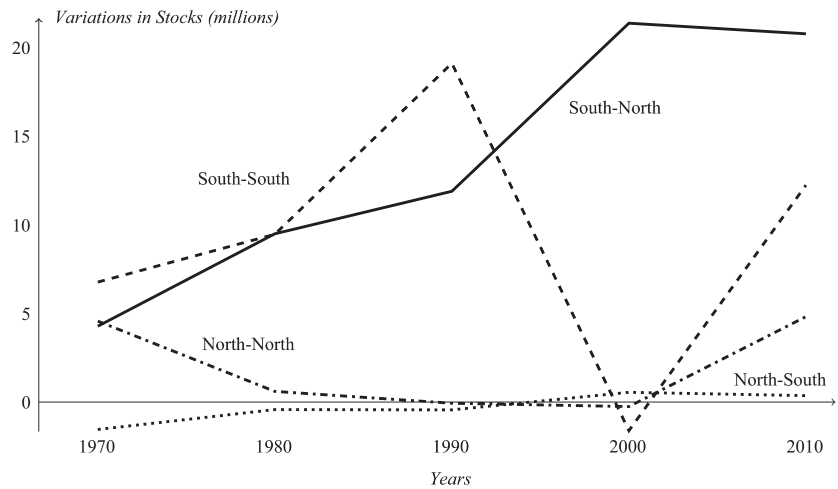
We rely on data from Özden et al. (2011) and World Bank (2013) to plot the decadal variations between 1960 and 2010 in migrant stocks, which have been used in the literature as a proxy for migration flows, along four main corridors. Figure 1 reveals how the dynamics of international migration drastically varies across corridors, strengthening the case for using dyadic data to analyse its determinants.

This paper is meant to represent a practitioners' guide to dyadic gravity models of migration, with three distinct but closely interconnected objectives. Section 2 analyses where the literature stands with respect to the effort to lay out the theoretical basis for the estimation of gravity equations through random utility maximisation (RUM) models, and which are the implications of the different micro-foundations for the specification of the equation that is brought to the data. Section 3 provides an overview of the main challenges connected to the estimation of gravity equations and to the interpretations of the results. In this respect, we focus on papers devoted to the analysis of the scale of migration flows or rates and disregard papers dealing with selection or sorting issues. Section 4 reviews the evidence that has been produced by the estimation of theory-based gravity equations. The paper then concludes with Section 5.

The authors are grateful to the guest editor Frédéric Docquier, to Tobias Müller and to an anonymous referee for their accurate reading of our paper. We also thank other participants in the Conference on 'International labour mobility and inequality across nations' held in Clermont Ferrand in January 2014; this paper benefited from the financial support of the FERDI (Fondation pour les Etudes et Recherches sur le Développement International) and of the programme 'Investissements d'Avenir' (ANR 10 LABX 14 01) of the French government; Jesús Fernández Huertas Moraga received financial support from the ECO2008 04785 and ECO2012 39412 projects funded by the Spanish Ministry for Economics and Competitiveness. The usual disclaimers apply.

[1] Niedercorn and Bechdolt (1969) quote Carey (1858) as an even earlier source.

FIGURE 1
Variations in Migrant Stocks Along Four Main Corridors



Note:
The partition of countries between the North and the South follows Ozden et al. (2011); the data referring to a decade are the variation in stocks with respect to the previous decade.

Source: Authors' elaboration of Ozden et al. (2011) and World Bank (2013).

2. MICRO FOUNDATIONS

a. Bilateral Migration Gross Flows

Let s_{jt} represent the stock of the population residing in country j at time t; we can write an accounting identity for the scale m_{jkt} of the migration flow from country j to country k at time t:

$$m_{jkt} = p_{jkt} s_{jt}, \tag{1}$$

where $p_{jkt} \in [0, 1]$ represents the actual share of individuals residing in j who move to k at time t. The migration literature has relied on RUM models that describe the location decision problem that individuals face to derive the *expected* value of p_{jkt}.

b. A RUM Model of Migration

The canonical RUM model of migration describes the utility that individual i who was located in country j at time $t-1$ derives from opting for country k belonging to the choice set D at time t as:

$$U_{ijkt} = w_{jkt} - c_{jkt} + \epsilon_{ijkt}, \tag{2}$$

where w_{jkt} represents a deterministic component of utility and c_{jkt} denotes the time-specific cost of moving from j to k, which can be both modelled as a function of variables that are observed by the econometrician, and ϵ_{ijkt} is an individual-specific stochastic term. The distributional assumptions on ϵ_{ijkt} determine the expected probability that opting for country k represents the utility-maximising choice of individual i. If we assume that ϵ_{ijkt} follows an independent and identically distributed extreme value type 1 distribution (McFadden, 1974), then:

$$E(p_{jkt}) = \frac{e^{w_{jkt} \quad c_{jkt}}}{\sum_{l \in D} e^{w_{jlt} \quad c_{jlt}}}. \tag{3}$$

This allows us to rewrite the expected gross migration flow from country j to country k as follows:

$$E(m_{jkt}) = \frac{e^{w_{jkt} \quad c_{jkt}}}{\sum_{l \in D} e^{w_{jlt} \quad c_{jlt}}} s_{jt}. \tag{4}$$

If we assume that the deterministic component of utility does not vary with the origin j, then we can rewrite (4) in a way that makes evident why this closely resembles to a gravity equation:

$$E(m_{jkt}) = \phi_{jkt} \frac{y_{kt}}{\Omega_{jt}} s_{jt}, \tag{5}$$

where $y_{kt} = e^{w_{kt}}$, $\phi_{jkt} = e^{\quad c_{jkt}}$ and $\Omega_{jt} = \sum_{l \in D} \phi_{jlt} y_{lt}$. The expected migration flow in (5) depends in a multiplicative way on (i) the ability s_{jt} of the origin j to send out migrants, (ii) the attractiveness y_{kt} of destination k, (iii) on the accessibility $\phi_{jkt} \leq 1$ of destination k for potential migrants from j, and it is inversely related to (iv) Ω_{jt}, which represents the exponentiated value of the expected utility of prospective migrants from the choice situation (Small and Rosen, 1981).[2]

We can immediately observe that $\partial \Omega_{jt} / \partial \phi_{jlt} = y_{lt} > 0$, so that a reduction in the accessibility of an alternative destination l invariably leads to an increase in the expected bilateral migration flow from j to k in (5). This, in turn, implies that we can extend to migration flows the thought experiment about trade flows proposed by Krugman (1995): if we imagine moving two European countries to Mars while keeping their attractiveness and bilateral accessibility unchanged, then the migration flows between the two countries would definitely increase.

If we take the ratio between $E(m_{jkt})$ and the corresponding expression for the expected number of stayers, normalising ϕ_{jjt} to one, we have that:

$$\frac{E(m_{jkt})}{E(m_{jjt})} = \phi_{jkt} \frac{y_{kt}}{y_{jt}}. \tag{6}$$

This ratio depends only on the attractiveness of destination k and of the origin j, and on the accessibility ϕ_{jkt}, while both Ω_{jt} and s_{jt} cancel out. This represents a manifestation of the well-known property of the independence from irrelevant alternatives that follows from the distributional assumptions *à la* McFadden (1974) on the stochastic term in (2): a variation in the attractiveness or in the accessibility of an alternative destination induces an identical proportional change in both $E(m_{jkt})$ and $E(m_{jjt})$, thus leaving (6) unchanged.

Bringing (5) to the data requires adding a well-behaved error term η_{jkt}, with $E(\eta_{jkt}) = 1$, to it, so that:

$$m_{jkt} = \phi_{jkt} \frac{y_{kt}}{\Omega_{jt}} s_{jt} \eta_{jkt}. \tag{7}$$

[2] Ω_{jt} also captures the deterministic component of utility of not migrating, that is, opting for the origin j.

The elegance and tractability of this model have made it the canonical reference in the migration literature, but it might be exposed to problems related to (i) the adequacy of the distributional assumption on the stochastic term and (ii) the specification of the deterministic component of utility. We are going to explore each of these two points in turn.

(i) Distributional Assumptions on the Stochastic Component

The derivation of (5) is based on the assumptions that the attractiveness of destination k varies neither across origin countries nor across individuals and that the stochastic component of utility is iid EVT-1. The hypotheses on the stochastic component can be regarded as 'the natural outcome of a well-specified model that captures all sources of correlation over alternatives into representative utility' (Train, 2003, p. 76), but the restrictive assumptions on the deterministic component of utility jeopardise the chances that the model is well specified.

Imagine, for instance, that destination countries differ with respect to the gender gap in wages: the assumption that the deterministic component of utility does not vary with gender is going to introduce a positive correlation in the stochastic component of utility for a woman across countries characterised by a similar gender gap in wages. Individuals could be also heterogeneous with respect to the psychic costs of migration to any destination (Sjaastad, 1962), and this would introduce a positive correlation in the stochastic component of utility across all countries but the origin (Ortega and Peri, 2013).

What happens if we introduce more general distributional assumptions, allowing for a correlation in the stochastic component of utility in (2) across different alternatives in the choice set? We can draw on Bertoli and Fernández-Huertas Moraga (2013) to generalise (5):

$$E(m_{jkt}) = \phi_{jkt}^{1/\tau} \frac{y_{kt}^{1/\tau}}{\Omega_{jkt}} s_{jt}, \tag{8}$$

where the parameter τ in (8) is inversely related to the correlation in the stochastic component of utility across alternatives. A key difference between (5) and (8) is that the resistance term Ω_{jkt} in the latter equation varies with the destination k, with the functional form of Ω_{jkt} depending on the different distributional assumptions that are adopted (Bertoli and Fernández-Huertas Moraga, 2013; Ortega and Peri, 2013; Bertoli and Fernández-Huertas Moraga, 2015).[3] This, in turn, implies that the resistance term no longer cancels out when we take the ratio between two different expected migration flows:[4]

$$\frac{E(m_{jkt})}{E(m_{jjt})} = \phi_{jkt}^{1/\tau} \frac{y_{kt}^{1/\tau}}{y_{jt}} \frac{\Omega_{jjt}}{\Omega_{jkt}}. \tag{9}$$

More general distributional assumptions, which are more consistent with the constraints imposed on the specification of the deterministic component of utility, no longer satisfy the

[3] Specifically, the distributional assumptions introduced by Ortega and Peri (2013), which capture the idea that agents have heterogeneous preferences for migration with the introduction of an individual specific stochastic component of utility that is common to all locations except the origin, imply that Ω_{jkt} does not vary with $k \in D/\{j\}$, but it nevertheless entails that $E(m_{jkt})/E(m_{jjt})$ does not uniquely depend on the attractiveness of k and j and on the accessibility ϕ_{jkt}.

[4] This expression is derived under the assumption, which is maintained in the literature (Beine et al., 2013; Bertoli and Fernández Huertas Moraga, 2013; Ortega and Peri, 2013; Bertoli and Fernández Huertas Moraga, 2015), that the origin country has no close substitute in the choice set.

independence from irrelevant alternatives property: specifically, an increase in the attractiveness of a destination that is perceived as a close substitute to k, will reduce $E(m_{jkt})$ more than $E(m_{jjt})$ (Bertoli et al., 2013b), thus inducing a decline in (9). This, in turn, questions the long-standing tradition in the migration literature of estimating the determinants of bilateral migration rates as a function of the attractiveness of j and k only (Hanson, 2010). A second key difference between (5) and (8) is that the bilateral accessibility ϕ_{jkt} and the attractiveness y_{kt} are raised to the power of $1/\tau$, with implications for the interpretation of the estimated coefficients that will be discussed in Section 3*d*.

(ii) The Specification of the Deterministic Component of Utility

The canonical RUM model of migration is surprisingly silent about the time dimension of the location decision problem that potential migrants face. The inclusion of a time subscript t in (2) suggests that individuals make repeated location choices during the course of their lifetimes. For instance, an individual who decided to migrate at time t might decide in a following period to return to their origin country or to move on to another destination. Similarly, an individual who found optimal not to change their location at time t could still consider moving at a later point in time.

These simple observations call for rewriting location-specific utility in a way that explicitly reflects the sequential nature of the location decision problem, following the literature on dynamic discrete choice models (Artuç et al., 2010; Arcidiacono and Miller, 2011; Kennan and Walker, 2011):

$$U_{ijkt} = w_{kt} + \beta V_{t+1}(k) - c_{jkt} + \epsilon_{ijkt}, \tag{10}$$

where $\beta \leq 1$ represents a discount factor, and $V_{t+1}(k)$ is the expected value of the optimal sequence of moves from time $t + 1$ onwards, conditional upon being located in country k at time t. The specification of utility in (10) reveals that the deterministic component of the attractiveness of country k at time t is $w_{kt} + \beta V_{t+1}(k)$,[5] and it thus depends also on (i) the future attractiveness of all locations in the choice set and (ii) the future values of the whole matrix of bilateral accessibility parameters.

We can observe, following Bertoli et al. (2013a), that (10) reduces to (2) only if we assume either that individuals take myopic decisions, that is, $\beta = 0$, or that we live in a frictionless world with no migration costs,[6] so that $V_{t+1}(k)$ does *not* vary with k and there is no path dependence in migration decisions.

If we derive the expression for the expected bilateral migration rate from (10) while maintaining the assumption that ϵ_{ijkt} is iid EVT-1, then we have (Bertoli et al., 2013a):

$$E(m_{jkt}) = \phi_{jkt} \frac{y_{kt}}{\Omega^V_{jt}} e^{\beta V_{t+1}(k)} s_{jt}, \tag{11}$$

where the resistance term Ω^V_{jt} is given by $\sum_{l \in D} \phi_{jlt} y_{lt} e^{\beta V_{t+1}(l)}$, and it does not vary with k. If we take the ratio between the expected number of migrants to k and the expected number of stayers at time t, we obtain:

[5] Notice that $w_{kt} + \beta V_{t+1}(k)$ does *not* represent the present discounted value of the expected stream of w_{ks}, with $s \geq t$+1.

[6] This represents a theoretically interesting limiting case, as in Anderson (2011), but certainly not a good approximation of the real world.

$$\frac{E(m_{jkt})}{E(m_{jjt})} = \phi_{jkt} \frac{y_{kt}}{y_{jt}} e^{\beta[V_{t+1}(k) - V_{t+1}(j)]}. \tag{12}$$

The expression in (12) reveals that even the traditional distributional assumptions *à la* McFadden (1974) do not allow to express this ratio just as a function of the current attractiveness of j and k and of the accessibility ϕ_{jkt}, as (12) is sensitive to variations in the future attractiveness of alternative destinations (Bertoli et al., 2013a).

3. CHALLENGES FOR THE ESTIMATION

a. What is the Origin of the Migrant?

An international migrant can be defined as 'any person who changes his or her country of usual residence' (United Nations, 1998), but the measures of the bilateral gross migration flows m_{jkt} often depart from this definition. Specifically, the origin j can be defined as (i) the country of birth, (ii) the country of citizenship or (iii) the country of last residence of the migrant. These three criteria partly overlap, but do not coincide, because of naturalisations and of repeated migration episodes. Existing data sources rarely provide information on more than one of the criteria (i)–(iii), so that, say, data on bilateral migration flows based on the country of birth j aggregate the migration decisions of individuals who are citizens and that resided in countries other than j. The adoption of one of these three criteria, which is often data-driven, presents some advantages and limitations. For instance, some dyadic determinants of migration costs, such as visa waivers, depend on citizenship, while linguistic proximity could depend more closely on the country of birth and economic conditions in the country of last residence could shape the incentives to move. This type of measurement error contributes to departing from the iid assumption in Section 2*b*(*i*).

b. The Empirical Counterpart for the Log Odds

The RUM model analysed in Section 2 implies that the logarithm of the odds of migrating to country k over staying in country j in (6) can be expressed as a linear function of the differential in the deterministic component of utility associated with the two countries. Ideally, the empirical counterpart of the log odds would be represented by the ratio between the gross flow of migrants from j to k observed on a certain time period[7] over the number of individuals who remained in j throughout the period.

As far as the numerator of this ratio is concerned, gross flows have been used by Mayda (2010), Ortega and Peri (2013), Bertoli and Fernández-Huertas Moraga (2013), McKenzie et al. (2014) and Bertoli et al. (2013a). Other papers have used a proxy for the gross flows represented by the variations in migration stocks (Beine et al., 2011a; Beine and Parsons, 2015; Bertoli and Fernández-Huertas Moraga, 2015). A limitation is that variations in stocks differ from gross flows as they are also influenced by return migration, migration to third countries, deaths and naturalisations (if the definition of immigrants is based on citizenship)

[7] The length of the time period also represents a crucial analytical choice: longer time periods, such as a decade, create problems for the (implicit) assumption in the RUM model that the deterministic component of location specific utility in (2) does not vary within the period.

and births (if the country of destination adopts the *ius sanguinis*).[8] Furthermore, while m_{jkt} is by definition non-negative, variations in stocks can take negative values, which have been excluded from the sample (Beine et al., 2011a), set to zero (Bertoli and Fernández-Huertas Moraga, 2015) or added to the proxy for the flow from k to j (Beine and Parsons, 2015). Grogger and Hanson (2011), Llull (2011) and Belot and Hatton (2012) have used stocks for the numerator, but this choice creates a tension with the underlying micro-foundation of the gravity equation, unless one assumes a frictionless world.

For the denominator, the size of population at origin has been used (Bertoli and Fernández-Huertas Moraga, 2015), possibly restricted to certain age cohorts (Bertoli et al., 2013a), but this also includes immigrants, or the number of natives at origin (Beine and Parsons, 2015), which represents a superior alternative as it only includes stayers and returnees. A convenient alternative, for data sets that include multiple destinations, is represented by the inclusion of origin-time dummies d_{jt} that control for the denominator of the dependent variable, although this choice comes at a cost that is discussed in Section 3*d* below.

c. Multilateral Resistance to Migration

Bertoli and Fernández-Huertas Moraga (2013) define multilateral resistance to migration as the confounding influence that the attractiveness of alternative destinations exerts on the bilateral migration rate. Section 2 follows Bertoli et al. (2013a) and shows how multilateral resistance to migration can arise either from more general distributional assumptions on the stochastic component in (2), or from explicitly accounting for the sequential nature of migration decisions.

Ignoring the term Ω_{jkt} in (9) generates biases in the estimation of the coefficients of the determinants of migration. For example, both Bertoli and Fernández-Huertas Moraga (2013) and Bertoli et al. (2013a) find that the effect of economic conditions at origin on migration rates is overestimated when the influence of alternative destinations is ignored. The reason is that economic conditions can be positively correlated between origins and alternative destinations, both over time and space. Thus, when alternative destinations are disregarded, the origin term w_{jt} picks up both its own effect and the effect of these alternative destinations that goes through Ω_{jkt}. The scope for large biases is even more pronounced when migration policies are considered. Given that migration policies tend to be coordinated among destination countries, for example within the Schengen area, it is not surprising that studies controlling for multilateral resistance to migration tend to find much larger policy effects than studies that do not control at all (Bertoli and Fernández-Huertas Moraga, 2013; Bertoli and Fernández-Huertas Moraga, 2015). This happens even in the case of empirical strategies that only control for Ω_{jkt} under less general distributional assumptions (Ortega and Peri, 2013; Beine and Parsons, 2015).

Different authors have proposed different strategies to control for Ω_{jkt}. When the panel and longitudinal dimension of the data set are large enough, the resistance term nicely conforms with the structure of the CCE estimator proposed by Pesaran (2006). This is the methodology used by Bertoli and Fernández-Huertas Moraga (2013) and Bertoli et al. (2013a), and it has the additional advantage of being robust even in the presence of residual cross-sectional dependence in the data (Pesaran and Tosetti, 2011). Using less data-demanding approaches, Ortega and Peri

[8] A distinct advantage of variations in stocks is that they can allow to obtain (a proxy for) migration flow data disaggregated by education although the study of selection and sorting is out of the scope of this paper.

(2013) control for the multilateral resistance to migration that is induced by an heterogeneity in the preference for migration, so that Ω_{jkt} does not vary across destinations k except the origin j itself. This empirically corresponds to estimating the gravity equation with origin-year dummies d_{jt}. Bertoli and Fernández-Huertas Moraga (2015) go one step further and assume that potential migrants are heterogeneous in their preferences towards subsets (nests) of destination. With their cross-sectional data, this specific form of Ω_{jkt} can be controlled for with origin-nest dummies. Finally, Beine and Parsons (2015) use destination-year dummies d_{kt}, which allow them to partly control for the dynamic resistance terms introduced in Section $2b(ii)$.

Whether any of these alternative approaches or even the classical one that ignores multilateral resistance to migration altogether is enough to generate unbiased estimates is ultimately an empirical question. Following the theory, one necessary condition for the estimates to be RUM-consistent is to make sure that their residuals are cross-sectionally independent. In this sense, Bertoli and Fernández-Huertas Moraga (2015) propose adapting the CD test by Pesaran (2004) to verify that Ω_{jkt} is properly controlled for.

d. Estimates and Structural Parameters of the RUM Model

Using a micro-founded model with more general distributional assumptions comes at a cost in terms of the interpretation of the coefficients. As discussed in Section $2b(i)$ above, generalising the distributional assumptions on ϵ_{ijkt} in (2) implies that the estimation of the gravity equations does not identify the vector of structural parameters that relate the attractiveness w_{kt} and the accessibility ϕ_{jkt} of a destination to the vectors of observed determinants, but the ratio between this vector and the dissimilarity parameter τ. Aggregate migration data do not necessarily allow to separately identify τ, which influences the elasticity of bilateral migration flows with respect to each of the determinants of w_{kt} and ϕ_{jkt} (Bertoli and Fernández-Huertas Moraga, 2015). One can rely on the fact that $\tau \in (0,1]$ and that the elasticities are monotonic functions of τ to construct bounds for the elasticities of interest, following Schmidheiny and Brülhart (2011). The inclusion of origin-time dummies d_{jt} among the regressors[9] implies that the estimates are consistent with a RUM model that is not based on distributional assumptions *à la* McFadden (1974), so that the fundamental uncertainty in the estimated elasticities should always be considered.

e. Estimation in Logs or in Levels

The pseudo-gravity model of migration derived from the underlying RUM model can be estimated using as the dependent variable either the level of the bilateral gross migration flow in (7), or the empirical counterpart q_{jkt} of the ratio of choice probabilities in (6). This second option requires estimating, through OLS, the following equation:

$$q_{jkt} = \ln(\phi_{jkt}) + \ln(y_{kt}) - \ln(y_{jt}) + \ln\left(\frac{\eta_{jkt}}{\eta_{jjt}}\right). \quad (13)$$

Santos Silva and Tenreyro (2006) made the point that the assumption that $E(\eta_{jkt}) = 1$ does not imply that $E\left[\ln\left(\eta_{jkt}/\eta_{jjt}\right)\right] = 0$, and that the heteroscedasticity of η_{jkt} entails that the

9 See, for instance, Beine et al. (2011a), Ortega and Peri (2013) and McKenzie et al. (2014) for different justifications for the inclusion of these dummies.

expected value of $\ln\left(\eta_{jkt}/\eta_{jjt}\right)$ in (13) will be a function of the value of the regressors, thus making OLS estimates biased and inconsistent. This, in turn, calls for relying on the bilateral gross migration flow as the dependent variable as in (7), and estimating the model with Poisson pseudo-maximum likelihood (PPML). This choice always requires including origin-time dummies among the regressors, to control for the resistance term Ω_{jt} and for the number of potential migrants s_{jt}, while the inclusion of these dummies is, as discussed in Section 2*b*, not strictly necessary when estimating (13).[10]

The choice of the estimation technique for the gravity model of migration confronts the researcher with an important trade-off: the reliance on linear models through the logarithmic transformation widens the menu of estimators that can be adopted, as discussed in Section 3*b*, to deal with multilateral resistance to migration, while Bertoli and Fernández-Huertas Moraga (2015) represents, to date, the only paper that deals with multilateral resistance to migration with PPML under more general distributional assumptions than Ortega and Peri (2013)[11] through a richer structure of fixed effects. Also, since PPML requires the use of origin-time dummies, it is not possible to identify origin-time effects, such as the effect of income at origin, while the logarithmic transformation makes this feasible.

(i) Presence of Zeros in the Data

The case for relying on PPML is strengthened when the dependent variable takes zero values, as Santos Silva and Tenreyro (2011) have shown that this estimator performs well even in the presence of a large share of zeros in the data.[12] An alternative to linear models is represented by a two-stage selection model *à la* Heckman adopted by Beine et al. (2011a). Identification is improved by the availability of a variable that can be excluded from the second-stage equation, but credible exclusion restrictions are hard to find with data that have a longitudinal dimension.

f. Omitted Variables and Instrumentation

The existence of omitted variables drives a wedge between w_{kt} and c_{jkt} in (2) and their empirical counterparts. This calls for estimation approaches that are consistent with more general distributional assumptions on ϵ_{ijkt} in (2), as omitted variables end up in the error term and can give rise to a correlation in the stochastic component of utility across destinations (Train, 2003). Controlling for multilateral resistance to migration can make instrumentation unnecessary as long as the endogeneity problem is not due to reverse causality, or as long as the resistance terms capture a big part of the omitted factors.

If the two above conditions do not apply, instrumentation of some of the key variables might be needed. Three issues arise in that respect. The first issue is, of course, the search for a valid instrument, which is not trivial. The presence of serial correlation in the error term of specification (4) invalidates the use of internal instruments, that is, past bilateral flows in a panel set-up. This means that external instruments should be favoured. For instance, networks

---

[10] The estimation of (13) with the CCE estimator proposed by Bertoli and Fernández Huertas Moraga (2013) allows to deal with heteroscedastic disturbances in (7).

[11] PPML estimates are always consistent with heterogeneity in the propensity to migrate when origin time dummies are included.

[12] The estimation of the reduced sample of non zero observations or with scaled OLS gives rise to large biases (Santos Silva and Tenreyro, 2011).

are clearly endogenous in equation (4). Endogeneity might come from omitted variables, for example networks are correlated with unobserved cultural proximity, but in some cases also from some kind of reverse causality, for example, flows are computed from variations in stocks, which represent the macro proxy of the size of networks. To that purpose, Beine et al. (2011a) use the past existence of bilateral guest worker programmes at destination to instrument for networks.

A second issue is that instrumentation preferably needs to take place in a Poisson regression set up, as discussed in Section 3*e* above. Tenreyro (2007) proposes to combine PPML estimation and instrumentation using a GMM type of estimator. Beine et al. (2014) implement that approach in the context of international migration of students. Nevertheless, the estimation might face in practice important problems of convergence towards the optimal values of the estimates and one cannot rule out the existence of local maxima in the support of admissible values for the key parameters. Finally, if multilateral resistance to migration is still an issue, the instrumentation procedure should ideally account for it, both in the first and in the second stage.

4. SOME RUM BASED EMPIRICAL EVIDENCE

The attractiveness w_{jkt} of a country for potential migrants from j and the bilateral migration costs c_{jkt} are usually modelled as linear functions of two (possibly overlapping) vectors of variables, which can vary over all combinations of the origin (j), destination (k) and time (t) dimension. We acknowledge our review is far from being exhaustive. In particular, we review some existing empirical evidence on the determinants of international migration flows (and rates) derived from the estimation of gravity models with dyadic data based on an underlying RUM model.

a. Origin or Destination-specific Factors

(i) Income

A key determinant of the attractiveness w_{kt} of each location is represented by its level of income *per capita*. A RUM-based model of migration does not impose any constraint on the functional form of the relationship between income *per capita* and the deterministic component of location-specific utility in (2). Grogger and Hanson (2011) favour a specification where w_{kt} depends linearly on income *per capita*, while other papers in the literature opt for a logarithmic specification (Mayda, 2010; Bertoli et al., 2013b; Bertoli and Fernández-Huertas Moraga, 2013; Ortega and Peri, 2013; McKenzie et al., 2014).[13] The literature generally assumes that the income prospects of potential migrants from all origins can be measured through GDP *per capita* at destination,[14] thus mostly imposing the assumption of a common trend in migrants' earnings at destination, with Bertoli and Fernández-Huertas Moraga (2013) representing an exception in this respect, and also minimising the concerns about reverse causality. Refinements have been proposed by Grogger and Hanson (2011), which apply country-specific income tax schedules to obtain measures of post-tax earnings, Grogger and Hanson (2011) and Belot and Hatton (2012), which recover education-specific earnings, and by Beine et al. (2013), which focus on wages rather than on earnings. The empirical evidence points to

[13] This choice is also related to the modelling of credit constraints, which is discussed in Section 4*a*(*ii*).
[14] We have relied on this common practice for the derivation of (5).

a robust positive relationship between income *per capita* and w_{kt}, with variations in earnings at destination that exert a stronger influence on the bilateral migration rate than identical proportional variations at origin in estimates that are consistent with departures from the standard distributional assumptions (Bertoli et al., 2013b).[15]

(ii) Credit Constraints

The canonical RUM model of migration with distributional assumptions *à la* McFadden (1974) implies that a simultaneous identical variation in the (logarithm of) income *per capita* at origin and at destination does not influence the bilateral migration rate. Such a perfect symmetry disappears if we consider that potential migrants might face credit constraints that hinder their location choices. Credit constraints can be accommodated into the model by assuming that bilateral migration costs c_{jkt} are negatively correlated with income at origin and hence with w_{jt}. If the dependency of bilateral migration costs on economic conditions at origin is not properly controlled for, then an increase in incomes at origin would reduce the bilateral migration rate less than an identical decrease at destination, and it might even expand the scale of bilateral migration flows. The role of credit constraints has thus been captured either through the inclusion higher-order terms of income at origin (Vogler and Rotte, 2000; Clark et al., 2007; Pedersen et al., 2008; Mayda, 2010), controlling for the incidence of poverty at origin (Belot and Hatton, 2012) or splitting the sample as a function of income at origin (Ortega and Peri, 2013).[16] The econometric evidence provided by Vogler and Rotte (2000), Clark et al. (2007), Pedersen et al. (2008) and Belot and Hatton (2012) suggests that credit constraints do hinder observed international migration flows, blurring the effect of income if not properly controlled for (Belot and Hatton, 2012).

(iii) Expectations

The sequential model of migration that we summarised in Section 2*b*(*ii*) implies that the current bilateral migration rate depends on the expectations about the evolution of economic conditions in all countries belonging to the choice set. Bertoli et al. (2013a) have recently provided econometric evidence on the highly significant role of expectations in driving bilateral migration flows to Germany between 2006 and 2012. Variations in expectations about the future attractiveness of the origin country can influence current migration decisions even after controlling for traditional determinants of the current attractiveness of a country. Furthermore, when the confounding influence exerted by the future attractiveness of alternative destinations is not controlled for, the estimates of the effect of current labour market conditions at origin are significantly upward biased.

(iv) General Immigration Policies

Migration costs c_{jkt} can be, at least partly, policy-induced. The immigration policies adopted by the country of destination can be either general, that is, addressed to all countries

---

[15] The heterogeneity of the approaches, in terms of wage data, specifications and data frequencies, prevents us from presenting some clear cut result in terms of elasticities. For instance, Grogger and Hanson (2011) focus on the skill ratio rather than on migration flows. Using annual data of wage compensations, Beine et al. (2013) obtain an elasticity around 0.8, implying that an increase in the wage differential of 1 per cent boosts the bilateral migration flow by slightly less than 1 per cent.

[16] The inclusion of origin time dummies d_{jt} also allows to purge the estimated effect of income *per capita* on location specific utility from the possible dependency of c_{jkt} on w_{jt}.

of origin, or bilateral. We analyse here evidence on general immigration policies, while bilateral policies are dealt with in Section 4*b*(*ii*). Limited progress has been made on the measurement of policy-induced migration costs compared to the existing data sources on tariff and non-tariff barriers to trade (Anderson and van Wincoop, 2004). Early attempts have been provided by Clark et al. (2007), Mayda (2010) and Ortega and Peri (2013). In particular, Ortega and Peri (2013) analyse the role of general immigration policies in a micro-founded gravity model as in (8). The key policy measure, which represents an extension of Mayda (2010), refers to an index of entry tightness over the period 1980–2006 for 15 OECD countries. This index, which is not comparable across destinations, is negatively associated with the scale of incoming migration flows in estimates where between-destination variability is not used for identification. An attempt to build measures of immigration policies that are comparable both between countries and over time is represented by the ongoing IMPALA project, which aims at building a database based on immigration laws in the 26 most important destination countries.[17] While progress has been made on this front, we are nevertheless very far away from a full-fledged usable database in the estimation of gravity models. In the absence of satisfying measures on immigration, one can nevertheless make use of the panel dimension and include d_{kt} fixed effects that control for the influence of general immigration policies, as in Beine et al. (2011a), Bertoli and Fernández-Huertas Moraga (2015) and Beine and Parsons (2015).

(v) Environmental Factors

There is a very substantial empirical literature on the impact of environmental factors, and climatic factors in particular, on international migration. The channels through which climatic factors spur emigration are many-fold, with four of them mostly considered in the literature. First, negative climatic shocks decrease income at origin, which influences w_{jt}, through a decline in wages or a rise in the employment rate. Second, the shocks might increase bilateral migration costs c_{jkt} if they destroy assets, thus making credit constraints more binding. Third, detrimental climatic shocks tend to decrease attractiveness at origin independently from income (for instance, because of an increase in morbidity), which in turn leads to emigration. A fourth channel can be called the volatility channel: if climatic conditions become more volatile, then this can increase the volatility of w_{jt}, inducing risk-averse people to opt for migration.

Most of the empirical literature linking climatic factors and migration has operated in models of monodic migration flows (see, for instance, Marchiori et al., 2012), as opposed to dyadic flows which is the basic unit of analysis in gravity frameworks. In general, the literature finds much evidence in favour of a strong labour market channel but also finds compelling evidence that in some cases, the liquidity channel is at work. In contrast with this extensive literature on climatic shocks, there is much less work relying on gravity models of migration. Beine and Parsons (2015) represent a noticeable exception. Their use of a longitudinal multiple-origin multiple-destination data set allows the inclusion a rich combination of fixed effects for capturing unobservable factors. In particular, the inclusion of d_{kt} fixed effects allows to control for general immigration policies. This is particularly important since the main effects of climatic factors are supposed to operate in South–North (and South–South) international migration. Immigration policies in developed countries are expected to be quite restrictive for prospective migrants coming from less developed countries, the areas that are the most

[17] The general presentation of the project and an analysis of preliminary data are exposed in Burgoon et al. (2013).

adversely affected by climatic shocks. Beine and Parsons (2015) find support in favour of a strong labour market channel in South–North migration, but reject the so-called amenity channel.

b. Dyadic Factors

The dyadic factors that influence migration costs c_{jkt} can be both time-invariant, such as linguistic and cultural proximity, and time-varying factors, such as bilateral migration policies and networks. We cover these factors in reverse order.

(i) Networks

An extensive literature has been devoted to the role of migration networks on the magnitude and the shape of bilateral migration flows.[18] The role of networks has been analysed in micro-founded gravity models such as (4); while there are obviously econometric challenges to be overcome in order to correctly estimate that effect, the few existing papers based on structural gravity models (Beine et al., 2011a; Beine and Parsons, 2015; Bertoli and Fernández-Huertas Moraga, 2015) come up with quite consensual results:[19] a 10 per cent increase in the bilateral migration stock leads to a 4 per cent increase in the bilateral migration flow over the next ten years. This elasticity increases to 0.7 when we restrict our attention to migration to OECD destinations, and it is higher for low-educated than for high-educated migrants, thus lowering the average level of education of the migrants.[20] We can also notice that the share of explained variability by structural gravity models of migration is in the range of 50 to 70 per cent, and at least one-third of that proportion can be ascribed to the network effect. Failure to account for networks can lead to an omitted variable bias. This is well illustrated by the role of colonial links. Once accounted for the network effect, regressions based on micro-founded gravity models such as (4) fail to find any remaining role for colonial links.

(ii) Bilateral Immigration Policies

Two broad types of measures capturing bilateral policies have been used in the literature. First, one can capture the prevalence of bilateral agreements between countries: for instance, Grogger and Hanson (2011) and Beine et al. (2013) find larger bilateral migration flows when both the origin and the destination country are signatories of the Schengen agreement,[21] and Beine et al. (2013) provide similar evidence for the bilateral agreements between OECD countries collected by the IOM. The second main measure relates to bilateral visa policies. Visa waivers, which do not belong *de iure* to the legal framework that regulates immigrants' admission at destination, can facilitate the legal entry of migrants, thus reducing the bilateral migration costs c_{jkt}, and also reflect a preferential treatment at the dyadic level. Bertoli and Fernández-Huertas Moraga (2013) provide evidence on the impact of

[18] For classical examples of a microeconomic analyses of the role of migrants' networks, which are not covered here, see Munshi (2003) and McKenzie and Rapoport (2010).

[19] Additional evidence is also provided by Dreher and Poutvaara (2011); Beine et al. (2014) and Peder sen et al. (2008).

[20] This aggregate effect can be decomposed into an assimilation channel, for example decrease in policy *un*related migration costs such as information and adaptation costs, and into a policy related effect, with Beine et al. (2011b) proposing an identification strategy to disentangle the two channels.

[21] Ortega and Peri (2013) provide similar evidence, but their Schengen dummy is not bilateral, as it is based only on the signatory status of the destination country.

visa waivers on bilateral migration flows to Spain in a specification that uses high-frequency migration data and controls for time-varying bilateral unobservables, including cultural proximity, through a rich structure of fixed effects. Similar evidence is provided by Bertoli and Fernández-Huertas Moraga (2015) and Beine and Parsons (2015), with this latter paper using longitudinal data on bilateral visa policies collected by the DEMIG project at Oxford University.[22]

(iii) Linguistic and Cultural Proximity

As in the trade literature, the most important time-invariant dyadic components of bilateral migration costs c_{jkt} are bilateral distance, colonial links, linguistic and cultural proximity. Bilateral distance does not require much explanation. As discussed above, the influence of colonial links can be indirectly captured through the network effect. This is in contrast with linguistic proximity that exerts some additional effect beyond its influence through networks. Most of the analysis based on gravity equations and covered here capture the role of languages either through the use of dummies for the existence of a common (official or spoken) language between j and k, or through some simple measures of linguistic proximity. More elaborated indicators of linguistic proximity have been nevertheless used in gravity equations: Belot and Ederveen (2012) and Adsera and Pytlikova (2012) employ various measures of proximity, based either on family trees established by linguists or on measures of phonetic similarity between languages. This captures the fact that Italian prospective migrants can more easily become proficient in the local language in either Spain or France than in Japan, although Italy does not share a common language with any of these three destinations. Cultural proximity is a more elusive concept than linguistic proximity. Belot and Ederveen (2012) use particular measures capturing, at least partly, this dimension: these are variables describing bilateral religious distance and survey-based measures capturing the cultural orientation of countries, both fostering bilateral migration flows

5. CONCLUSIONS

The use of bilateral data for the analysis of international migration is at the same time a blessing and a curse. It is a blessing because the dyadic dimension of the data allows to analyse many previously unaddressed questions of the literature. The development and the use of country-pair flows and stocks of international migration allow to identify many important determinants such as the network effect, the role of poverty constraints or the impact of cultural links between countries. This paper reviews some of the recent studies using this type of data to identify factors affecting international migration flows. Our review demonstrates that significant efforts have been conducted by many scholars and that overall we have a much better knowledge of the main determinants.

Still, the use of bilateral data is also a curse. The methodological challenges that are implied by the use of this type of data are numerous, and our paper covers some of the most important ones. We show that a good connection with the underlying micro-foundations is

[22] As for the results of income, the heterogeneity in the specifications prevents us from comparing the typical estimated elasticities obtained in the literature. Nevertheless, it is worth mentioning that Bertoli and Fernández Huertas Moraga (2015) find that the imposition of a bilateral visa requirement tends to decrease the size of the bilateral migration flow over a period of 10 years by around 45 per cent. This is in line with Beine and Parsons (2015).

desirable, something very much in line with the literature on trade. The reference to the underlying theoretical frameworks such as the RUM model clarifies the need to account for important issues such as multilateral resistance to migration. In turn, this has strong implications for the econometric estimation methods that need to be used. Additional issues such as the presence of many zero observations or endogeneity concerns due to omitted factors have also strong implications for the choice of the appropriate econometric techniques. Fortunately, the recent evolution of the literature suggests that scholars are increasingly aware of these challenges.

REFERENCES

Adsera, A., and M. Pytlikova (2012), 'The Role of Language in Shaping International Migration,' Discussion Paper 6333 (Bonn: IZA).

Anderson, J. E. (2011), 'The Gravity Model,' *Annual Review in Economics*, **3**, 1, 133 60.

Anderson, J. E., and E. van Wincoop (2004), 'Trade Costs,' *Journal of Economic Literature*, **42**, 3, 691 751.

Arcidiacono, P., and R. A. Miller (2011), 'Conditional Choice Probability Estimation of Dynamic Discrete Choice Models With Unobserved Heterogeneity,' *Econometrica*, **79**, 6, 1823 67.

Artuç, E., S. Chaudhuri, and J. McLaren (2010), 'Trade Shocks and Labor Adjustment: A Structural Empirical Approach,' *American Economic Review*, **100**, 3, 1008 45.

Beine, M., and C. Parsons (2015), 'Climatic Factors as Determinants of International Migration,' *Scandinavian Journal of Economics*, forthcoming.

Beine, M., F. Docquier, and Ç. Özden (2011a), 'Diasporas,' *Journal of Development Economics*, **95**, 1, 30 41.

Beine, M., F. Docquier, and Ç. Özden (2011b), 'Dissecting Network Externalities in International Migration,' Working Paper 3333 (Munich: CESifo).

Beine, M., P. Bourgeon, and J. C. Bricongne (2013), 'Aggregate Fluctuations and International Migration,' Working Paper 4379 (Munich: CESifo).

Beine, M., R. Noel, and L. Ragot (2014), 'Determinants of the International Mobility of Students,' *Economics of Education Review*, **41**, August, 40 54.

Belot, M., and S. Ederveen (2012), 'Cultural Barriers in Migration between OECD Countries,' *Journal of Population Economics*, **25**, 3, 1077 105.

Belot, M., and T. Hatton (2012), 'Skill Selection and Immigration in OECD Countries,' *Scandinavian Journal of Economics*, **114**, 4, 1105 28.

Bertoli, S., H. Brücker, and J. Fernández Huertas Moraga (2013a), 'The European Crisis and Migration to Germany: Expectations and the Diversion of Migration Flows,' Working Paper No. 2013/21 (Clermont Ferrand: CERDI, University of Auvergne).

Bertoli, S., and J. Fernández Huertas Moraga (2013), 'Multilateral Resistance to Migration,' *Journal of Development Economics*, **102**, May, 79 100.

Bertoli, S., and J. Fernández Huertas Moraga (2015), 'The Size of the Cliff at the Border,' *Regional Science and Urban Economics*, **51**, March, 1 6.

Bertoli, S., J. Fernández Huertas Moraga, and F. Ortega (2013b), 'Crossing the Border: Self selection, Earnings and Individual Migration Decisions,' *Journal of Development Economics*, **101**, 1, 75 91.

Burgoon, B., M. Beine, A. Boucher, M. Crock, J. Gest, M. Hiscox, P. McGovern, H. Rapoport, J. Schap er, and E. Thielemann (2013), 'Comparing Immigration Policies: An Overview from the IMPALA Database,' Paper presented at the MAFE meeting, San Diego.

Carey, H. C. (1858), *Principles of Social Science* (Philadelphia, PA: Lippincott).

Clark, X., T. Hatton, and J. Williamson (2007), 'Explaining US Immigration, 1971 1998,' *Review of Economics and Statistics*, **89**, 2, 359 73.

Dreher, A., and P. Poutvaara (2011), 'Foreign Students and Migration to the United States,' *World Development*, **39**, 8, 1294 307.

Grogger, J., and G. H. Hanson (2011), 'Income Maximization and the Selection and Sorting of International Migrants,' *Journal of Development Economics*, **95**, 1, 42 57.

Hanson, G. H. (2010), 'International Migration and the Developing World,' in D. Rodrik and M. Rosen zweig (eds.), *Handbook of Development Economics* (Amsterdam: North Holland), Volume 5, 4363 414.

Head, K., and T. Mayer (2015), 'Gravity Equations: Workhorse,Toolkit, and Cookbook,' in G. Gopinath, E. Helpman, and K. Rogoff (eds.), *Handbook of International Economics* (Amsterdam: Elsevier), Volume 4, 131 95.

Kennan, J., and J. R. Walker (2011), 'The Effect of Expected Income on Individual Migration Decisions,' *Econometrica*, **79**, 1, 211 51.

Krugman, P. (1995), 'Increasing Returns, Imperfect Competition and the Positive Theory of International Trade,' in G. M. Grossman and K. Rogoff (eds.), *Handbook of International Economics* (Amsterdam: North Holland), Volume 3, 1243 77.

Llull, J. (2011), 'Understanding International Migration: Evidence from a New Dataset of Bilateral Stocks (1960 2000),' mimeo, Univeristat Autònoma de Barcelona.

Marchiori, L., J. F. Maystadt, and I. Schumacher (2012), 'The Impact of Weather Anomalies on Migra tion in Sub Saharan Africa,' *Journal of Environmental Economics and Management*, **63**, 3, 355 74.

Mayda, A. M. (2010), 'International Migration: A Panel Data Analysis of the Determinants of Bilateral Flows,' *Journal of Population Economics*, **23**, 4, 1249 74.

McFadden, D. (1974), 'Conditional Logit Analysis of Qualitative Choice Behavior,' in P. Zarembka (ed.), *Frontiers in Econometrics* (New York: Academic Press), 105 42.

McKenzie, D. J., and H. Rapoport (2010), 'Self selection Patterns in Mexico US Migration: The Role of Migration Networks,' *Review of Economics and Statistics*, **92**, 4, 811 21.

McKenzie, D. J., C. Theoharides, and D. Yang (2014), 'Distortions in the International Migrant Labor Market: Evidence from Filipino Migration and Wage Responses to Destination Country Economic Shocks,' *American Economic Journal: Applied*, **6**, 2, 49 75.

Munshi, K. (2003), 'Networks in the Modern Economy: Mexican Migrants in the US Labor Market,' *Quarterly Journal of Economics*, **118**, 2, 549 99.

Niedercorn, J. H., and B. V. Bechdolt (1969), 'An Economic Derivation of the "Gravity Law" of Spatial Interaction,' *Journal of Regional Science*, **9**, 2, 273 82.

Ortega, F., and G. Peri (2013), 'The Role of Income and Immigration Policies in Attracting International Migrants,' *Migration Studies*, **1**, 1, 47 74.

Özden, Ç., C. R. Parsons, M. Schiff, and T. L. Walmsley (2011), 'Where on Earth is Everybody? The Evolution of Global Bilateral Migration 1960 2000,' *World Bank Economic Review*, **25**, 1, 12 56.

Pedersen, P. J., M. Pytlikova, and N. Smith (2008), 'Selection and Network Effects Migration Flows into OECD Countries 1990 2000,' *European Economic Review*, **52**, 7, 1160 86.

Pesaran, M. H. (2004), 'General Diagnostic Tests for Cross Section Dependence in Panels,' Discussion Paper 1204 (Bonn: IZA).

Pesaran, M. H. (2006), 'Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure,' *Econometrica*, **74**, 4, 967 1012.

Pesaran, M. H., and E. Tosetti (2011), 'Large Panels with Common Factors and Spatial Correlation,' *Journal of Econometrics*, **161**, 2, 182 202.

Ravenstein, E. G. (1885), 'The Laws of Migration,' *Journal of the Statistical Society*, **48**, 2, 167 235.

Ravenstein, E. G. (1889), 'The Laws of Migration Second Paper,' *Journal of the Royal Statistical Society*, **52**, 2, 241 305.

Santos Silva, J. M. C., and S. Tenreyro (2006), 'The Log of Gravity,' *Review of Economics and Statis tics*, **88**, 4, 641 58.

Santos Silva, J. M. C., and S. Tenreyro (2011), 'Further Simulation Evidence on the Performance of the Poisson Pseudo maximum Likelihood Estimator,' *Economics Letters*, **112**, 2, 220 22.

Schmidheiny, K., and M. Brülhart (2011), 'On the Equivalence of Location Choice Models: Conditional Logit, Nested Logit and Poisson,' *Journal of Urban Economics*, **69**, 2, 214 22.

Sjaastad, L. A. (1962), 'The Costs and Returns of Human Migration,' *Journal of Political Economy*, **70**, 1, 80 93.

Small, K. A., and H. S. Rosen (1981), 'Applied Welfare Economics with Discrete Choice Models,' *Econometrica*, **49**, 1, 105 30.

Tenreyro, S. (2007), 'On the Trade Impact of Nominal Exchange Rate Volatility,' *Journal of Development Economics*, **82**, 2, 485 508.

Tinbergen, J. (1962), *Shaping the World Economy: Suggestions for an International Economic Policy* (New York: The Twentieth Century Fund).
Train, K. (2003), *Discrete Choice Methods with Simulation* (Cambridge: Cambridge University Press).
United Nations (1998), Recommendations on Statistics of International Migration. Revision 1, Department of Economic and Social Affairs, Statistics Division.
Vogler, M., and R. Rotte (2000), 'The Effects of Development on Migration: Theoretical Issues and New Empirical Evidence,' *Journal of Population Economics*, **13**, 3, 485 508.
World Bank (2013), Bilateral Migration Matrix 2010. Available at: http://go.worldbank.org/JITC7 NYTT0 (accessed 21 October 2014).