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Movements as a Source of Growth

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Abstract: This paper contributes a theoretical model to study the effects of short-term movements of skilled labour on a country's economic growth. As traditional migration models emphasise the long-term effects of migration on factor endowments, they typically omit the analysis of gross labour flows. Gross flows however capture the volume of interactions and knowledge exchanges between workers living in different countries, which in turn affect the stock of knowledge available to their places of residences, and hence their ability to innovate and grow. A simulation based on available US, British and Australian data on international business visits reveals that short-term skilled labour movements have a positive and not insignificant effect on growth.

Key Words: international migration, temporary labour movements, skilled labour, economic growth.

JEL Classification: F2, J6.

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1   Introduction

Continuous advancements in communication and transportation technologies and the ensuing globalisation of the world economy have been expanding towards temporary movements (let alone 'virtual' exchanges through videoconferencing, telecommuting, and the worldwide web) the range of ways in which workers can be internationally mobile. These developments have been concurrent with skill-biased technological and organisational changes at the firm level (e.g. Bauer and Bender, 2004). In turn, these have raised the international competition for skilled labour, leading a number of governments to adopt *ad hoc* immigration policies to attract skilled foreign migrants (e.g. OECD, 2002), and raised new concerns for policymakers as to whether their countries have been losing skilled labour to other nations (e.g. Carrington and Detragiache, 1999).

One characteristic of the current debate on skilled labour movements is an emphasis on forms of migration that, albeit temporary, typically last for more than a year (e.g. OECD, 2002). The resulting economic analyses therefore study the contribution of migrants to a country's factor endowments by focusing on the net balance between in- and outflows of workers. This approach however appears restrictive, as it overlooks labour movements that are economically-motivated but involve an international relocation that is of short duration (typically one year or less). In the statistics of international organisations such as the United Nations and International Monetary Fund, labour movements lasting less than a year are conventionally treated as movements of visitors rather than migrants. These flows fall therefore outside the statistics used by migration studies. However short-term work-related movements ought to be included in the analyses and discussions on skilled migration for at least

two reasons. First, they are very much part of the way in which skilled workers of the global economy move (e.g. IATS, 1988; OECD, 2002). Furthermore, there is evidence that they have been increasingly substituting longer-term forms of migration (e.g. Salt, 1992).

Second, the focus on net balances does not really measure the movement of ideas and knowledge associated with the movement of people ('head-content'), as it only accounts for the net change in a country's endowment of labour ('headcount'). It has been found that short-term labour movements, and in particular business trips, are a channel for the transfer of knowledge within a firm as well as across separately owned companies and supply chains (e.g. Wood, 2001). It has also been suggested that business travellers may act as the mechanism through which a country can tap into the flow of knowledge that is continuously developed around the world, enhancing both its innovation capabilities and its ability to adopt more productive technology (e.g. Dosi et al., 1988; Cohen and Levinthal, 1989; Rogers, 1995; Leahy and Neary, 2003). Since the contribution to knowledge of incoming and outgoing visitors and residents is unlikely to be identical, the study of *gross* rather than *net* flows of work-related movements is also necessary for an exhaustive analysis of brain drains and gains. Gross flows are in fact a better proxy than net flows for measuring the head-content associated with short-term skilled labour movements, as they give a measure of the volume of interactions, and hence the potential for knowledge exchanges and development, between workers of different countries.

Figure 1 visualises the magnitude of short-term labour movements as measured by international business trips for the US, UK, and Australia for the year 1997. The

column to the left shows the gross flows of outgoing and incoming business travellers, respectively, as a proportion of domestic employment. The column in the middle indicates the same ratio, as measured by the number of equivalent workers, which adjusts the flow of travellers by the number of days spent abroad in a year. This column represents the contribution of business trips a country's factor endowment. The column to the right shows the skill composition of business travellers. This is calculated as the ratio between the share of travellers that are skilled (completed high school) on the basis of their educational (US and Australia) or occupational level (UK) following Keesing (1965), and the corresponding share in the domestic employment. Data are sourced from the International Passengers Survey collected in these three countries, and are restricted to international travel for business purposes thereby excluding movements related to tourism, education or other reasons (e.g. visiting family or friends). Information on the average skill level of native and temporary workers was obtained from previous studies[1]. Employment data are taken from existing studies (US: Anderson, 2002) or Labour Force Surveys (UK: Eurostat; Australia: Australian Bureau of Statistics).

TABLE 1   SUMMARY STATISTICS OF INTERNATIONAL BUSINESS TRAVEL IN THE US, UK AND AUSTRALIA IN 1997

	Business travellers as a % of domestic employment	Equivalent workers as a % of domestic employment	Ratio of skilled among travellers vs. domestic employment
United States			
Outgoing	6.1	1.9	2.32
Incoming	5.5	0.9	
United Kingdom			
Outgoing	29.9	0.7	2.27
Incoming	26.4	0.5	
Australia			
Outgoing	4.1	0.6	3.77
Incoming	3.9	0.4	

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[1] Anderson (2002 – US), the International Air Travel Survey (1988 - UK) and Tani (2003 – Australia).

As illustrated by Table 1 short-term work-related movements are rather large in volume, ranging from about 4% for Australia to almost 30% for the UK[2], and have a high skill composition vis-à-vis domestic employment (column to the right). On average, the proportion of skilled workers among business travellers is more than double the corresponding proportion in domestic employment. The volumes of short-term business visitors are large even when these flows are adjusted for the time spent abroad (column to the right), ranging between 0.4% (Australia) and 1.9% (US) of domestic employment. Yet, these flows are typically excluded from economic analyses of skilled labour movements.

This paper contributes to address this gap by expanding the traditional approach used in the economic analysis of migration to include short-term skilled labour movements. One of the main results of the model is that higher growth can be achieved through higher volumes of skilled labour mobility across countries ('churning'), even if there are no permanent changes in factor endowments and no international migration. Hence, even countries that find it difficult (or impossible) to attract skilled labour on a permanent basis may find a source of growth in short-term skilled labour movements. Although the theoretical model is set in the context of economic growth, it is applicable to other observational units. For example, it could be used to study why most economics (or medical) departments have visitors' programmes that have a significant financial cost rather than restricting their seminar activities to their own

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[2] This figure is likely to reflect the geographic location of the UK, which favours short international trips relative to the US and Australia.

research staff.

The rest of the paper is organised as follows. Section 2 reviews the literature on short-term labour movements. Section 4 develops the theoretical model. Section 5 presents some empirical evidence based on aggregate data. Section 6 discusses some policy implications and concludes.

2   Literature

Definitional issues

Broadly speaking temporary labour movements are work-related movements that last for only a short period of time, though there is no internationally agreed definition about how short their time span should be. The United Nations and the International Monetary Fund, respectively, use a 12-month convention before recording non-residents as migrants rather than visitors, and accounting for compensation earned abroad as income for the host rather than the sending country. Other institutions use different conventions. The World Trade Organisation applies the word temporary to mean up to 90 days for certain labour movements and up to 5 years for others. National governments too use the term differently. For example a temporary migration visa for Australia is valid for up to four years.

This heterogeneity of conventions is reflected in the legal and statistical treatment of various forms of temporary movement, and the extent of their economic analysis. Some movements, such as seasonal migration, international commuting, and guest-workers programs, are viewed as a form of migration that is clearly economically motivated. These labour flows are regulated by a country's employment and migration laws, and tend to be relatively well documented (e.g. OECD, 1994). Their

economic effects are therefore investigated in some detail, particularly with regards to labour markets and welfare for both countries of origin and destination (e.g. Priore, 1979; Gould, 1980; Martin and Teitelbaum, 2001).

In contrast, other temporary movements like international business trips, temporary assignments, and short intra-company transfers (let alone work-related exchanges that do not involve a physical transfer such as videoconferencing and telecommuting) are more difficult to classify and interpret as a genuine form of labour migration. Part of the problem is related to data. Information is generally unavailable or confidential for transfers and assignments, or it is of limited use for economic analysis. International Passengers Surveys provide a large amount of statistics on the in- and out-bound flows of temporary visitors to a number of countries, the length of trip, and the main reason for travel (e.g. tourism, business, conference, education, settlement), but typically do not report the exact motivation for doing so. As a result, marketing and follow up trips facilitating an international transaction cannot be distinguished from business visits aimed at transferring or developing specialist knowledge in a foreign country.

A few studies suggest that international business trips *are* a form of labour migration, though they generally confine their analysis to *air* travel, as it is the most common way to carry out trips beyond a certain distance or to/from countries separated by natural barriers, like Australia, the UK or the US. Typically the link between air business travel and labour migration rests on two observations. The first is that business trips are associated with an exchange of skills and knowledge, whose effect last well beyond the duration of a business visit. The knowledge exchanged is

embodied in business travellers, and hence moves with them, as well as disembodied, as business travellers gain access to information and data that they subsequently share. Consider the case of a foreign buyer that carries out an international business trip to train her suppliers in producing according to the standards and tastes prevailing in her country of residence. Her visit affects the endowment of knowledge of her country of destination beyond her return home. In general, studies focusing on the effects of temporary labour movements on the country of destination document these and other types of skill transfers, both within multinational firms, and across separately owned firms, albeit mostly within the same supply chain (e.g. Wood, 2001, and the literature cited in it). Studies focusing on the country of origin have also highlighted that air business travels may play a strategic role in allowing travellers, and their country of residence, to learn and keep abreast of technological advances that are generated internationally. Air business travellers, thanks to their mobility, can tap into the flows of ideas and innovations that are continuously developed around the world and take them home, enabling their country of residence to maintain the 'adaptive capability' needed to innovate or to quickly introduce more productive foreign technology (e.g. Rogers, 1995).

The second observation is the increasing substitutability between business travel and other forms of labour migration, which has been observed in a number of countries (e.g. Salt, 1992).

The view that business travel *is not* a form of labour migration is generally based on the argument that it provides ancillary services that facilitate the international exchange of goods or services (e.g. accompanying exported goods). Hence it should

be considered as a component of the international trade of commodities and services. The World Trade Organisation, in the General Agreement for the Trade of Services Mode 4 (Movements of Natural Persons), suggests that if an international labour movement occurs as a result of a contract for the provision of services then it should be treated as a service (*contract for services*), and be governed by its legislation, but if it arises from an employment contract it should be viewed as a labour movement (*contract of services*), and be regulated by domestic migration laws. Unfortunately the distinction between contracts *for* and *of* service is practically impossible to apply: the legal categories are not mutually excludable[3] and they do not take into account alternative ways in which an identical service can be delivered[4]. In practice the GATS Mode 4, which aims at reducing the barriers to the international movement of services and related labour movements, still allows each country to impose quotas and other restrictions[5] on the same flows it sets to liberalise, implicitly supporting that these labour movements can be viewed, after all, as a form of labour migration.

Theoretical approach

Notwithstanding the lack of definition and detailed data, there is a small and fragmented literature on the economic effects of short-term labour movements such as business travel, which documents the high human capital content of its users, its increasing substitution with more permanent forms of labour migration (Salt, 1992), and its possible impact on rising wage inequality in the industrialised world, as

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[3] For example, the test applied by the tax law in the UK to separate a contractor (contract *for* services) from an employee (contract *of* services) is wider than the corresponding tests applied by industrial or patent law.

[4] The GATS makes no provisions for either self-employed temporary migrants or foreign citizens temporarily employed by a domestic company. Hence identical services delivered by the same person under an employment contract with a local company or a services contract with a foreign provider may be treated differently (e.g. Charnovitz, 2002).

[5] These include (among others): minimum educational qualification level and professional experience, determined periods of prior employment, economic needs tests giving preference to domestic workers, and the very definition of 'temporary'.

travellers can apply their skills across the combined labour markets of countries of origin and destination (Anderson, 2002).

With reference to the theoretical approach commonly used in migration studies, the literature can be broadly divided in two. The first group treats labour movements as a change in labour (or skill) supply in both countries of origin and destination (e.g. Barro and Sala-i-Martin, 1999; OECD, 2002). This interpretation reflects the traditional economic perspective of viewing labour as a factor of production, or 'headcount' (e.g. World Bank, 1995). Under this approach temporary and permanent migrants differ for a number of reasons, but not in their economic effects. As written by Winters (2002), temporary labour migration "has none of cultural, social or political dimensions that are associated with international migration because it explicitly does not entail shifts in residence. However, its direct economic consequences can be thought of as those of migration. Workers enter a country temporarily to carry out particular jobs and thus labour inputs in one economy are reduced while those in another are increased" (p.6). This interpretative framework has raised some criticisms for its over-simplification of the creative abilities of humans (and migrants), which are reduced to an input (Simon, 1989).

The second group of studies treats labour and migrants as agents in forming and diffusing knowledge. Migrants enhance knowledge in both countries of origin and destination by facilitating technological spill-overs and contributing new ideas, or 'head-content'. The contribution of permanent and temporary migrants normally differs, as it also depends on the frequency of movement. Existing work principally focuses on the characteristics of the innovation process (e.g. Dosi et al., 1988; Cohen

9

and Levinthal, 1989), exploring the role played by temporary migrants insofar as they can help a country to absorb and transfer new technology and information (e.g. Rogers, 1995; Leahy and Neary, 2003). Less attention has been devoted to mobility *per se* as a constituent element in the formation of knowledge. Typically these studies do not offer a formal treatment of the mechanisms through which temporary labour movements affect growth.

This paper combines both approaches in a single theoretical growth model where the contribution of labour movements lasting for less than a year can be studied with respect to changes in factor endowments (headcount) and changes in the stock of knowledge used for producing and growing (head-content). As the paper focuses on short-term labour movements vis-à-vis movements that last for a year or more, the words short-term and temporary are used interchangeably, while movements lasting for more than a year are generally labelled as permanent.

3   The theoretical model

The neoclassical growth framework of Solow and Swan is a convenient starting point to include study the relationship between short-term migration and economic growth. The analysis can benefit from previous theoretical work (Barro and Sala-i-Martin, 1995 or BS in the rest of the paper). There is also an empirical advantage in that the variables appearing in the model are well suited to exploit the format and the aggregate nature of available data on temporary labour movements.

Temporary workers are treated as affecting the economy through two distinct mechanisms. The first is the traditional labour supply channel: temporary migration

changes the input (and normally quality) of labour in both countries of origin and destination. The ensuing economic impact arises because skills are *embodied* in, and hence move with, the temporary migrant (*embodied effect*). As a result, the economic impact is proportional to the net flows of migrants (headcount).

The second mechanism is the contribution to knowledge arising from participation in the international flow of ideas and technologies that are continuously developed around the world. This effect is modelled as an externality due to labour mobility itself: the higher the number of workers exchanging information and ideas, or the higher the frequency of their movements ('churning'), the higher the contribution to knowledge that a country receives from its in- and outbound visitors, and vice-versa (*disembodied effect*). The disembodied effect therefore depends on gross (rather than net) in- and outflows of visitors (head-content). It also operates differently for permanent and temporary migrants: for the destination country the addition to knowledge of permanent migrants is high after arrival, but it fades as time goes on, assuming no further movement. On the contrary, the contribution to knowledge of temporary migrants is directly related to the frequency of their international mobility.

Consider a country that uses labour and capital to produce according to:

$$Y_t = F(K_t, A_t L_t) c\left(\frac{AV_{It}}{L_t}, \frac{AV_{Ot}}{L_t}, \frac{K_k}{A_t L_t}\right) \tag{1}$$

where Y_t is the country's GDP at time t, F is a monotonic function exhibiting constant returns to scale, K_t indicates capital in its broad sense (physical and human), A_t is a labour-augmenting technology (as in the original Solow-Swan model technological progress is exogenous), and L_t indicates the country's labour supply.

$c(\dfrac{AV_{It}}{L_t}, \dfrac{AV_{Ot}}{L_t}, \dfrac{K_k}{A_t L_t})$ is a function representing the externality associated with the

flows of effective incoming (AV_{It}) and outgoing (AV_{Ot}) 'equivalent workers' due to

temporary labour movements, respectively, as a proportion of the country's labour

force L_t and the amount of capital per effective worker $\dfrac{K_k}{A_t L_t}$. The motivation for

representing $c(.)$ as an externality rather than a function affecting only the technology

parameter is that the gross flow of equivalent workers emerges as being highly

correlated to multifactor productivity (MFP), as illustrated by Figure 1. The figure

represents the relationship between MFP and gross flows of equivalent workers for

Australia during the period 1976-7 and 2000-1. The correlation coefficients between

the two series are .9744 (level) and .4029 (change), respectively.

FIGURE 1   GROSS FLOWS OF EQUIVALENT WORKERS AND MULTI-FACTOR PRODUCTIVITY FOR AUSTRALIA (1977-2001)
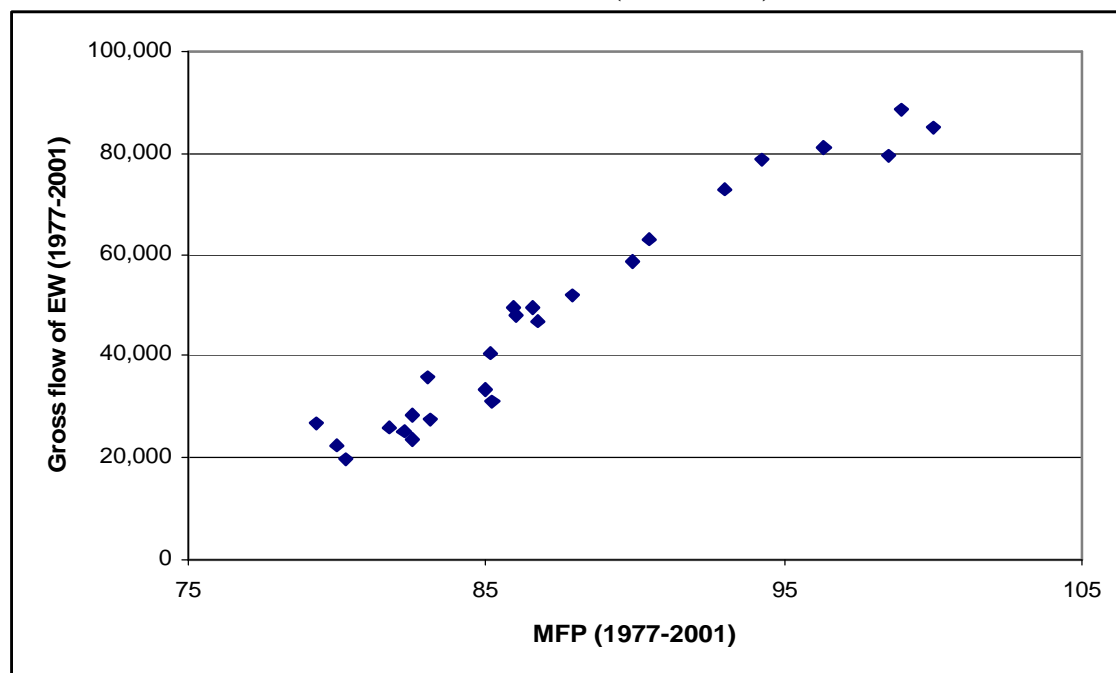
Source: MFP: Australian Bureaus of Statistics (2002): "Multifactor productivity Australia" (cat.1360). Equivalent workers: author's calculation based on Department of Immigration, Multicultural and Indigenous Affairs (DIMIA): Overseas Arrivals and Departures, various years.

The calculation of an equivalent worker is the product of number of visits and their average length divided by 250, which corresponds to the average number of business days in a year (e.g. Anderson, 2002):

$A_t V_{It}$ = *gross inflow of travellers * (length of stay/250)*; and

$A_t V_{Ot}$ = *gross outflow of travellers *(length of stay/250)*.

It is assumed that in and out-flows of temporary migrants are proportional to the country's labour force as follows:

$$A_t V_{It} = \boldsymbol{l}_t L_t \qquad\qquad\qquad (2a)$$

$$A_t V_{Ot} = \boldsymbol{q}_t L_t \qquad\qquad\qquad (2b)$$

where $\boldsymbol{l}_t$ and $\boldsymbol{q}_t$ are positive parameters. It is also assumed that $?c(.)/??_t > 0$ and $?c(.)/??_t > 0$, so that each new addition of disembodied knowledge associated with temporary migration improves the domestic production. Making $c(.)$ depending on

$\dfrac{K_k}{A_t L_t}$ reflects that participating in the world-wide exchange of ideas is easier for

countries with a good level of infrastructure (e.g. Gaspar and Glaeser, 1998).

As in BS, the marginal productivities of capital and labour are positive but exhibit diminishing returns, so that $\partial Y_t/\partial K_t > 0$ and $\partial Y_t/\partial L_t > 0$ but $\partial^2 Y_t/\partial K_t^2 < 0$ and $\partial^2 Y_t/\partial L_t^2 < 0$. However, private and social marginal returns to capital and labour differ as a consequence of the disembodied effect $c(?_t,?_t,k_t)$:

$$\partial Y_t/\partial K_{private} = F_K c(.) < \partial Y_t/\partial K_{private} + c_K F(.) = \partial Y_t/\partial K_{social}$$

$$\partial Y_t/\partial L_{private} = F_L c(.) < \partial Y_t/\partial L_{private} + c_L F(.) = \partial Y_t/\partial L_{social}$$

As in BS, trade with the rest of the world occurs only through international labour movements. Capital can move internationally, but the extent of its flows depends on the volume of labour migrants. Commodity trade is not permitted.

The production function (1) is reformulated in the intensive form to simplify the analysis by transforming the variables in terms of the capital per effective labour ratio $k_t = K_t/A_tL_t$:

$$\frac{Y_t}{A_tL_t} = y_t = f(\frac{K_t}{A_tL_t},1)c(\boldsymbol{l}_t,\boldsymbol{q}_t,k_t) = f(k_t)c(\boldsymbol{l}_t,\boldsymbol{q}_t,k_t) \qquad (3)$$

Labour supply in the home country is the sum of:

(i)   native labour, which is assumed to grow at a constant exogenous annual rate n;

(ii)   the net inflow of permanent migrants into the country M_t. If $M_t > 0$ then the country is a net receiver of workers, while $M_t < 0$ indicates that the country is a net exporter of labour. For simplicity, each permanent migrant is assumed to carry an identical quantity of physical and human capital $\boldsymbol{k}$.

(iii)   the net flow of equivalent workers $(\boldsymbol{l}_t - \boldsymbol{q}_t)L_t$. When $(\boldsymbol{l}_t - \boldsymbol{q}_t) > 0$ the country is a net importer of temporary foreign workers, while $(\boldsymbol{l}_t - \boldsymbol{q}_t) < 0$ indicates a net outflow of domestic resident workers[6]. For simplicity, inward and outward temporary migrants are treated as carrying an identical quantity of human and physical capital $\boldsymbol{j}$, as suggested by empirical evidence[7].

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[6] Resident includes natives as well as permanent migrants migrated in previous periods.

[7] Although the assumption might appear restrictive, it is *a priori* unclear why the skill level of travellers from different countries should differ. Empirical data on European, US and Australian business trips suggests that travellers have similar skill levels, based on occupational profiles (e.g. IATS, 1988; Anderson, 2002; Tani, 2003).

The *total* domestic labour force grows at the rate:

$$\frac{\dot{L}_t}{L_t} = n_t + m_t + \boldsymbol{l}_t - \boldsymbol{q}_t \tag{4}$$

where the dot indicates a change over time, $m_t \equiv M_t/L_t$, and $(\boldsymbol{l}_t - \boldsymbol{q}_t)$ are the net permanent and temporary migration rates, respectively.

As in BS, permanent migrants are sensitive to the wage level paid in the host country so that m_t is a positive but decreasing function of the wage in the host country: $m_t = m(k_t)$, $m' > 0$, and $m'' < 0$.

The net temporary migration rate $(\boldsymbol{l}_t - \boldsymbol{q}_t)$ is modelled as depending only on the ratio of in- and outbound equivalent workers to domestic labour, respectively. Treating $\boldsymbol{l}_t$ and $\boldsymbol{q}_t$ as functions of the level of economic activity is perhaps more realistic. However using $\boldsymbol{l}_t = \boldsymbol{l}(k_t)$ and $\boldsymbol{q}_t = q(k_t)$ raises the complexity of the solutions without modifying their substance, and it is not pursued further.

By definition the stock of human and physical capital grows annually by the amount of new investments net of depreciation, and the capital carried by permanent and temporary migrants:

$$\dot{K}_t = sF(K_t, A_t L_t)c(\boldsymbol{l}_t, \boldsymbol{q}_t, k_t) - \boldsymbol{d}K_t + \boldsymbol{k}_t M_t + \boldsymbol{j}_t L_t(\boldsymbol{l}_t - \boldsymbol{q}_t) \tag{5}$$

where s is a positive constant representing the country's exogenous rate of investment as a proportion of GDP, $\boldsymbol{d}$ is a positive constant reflecting the annual depreciation rate of physical and human capital, and $\boldsymbol{k}_t M_t$ and $\boldsymbol{j}_t L_t(\boldsymbol{l}_t - \boldsymbol{q}_t)$ are the amount of capital

carried by permanent and temporary migrants, respectively. The latter are likely to carry predominantly human capital.

The growth path of the capital per effective worker is obtained by dividing both sides of equation (5) by $A_t L_t$. Rearranging the expression in terms of change in capital yields:

$$\dot{k}_t = sf(k_t)c(\boldsymbol{l}_t, \boldsymbol{q}_t, k_t) - (x + n + \boldsymbol{d})k_t - m(k_t)(k_t - \boldsymbol{\hat{k}}_t) - (\boldsymbol{l}_t - \boldsymbol{q}_t)(k_t - \boldsymbol{\hat{j}}_t) \qquad (6)$$

where $sf(k_t)c(\boldsymbol{l}_t, \boldsymbol{q}_t, k_t)$ is the change in the capital per effective worker arising from new investments and the externality of the disembodied effect due to temporary labour movements. This term, referred to as capital accumulation, is positive. Its value depends directly on k_t, even though it can not be established *apriori* as the sign of $\P(sf(.)c(.)/k_t/\P k_t = s[k_t(f'(.)c(.) + c'(.)f(.)) - f(.)c(.)]/k_t^2$ is indeterminate: $k_t(f'(.)c(.) + c'(.)f(.))$ is positive while $-f(.)c(.)$ is negative. In particular capital accumulation grows with the capital per effective worker ratio k_t whenever the sum of the marginal productivity of labour $(k_t f'(.) - f(.))$ and the marginal value of the externality $k_t c'(.)f(.)/c(.)$ is positive, and vice-versa. When $c(.)(k_t f'(.) - f(.)) = k_t c'(.)f(.)$ then capital accumulation becomes independent of k_t. Hence, despite capital's diminishing returns, capital accumulation can be an increasing, decreasing or constant function of capital per effective worker.

The term $[(x + n + \boldsymbol{d}) + m(k_t)(k_t - \boldsymbol{\hat{k}}_t) + (\boldsymbol{l}_t - \boldsymbol{q}_t)(k_t - \boldsymbol{\hat{j}}_t)$ represents the depreciation rate of capital per effective worker, comprising the exogenous rate of technological change x, the depreciation rate of capital $\boldsymbol{d}$, and the growth rates of natives (n),

permanent ($m(k_t)$) and temporary migrants ($\boldsymbol{l}_t - \boldsymbol{q}_t$). The parameters $\boldsymbol{\hat{k}}_t$ and $\boldsymbol{\hat{f}}_t$ indicate the effective human and physical capital brought by permanent and temporary migrants, respectively, i.e. $\boldsymbol{\hat{k}}_t = A_t \boldsymbol{?}_t$ and $\boldsymbol{\hat{f}}_t = A_t f_t$.

The impact of permanent and temporary migration on the steady state and growth can be either positive or negative depending on whether there is a net *in-* or *out*flow of migrants, and their capital content relative to natives. In general, net *in*flows of permanent and temporary immigrants carrying less capital than natives raise capital depletion. A similar effect occurs when there are net *out*flows of permanent and temporary emigrants with more capital than natives. Table A1 in the Appendix summarises the possible combinations of migration and capital content leading to an increase of the capital per effective labour ratio.

Similarly to the original Solow-Swan model, the growth rate of income per effective labour is obtained from the path describing the corresponding growth rate of the capital stock. Combining equations (1) and (5) and transforming the variables in the intensive form yields:

$$\dot{y}_t / y_t = \boldsymbol{g}_{y,t} = f'(k_t)c(\boldsymbol{l}_t, \boldsymbol{q}_t, k_t)\dot{k} / f(k_t) = [k_t f'(k_t)c(\boldsymbol{l}_t, \boldsymbol{q}_t, k_t) / f(k_t)]\boldsymbol{g}_{k,t} \qquad (7)$$

where the term inside the square brackets represents the share of income belonging to capital owners. When the production function (1) takes the form of a Cobb-Douglas, the capital share is constant and the growth rate of GDP per effective worker $\boldsymbol{g}_{y,t}$ directly mimics the behaviour of the growth rate of capital per effective worker $\boldsymbol{g}_{k,t} = \dot{k}_t / k_t$.

Steady state and transition dynamics

The steady state is reached when the accumulation and depletion of capital per effective worker exactly offset each other:

$$g_{k,t} = sf(k_t)c(\boldsymbol{l}_t, \boldsymbol{q}_t, k_t)/k_t - (x+n+\boldsymbol{d}) - m(k_t)(1 - \boldsymbol{\check{k}}_t/k_t) - (\boldsymbol{l}_t - \boldsymbol{q}_t)(1 - \boldsymbol{\hat{j}}_t/k_t) = 0 \quad (8)$$

Unlike the neoclassical model where there is a unique stable steady state that depends only on the value of k_t, the steady state of the model with permanent and temporary migration depends on the signs and values of the migration parameters $m(k_t)$, $(\boldsymbol{l}_t - \boldsymbol{q}_t)$, $(1 - \boldsymbol{\check{k}}_t/k_t)$, $(1 - \boldsymbol{\hat{j}}_t/k_t)$, as well as the functional form of the externality $c(\boldsymbol{l}_t, \boldsymbol{q}_t, k_t)$.

Consider, as an example, the case where there is only a net inflow of permanent migrants with a lower capital content than natives and no temporary migration, and let $f(k_t) = k_t^a$ with a < 1. As illustrated in Figure 1, which is based on Figure 9.2 in BS, capital accumulation is shown with the positive and decreasing sloped line sk_t^a while capital depletion is indicated with the positively sloped line $(x + n + \boldsymbol{d})k_t + m(k_t)(k_t - \boldsymbol{\check{k}}_t)$. The vertical distance between the two lines is the growth rate of capital per effective worker $g_{k,t}$, while their intersection is the steady state **1**, which corresponds to the steady state capital per effective labour ratio k^*.

FIGURE 1   THE GROWTH EFFECT OF TEMPORARY MIGRATION
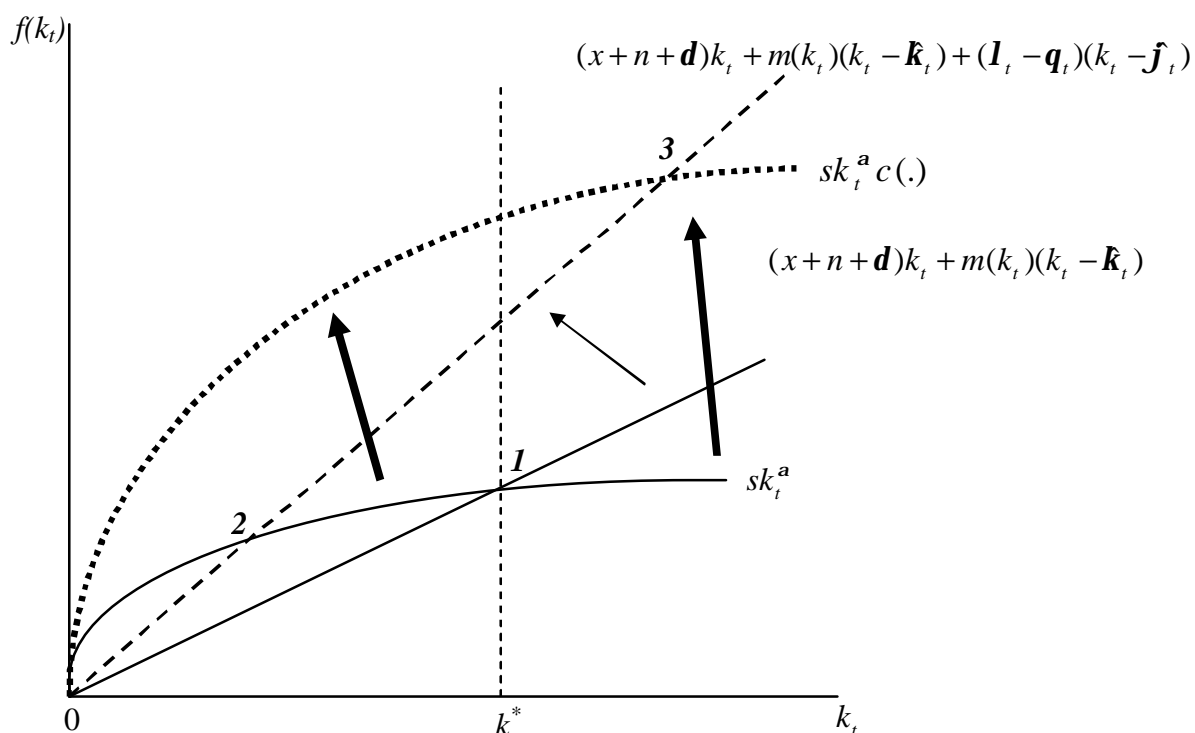
Let now introduce short-term labour migration and assume that there is a net outflow of highly skilled equivalent workers, so that $(l_t - q_t) < 0$ and $\hat{j}_t > k_t$. The *embodied effect* associated with the net outflow of temporary migrants reduces capital per effective labour as $\hat{j}_t > k_t$, and raises capital depletion to the dotted line $(x + n + d)k_t + m(k_t)(k_t - \hat{k}_t) + (l_t - q_t)(k_t - \hat{j}_t)$ in Figure 1. This has a negative impact on growth, and shifts the steady state towards point **2**.

The *disembodied effect* associated with the gross flows of in- and outbound temporary migrants raises the nation's stock of knowledge. The capital accumulation line shifts upwards to the line $sk_t^{\alpha\beta}c(.,)$. The new steady state occurs at point **3**, which is shown to correspond to a higher capital per effective worker relative to the case with only permanent migration, as the disembodied effect is assumed here to be greater than the

19

embodied effect. As a result growth has increased relative to the initial steady state k^* even though the country has suffered a temporary loss of skilled domestic labour.

Endogenous growth

An interesting feature of this model is the possible emergence of endogenous growth, which occurs when the disembodied effect on capital accumulation is so large that capital accumulation and depletion never intersect each other. Under these circumstances countries with lower capital per effective labour ratio may never catch up with richer countries, unlike the original Solow-Swan model. The condition for endogenous growth is $sk_t^{\alpha\beta}c(.) > (x + n + \boldsymbol{d})k_t + m(k_t)(k_t - \boldsymbol{\hat{k}}_t) + (\boldsymbol{l}_t - \boldsymbol{q}_t)(k_t - \boldsymbol{\hat{j}}_t)$ for each value of k_t.

Implications for migration policy

Using equation (6) a change in the net permanent migration rate $\partial\boldsymbol{g}_{k,t}/\partial m(k_t) = -m'(k_t)(1 - \boldsymbol{\hat{k}}_t/k_t)$ is *coeteris paribus* negative when $\boldsymbol{\hat{k}}_t < k_t$ and $m(k_t) > 0$, and positive in the opposite case. Permanent immigration reduces the growth in capital per effective worker when immigrants have less physical and human capital than natives, and vice-versa, as in BS.

A positive shock to either $\boldsymbol{q}_t$ (e.g. improved transport infrastructures) or $\boldsymbol{l}_t$ (e.g. an international research collaboration program favouring the outflow of domestic researchers) enhances growth in the home country when temporary migrants have similar or higher capital content than domestic workers. In particular the gross inflow of foreign visitors *always* leads to growth when foreign residents are more skilled than domestic workers: $(k_t - \boldsymbol{\hat{j}}_t) < 0$ (in this case $\partial\boldsymbol{g}_{k,t}/\partial\boldsymbol{q}_t = sf(k_t)c'(\boldsymbol{l}_t,\boldsymbol{q}_t,k_t)/k_t - (1 - \boldsymbol{\hat{j}}_t/k_t) > 0$), while the outflow of domestic labour has a positive effect only when the

disembodied effect $(sf(k_t)c'(\boldsymbol{l}_t,\boldsymbol{q}_t,k_t)/k_t)$ is larger than its corresponding effect on capital depletion $(1 - \boldsymbol{\hat{f}}_t/k_t)$, and vice-versa $(\partial \boldsymbol{g}_{k,t}/\partial \boldsymbol{l}_t = sf(k_t)c'(\boldsymbol{l}_t,\boldsymbol{q}_t,k_t)/k_t + 1 - \boldsymbol{\hat{f}}_t/k_t)$.

In this model temporary migrants can compensate a reduction in the capital per effective labour ratio caused by a net inflow of unskilled permanent migrants, as shown in Figure 1 (steady state at point 3 vis-à-vis point 1). Whether or not temporary migration offsets the growth impact of permanent migration ultimately depends on empirical values (see Table A.1 in the Appendix). The argument worth noting is that temporary migration can alleviate phenomena of brain drain, or net inflows of unskilled labour.

Another feature of the model is the prediction that even identical gross in- and outflows of temporary migrants $(\boldsymbol{l}_t = \boldsymbol{q}_t)$ lead to growth. This result emerges as a zero net inflow of temporary migrants (embodied effect) still makes a positive contribution to knowledge (disembodied effect) and growth. In particular in this case the contribution to knowledge depends only on the frequency of travel between workers living in different countries. The higher is churning the higher is the disembodied effect.

4   A simulation

This section simulates the impact of temporary migrants on a country's growth rate. The calculation has only illustrative purposes aimed at highlighting the contribution of short-term business visits. No use of econometric techniques is made, partly to overcome the difficulty surrounding the estimation of $sf(k_t)c(\boldsymbol{l}_t,\boldsymbol{q}_t,k_t)$ with the available data (this is beyond the scope of the paper), and partly because the migration

21

parameter $(l_{t,} - q_t)(k_t - \hat{j}_t)$ is a number that can be obtained with no recourse to statistical inference. Only available data are used for the empirical exercise as well as estimates from previous work.

The calculation is performed on US, British, and Australian data for the year 1997 reported in Table 1. As in BS (p.292) it is assumed that temporary migrant carry only human capital so that this ratio can be used as a proxy for the term $\hat{j}_t / k_t$ in equation (6) (this time expressed as a growth rate $\dot{k}_t / k_t$). Despite differences in collection method and other limitations of the data, the figures in the second and third columns in Table 1 indicate that these three countries are *net exporters* of skilled labour through international business travel[8], as the inflows of equivalent workers outweigh the corresponding outflows, and the value of $\hat{j}_t / k_t$ is greater than unit. As a result, for each country the embodied effect of temporary migration is expected to raise capital depletion and have a negative impact on the growth rate.

Table 2 shows the estimates of the embodied and disembodied effects of temporary migration on growth. The embodied effect in the first column is calculated as the product of the difference between gross inflows and outflows of equivalent workers, the term $(1 - \hat{j}_t / k_t)$, and two adjustments to correct for (i) the measurement of $\hat{j}_t / k_t$, which captures only human capital, and (ii) the need to rescale the result in terms of growth rate of GDP rather than capital per effective worker, according to equation (7).

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[8] The volume of business trips for the UK seems excessively large, as it represents a quarter of the country's employment. However, given the geographic proximity of the UK to continental Europe, it is likely that the figure reported reflects frequent travels and not only a high volume of travellers. This suspicion is somewhat supported by the lower average number of days of each visit (4.7 days for incoming and 6.1 for outgoing travellers, respectively), relative to those of the US (12.2 and 13.3) and Australia (14.1 and 29.5).

Similarly to BS, it is assumed that in each country the ratio of human to total capital in the domestic economy of is 5/8 and that the share of capital in each country's total income is 1/3 (p.292). As a result, the embodied effect on GDP growth for the US in 1997 shown in the top left column of Table 2 is calculated as: $-(0.009 - 0.019) \times (1 - 2.32) \times (5/8) \times (1/3) = -0.275\%$.

The second column of Table 2 shows the disembodied effect. The strategy used follows the assumption that its effect is identical to a higher expenditure in R&D. By so doing the disembodied effect can be calculated as the product of the gross flow of equivalent workers and the *social return* of R&D, for which a consensus estimate is 50% (e.g. OECD, 2000; Dowrick, 2002). The result obtained is further adjusted by 1/3 (or 8 hours per day) to transform the gross flows of equivalent workers in terms of efficiency units of labour.

The third column of Table 2 reports the net impact of temporary migration on the US, UK and Australian growth rates for 1997, respectively, calculated as the sum of embodied and disembodied effects.

TABLE 2   THE EFFECT OF TEMPORARY LABOUR MIGRATION ON GDP GROWTH IN 1997.

	Embodied Effect	Disembodied Effect	Net Effect on GDP Growth
US	-0.275%	+0.467%	+0.192%
UK	-0.053%	+0.200%	+0.147%
Australia	-0.135%	+0.160%	+0.025%

Table 2 shows that temporary labour migration has a small but non-negligible positive effect on growth. In particular, the cross-section results shown above appear to indicate that the net effect on growth increases with the absolute volume of equivalent

workers as the US emerge as the country that benefits the most from temporary migration, followed by the UK and Australia.

These calculations are not too far from the results obtained by Winters, Walmsley, Wang, and Grynberg (2002), who on the basis of a general equilibrium model and better data, estimate that a 3% increase in the flow of temporary migrants produces an increase of 0.6% in the GDP growth. The 3% increase in temporary labour movements simulated in their study is broadly similar to the gross flow of equivalent workers calculated for the US and shown in Table 2 (1.9% + 0.9% = 2.8%).

5   Conclusion

This paper suggests that migration statistics under-estimate the true extent of international skilled labour movements because they do not account for the flows of workers that thanks to modern means of transportation can move across borders without changing residence. These flows are relevant because of their skill composition, relative magnitude, and potential contribution to the stock of knowledge available to a country. One feature of the model is the prediction that growth can occur even when net flow of migrants (headcount) is nil, as a country' ability to accumulate capital crucially depends also on the gross flows of ideas (head-content) accessed through international labour movements lasting less than twelve months.

References

Anderson, E. (2002). "Skilled Worker Mobility and International Inequality". Unpublished mimeo, University of Sussex.

Barro, R.J. and Sala-I-Martin, X. (1995). *Economic Growth*. New York: McGraw-Hill.

Bauer, T. and Bender, S. (2004). "Organisational Change and Job Turnover", *Labour Economics*, 11(3), 265-291.

Carrington, W.J. and Detragiache, E. (1999). "How Extensive is the Brain Drain?". *Finance and Development,* 36(2), 46-49.

Charnovitz, S. (2002). "WTO Norms on International Migration". Paper presented at the IOM Workshop on Existing International Migration Law Norms, April 30th.

Cohen, W. and Levinthal, D. (1989). "Innovation and Learning: the Two Faces of R&D". *The Economic Journal,* 99(397), 569-596.

Dosi, G. et al. (eds) (1988). Technical Change and Economic Theory, Maastricht Economic Research Institute on Innovation and Technology (MERIT), International Federation of Institutes for Advanced Study (IFIAS) Research Series, no. 6. London and New York: Pinter.

Dowrick, S. (2002). "Ideas and Education: Level of Growth Effects?". National Bureau of Economic Research Working Paper 9709.

Eurostat (2002). Labour Force Survey (extraction). Luxembourg: Eurostat.

Gaspar, J. and Glaeser, E. (1998). "Communications Technology and the Future of Cities". *Journal of Urban Economics*, 43(1), 136-156.

Gould, J.D. (1980). "European Inter-Continental Emigration: the Role of 'Diffusion' and 'Feedback'". *Journal of European Economic History*, 9(2), 267-315.

Keesing, D.B. (1965). "Labor Skills and International Trade: Evaluating Many Trade Flows with a Single Measuring Device". *Review of Economics and Statistics*, 47, 287-294.

International Air Travel Survey (IATS) (1988). The European Frequent Business Traveller. Henley on Thames: European Data and Research Limited.

Leahy, D. and Neary, P. (2003). "Absorptive Capacity, R&D Spillovers and Public Policy". Unpublished mimeo, University College Dublin.

Martin, P. and Teitelbaum, M. (2001). "The Mirage of Mexican Guest Workers", *Foreign Affairs*, 80(6), 117-131.

Office of National Statistics (1999). Travel Trends. London: Office of National Statistics.

Organisation for Economic Co-operation and Development (OECD) (1994). SOPEMI Report. Paris: OECD.

Piore, M. (1979). *Birds of Passage: Migrant Labor Industrial Societies*. Cambridge: Cambridge University Press.

Rogers, M. (1995). International Knowledge Spill-Overs: A Cross-Country Study. In Steve Dowrick (ed), Economic Approaches to Innovation. Aldershot, UK and Brookfield, US: Edward Elgar Publications.

Salt, J. (1992). "Migration Processes among the Highly Skilled in Europe". *International Migration Review*, 26(2), 484-505.

Simon, J. (1989). *The Economic Consequences of Immigration*. Oxford and Cambridge, MA: Blackwell in association with The Cato Institute.

Tani, M. (2003). "International Business Travel and Australia Skills' Endowment". *Agenda*, 10(3), 248-259.

Winters, L.A. (2002). "The Economic Implications of Liberalising Mode 4 Trade". Joint WTO-World Bank Symposium on the Movement of Natural Persons (Mode 4) Under the GATS, WTO Geneva, 11-12 April 2002.

Winters, L.A., T. Walmsley, Z.K. Wang, and R. Grynberg (2002). "Negotiating the Liberalisation of the Temporary Movement of Natural Persons", Discussion Paper 87, Sussex University, October.

Wood, A. (2001). "Globalisation and Wage Inequalities: A Synthesis of Three Theories". *Weltwirtschaflisches Archiv*, 138(1), 54-82.

World Bank (1995). World Development Report 1995: Workers in an Integrating World. Washington: The World Bank.

Appendix

TABLE A.1   PERMANENT AND TEMPORARY MIGRATION MIX LEADING TO AN INCREASE OF THE CAPITAL PER EFFECTIVE LABOUR RATIO

		Skill Composition			
		$\hat{k}_t < k_t$ **and** $\hat{j}_t < k_t$	$\hat{k}_t > k_t$ **and** $\hat{j}_t < k_t$	$\hat{k}_t < k_t$ **and** $\hat{j}_t > k_t$	$\hat{k}_t > k_t$ **and** $\hat{j}_t > k_t$
Migration Types	$m(k_t) > 0$ *and* $l_t - q_t > 0$	*Never*	$m(k_t)(1 - \hat{k}_t/k_t) > (l_t - q_t)(1 - \hat{j}_t/k_t)$	$m(k_t)(1 - \hat{k}_t/k_t) < (l_t - q_t)(1 - \hat{j}_t/k_t)$	*Always*
	$m(k_t) < 0$ *and* $l_t - q_t > 0$	$m(k_t)(1 - \hat{k}_t/k_t) > (l_t - q_t)(1 - \hat{j}_t/k_t)$	*Never*	*Always*	$m(k_t)(1 - \hat{k}_t/k_t) < (l_t - q_t)(1 - \hat{j}_t/k_t)$
	$m(k_t) > 0$ *and* $l_t - q_t < 0$	$m(k_t)(1 - \hat{k}_t/k_t) < (l_t - q_t)(1 - \hat{j}_t/k_t)$	*Always*	*Never*	$m(k_t)(1 - \hat{k}_t/k_t) > (l_t - q_t)(1 - \hat{j}_t/k_t)$
	$m(k_t) < 0$ *and* $l_t - q_t < 0$	*Always*	$m(k_t)(1 - \hat{k}_t/k_t) < (l_t - q_t)(1 - \hat{j}_t/k_t)$	$m(k_t)(1 - \hat{k}_t/k_t) > (l_t - q_t)(1 - \hat{j}_t/k_t)$	*Never*