EU eastern enlargement and foreign investment: Implications from a neoclassical growth model

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In this paper, we study how eastward enlargement of the EU may affect the economies of old and new EU members and non-accession countries in the context of a multi-country neoclassical growth model where foreign investment is subject to border costs. We assume that at the moment of the EU enlargement border costs between the old and new EU member states are eliminated but remain unchanged between the old EU member states and the non-accession countries. In a calibrated version of the model, the short-run effects of the EU enlargement proved to be relatively small for all the economies considered. The long-run effects are however significant: in the accession countries, investors from the old EU member states become permanent owners of about 3/4 of capital, while in the non-accession countries, they are forced out of business by local producers. *Journal of Comparative Economics* **36** (2) (2008) 307–325. EERC at the National University "Kyiv-Mohyla Academy", 04070 Kyiv, Ukraine; Departamento de Fundamentos del Análisis Económico, Universidad de Alicante, 03080 Alicante, Spain.
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1. Introduction

On May 1, 2004, eight Central and Eastern European (CEE) transition countries, Cyprus and Malta joined the EU, which had previously been composed of 15 developed countries.[1] This EU enlargement was an unprecedented attempt at political and economic integration in terms of its scope, diversity and possible consequences. The channels through which EU enlargement may affect economies in the region are various: monetary union, foreign investment, migration, trade, etc.[2] In this paper, we focus on one of these channels, foreign investment.[3] We argue that this

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[1] Elsewhere in the text, we therefore refer to the EU existing before the enlargement as the EU15 and to the enlarged EU as the EU25.

[2] The monetary-union channel is explored in Kollmann (2004) in the context of a two-country computable general equilibrium model.

[3] By foreign investment, we mean both portfolio investment and foreign direct investment (FDI).

channel is important because there is a major difference between the capital stocks and hence, between the Marginal Productivities of Capital (MPC) of the EU15 and the non-EU15 transition countries, which is likely to generate large capital flows from the former to the latter countries.[4]

In the case of previous EU enlargements, the empirical literature shows that poor countries joining the EU experienced a subsequent increase in capital inflows, e.g., Baldwin et al. (1997), Grabbe (2001). Furthermore, in the wake of the 2004 EU enlargement, there were major differences in Foreign Direct Investment (FDI) stocks between accession and the non-accession transition countries, see, e.g., Egger and Pfaffermayr (2002) and Henriot (2003). In the paper, we argue that the these patterns arise because accession of a country to the EU reduces the costs that EU15 agents incur when investing in such a country (we refer to these costs as "border costs"). Border costs can be interpreted as "risk to invest" (in a broad sense) and all kinds of costs associated with managing foreign investment (e.g., cost of acquiring information, cost of monitoring), which is reduced or entirely removed if a country becomes an EU member; the reason is that an accession country takes over the whole legal stock of the EU which includes the four freedoms (free movement of goods, services, labour and capital) and also, a common competition law.

We introduce border costs in a multi-country neoclassical growth model. We first consider a two-country variant of the model where one country represents the EU15 and the other represents the new accession countries. We assume that border costs between the EU15 and the accession countries are eliminated after EU accession. Using this model, we ask: How may EU enlargement affect output, consumption, labour and welfare of the EU15 and the accession countries?

We then consider a three-country setup, where the three countries belong to the EU15, the accession and the non-accession groups of countries. We assume that at the moment of accession, border costs are entirely eliminated between the EU15 and the accession countries but remain unchanged between the enlarged EU and the non-accession countries. In the context of the three-country model, we address the following two questions. First, how can the introduction of poor non-accession countries affect the model's predictions with regard to the EU15 and the accession countries? Second, how may the EU accession of some transition countries affect the remaining (i.e., non-accession) transition countries?

Our analysis is related to recent empirical literature investigating FDI determinants in transition countries.[5] Furthermore, our border costs can be viewed as a measure of distance (in a broad sense) between countries, and are similar to the distance measures used in the FDI gravity literature, e.g., trade freight costs and tariffs in Brainard (1997).

The presence of border costs complicates the solution procedure considerably: our multi-country model has occasionally binding inequality constraints, so that equilibrium allocation is in general not interior, and policy functions have a kink. A one-country model with occasionally binding inequality constraints is extensively studied in Christiano and Fisher (2000), however, to the best of our knowledge, similar multi-country models have not been studied yet. To simplify the computation of equilibrium, we use two complementary strategies: one is to reduce the number of Kuhn–Tucker conditions by establishing some properties of equilibrium analytically, and the other is to convert a three-country model into a two-country model by using aggregation theory. In addition, we restrict the admissible set of initial conditions to be consistent with the optimal policy functions; this allows us to reduce the number of state variables in the model.

We calibrate the model to match the population sizes and the capital stocks of the EU15, the new accession and non-accession groups of countries, and we compute the transitional dynamics. Our main findings are as follows: In the short run, the implications of the model under the non-accession and accession scenarios are similar both qualitatively and quantitatively. To be specific, under both scenarios, a large initial difference in the MPC between the rich EU15 and the poor non-EU15 (accession or non-accession) countries leads to massive capital flows from the former to the latter; this decreases (increases) wages, output and consumption in the EU15 (non-EU15) countries. The long-run consequences of the non-accession and accession scenarios are however very different: under the former scenario, residents of the non-accession countries eventually buy out all domestic capital from EU15 investors, while under the latter scenario, EU15 investors continue to hold a part of the accession country's capital in perpetuity. Quantitatively,

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[4] Non-EU15 countries are those that do not enter the EU15. Similarly, non-EU25 countries are those that do not enter the EU25.

[5] See, e.g., Lankes and Venables (1996), Baldwin et al. (1997), Di Mauro (2000), Grabbe (2001, 2003), Buch et al. (2001), Åslund and Warner (2002), Egger and Pfaffermayr (2002), Deichmann et al. (2003), Henriot (2003), Carstensen and Toubal (2004).

the latter effect can be very large: in our benchmark model, EU15 investors end up owning more than 75% of the accession country's capital.

As far as welfare is concerned, our model predicts that the capital trade is beneficial for both the rich EU15 and the poor non-EU15 (accession or non-accession) countries independently of the scenario considered: the EU15 countries gain in welfare because they get additional capital income from their foreign assets, while the non-EU15 countries gain in welfare because they can instantaneously raise their living standards. In our model, EU enlargement is a win-win process in the sense that it increases welfare gains from capital trade for both the EU15 and accession countries relative to the non-accession scenario. Finally, under the empirically plausible parameterisations, our model implies that the 2004 EU accession of the eight transition countries should not significantly affect the economies of the non-accession transition countries.

The rest of the paper is organised as follows. Section 2 discusses the empirical relation between EU enlargements, foreign investment and border costs. Section 3 develops a dynamic multi-country general-equilibrium model of the EU enlargement where foreign investment is subject to border costs. Section 4 describes the methodology of the numerical study and presents the simulation results. Finally, Section 5 gives conclusions.

2. EU enlargements, foreign investment and border costs

The history of the European Union (EU) began in 1951, when six European countries (Belgium, France, Germany, Italy, Luxembourg and Netherlands) established the European Coal and Steel Community. Over the period from 1951 to 2004, the EU experienced five enlargements: Denmark, Ireland and the UK joined in 1973; Greece in 1981; Portugal and Spain in 1986; Austria, Finland and Sweden in 1995; and finally, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic and Slovenia in 2004. In Table 1, for each enlargement, we give the population size, total GDP, and GDP per capita of the EU and the accession groups of countries. For the fifth enlargement, we consider two different groups, one including all accession countries and the other composed only of accession countries in transition; the two groups differ in the presence of Cyprus and Malta. Finally, we report the statistics for the group of non-accession transition countries that are EU25-neighbours (Albania, Croatia, FYR Macedonia, Moldova, Belarus, Ukraine, Bulgaria, Romania).

Table 1
Selected statistics for the EU and the non-EU countries: the five EU enlargements

Enlargement	Group of countries	Statistic		
		Population, $\times 10^6$	GDP per capita, $\times 10^3$ 1995 \$US	GDP–per capita ratio
I 01.01.1973	EU-6 (*Belgium, France, Germany, Italy, Luxembourg, Netherlands*)	208.18	16.8	1.00
	Joined (*Denmark, Ireland, UK*)	64.11	12.53	0.80
II 01.01.1981	EU-9 (*EU-6, Denmark, Ireland, UK*)	277.83	19.33	1.00
	Joined (*Greece*)	9.64	10.70	0.56
III 01.01.1986	EU-10 (*EU-9, Greece*)	289.45	20.80	1.00
	Joined (*Portugal, Spain*)	48.42	11.08	0.52
IV 01.01.1995	EU-12 (*EU-10, Portugal, Spain*)	348.60	23.74	1.00
	Joined (*Austria, Finland, Sweden*)	21.90	27.03	1.20
V 01.05.2004	EU-15 (*EU-12, Austria, Finland, Sweden*)	378.98	27.20	1.00
	Joined all (*Cyprus, Malta, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Rep., Slovenia*)	74.34	4.65	0.18
	Joined only transition (*Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Rep., Slovenia*)	73.57	4.55	0.17
	Non-accession transition EU-neighbours (*Albania, Croatia, FYR Macedonia, Moldova, Belarus, Ukraine, Bulgaria, Romania*)	98.48	1.51	0.06

Notes. Statistics are computed for the date of the corresponding EU enlargement. The statistic "GDP per capita ratio" is a ratio of the GDP per capita of a group of countries in a row to that of the EU in the corresponding year.
Source. World Development indicators (2003), the World Bank.

As Table 1 shows, at the moment of accession, the countries joining the EU had on average a lower GDP per capita than the old EU member states did. (The fourth enlargement is an exception here since Austria, Finland and Sweden had higher GDP per capita than the EU average.) In the case of the fifth enlargement, the output difference between the EU15 and the accession countries is particularly large: at the moment of accession, the average accession country produced only 18% of output of the average EU15 country.

The empirical literature finds that the EU enlargements were accompanied by considerable capital inflows to the accession countries, see, e.g., Baldwin et al. (1997), Grabbe (2001), Egger and Pfaffermayr (2002). Regarding the first four enlargements, Grabbe (2001) argues that the countries that were furthest behind the EU at the moment of accession (Ireland, Greece, Portugal and Spain) experienced the largest capital inflows. As far as the fifth enlargement is concerned, Egger and Pfaffermayr (2002) document the large anticipatory effects of EU enlargement on FDI: the Eastern European countries that applied to join the EU in 1994–1995 experienced a significant increase in foreign investment over the period 1995–1998. Furthermore, Åslund and Warner (2002) report that in 2000, the CEE group of countries (which includes the accession transition countries, and Bulgaria and Romania) had an FDI equal to 5.9% of GDP, which is almost four times larger than that of the Commonwealth of Independent States (CIS) group of countries which stood at 1.6%.[6]

To understand why the accession countries experience an increase in foreign investment, we shall first review some findings from the empirical literature on the determinants of foreign investment. In the transition context, Lankes and Venables (1996) identify the following determinants: the host country's progress in economic transition, local market size, factor costs, access to EU markets, political stability and regulatory environment. Grabbe (2001) emphasises the importance of such factors as expanded markets, open borders, common regulatory environment and lower transportation costs for cross-border business. Grabbe (2003) adds to the previous list such factors as the visa and Schengen border regimes and greater integration of the accession countries with the EU member states. Deichmann et al. (2003) find a significant impact of social capital, labour skills, infrastructure, trade policy and market reforms on a country's FDI appeal. Carstensen and Toubal (2004) come to the conclusion that the different attractiveness of Central European versus Eastern European countries for FDI is explained mainly by differences in capital endowments and uncertainty in the legal, political and economic environments. Finally, when becoming an EU member, the country is also integrated into the EU budget rules and gets massive transfers from the EU budget under the heading of "structural policy" (up to a maximum of 4% of its GDP). Breuss et al. (2001, 2003) find that, first, structural funds have a positive influence on FDI and, second, there is a redistribution of FDI in Europe from the old to the new member states. The redistribution occurs because the cost of enlargement is financed primarily not by increasing the total expenditure of the EU budget but by reshuffling the transfers from the former cohesion countries (Greece, Ireland, Portugal and Spain) to the new "poor" countries in Eastern Europe.

The empirical literature on FDI determinants suggests why EU accession magnifies FDI inflows in accession countries. Specifically, to be able to join the EU, a country should take a major step toward integration with EU member states: it should adopt the EU's common political, economic and legislative institutions, the common visa and border-control policies, etc.[7] In other words, an accession country should become similar to the EU member states. This reduces border costs and makes the country more attractive for foreign investment. In an earlier version of the present paper, Garmel et al. (2005), we provide statistical evidence supporting the hypothesis that the accession countries converge toward the EU member states, as opposed to the non-accession countries.[8]

In the next section, we present a dynamic general equilibrium model in which the increasing institutional similarity between the EU15 and the accession countries reduces border costs for foreign investment. We use the model to

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[6] The CIS members are Azerbaijan, Armenia, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Uzbekistan and Ukraine.

[7] In addition, the accession countries receive EU structural funds which are used to catch up faster with existing EU members (see Breuss et al., 2001, 2003).

[8] To be specific, we investigate the evolution of the economic-freedom index for the EU15, accession and non-accession groups of countries over the 1996–2004 period. The economic-freedom index is designed by the Heritage Foundation and Wall Street Journal to reflect a country's overall economic situation. We interpret the difference between the groups' economic-freedom indices to be a measure of closeness of their economic environments. Our statistical tests show that, initially, the accession and non-accession countries were similar to each other and different to the EU15 countries; however, over the transition period, the accession countries become increasingly similar to the EU15 countries and increasingly different from the non-accession countries.

assess the consequences of the EU enlargement for the economies of the EU15, the accession and the non-accession countries.

3. The model

Time is discrete, and the horizon is infinite, $t \in T$, where $T = \{0, 1, 2, \ldots\}$. There are two countries referred to as the EU15 country and the non-EU15 country, which are meant to represent the groups of the EU15 and the non-EU15 countries. The countries are identical in their fundamentals, i.e., preferences and technology, but may differ in their population and initial endowments. Variables in the EU15 country are denoted by letters without superscript, and those of the non-EU15 country are denoted by letters with superscript "n". The population sizes of the two countries are denoted by v and v^n, and they are constant over time. Capital is mobile across countries, but labour is immobile. We describe only the EU15 country; a description of the non-EU15 country follows by a formal interchange of variables with and without superscripts.

3.1. The EU15 country

The consumer side of the EU15 country consists of an infinitely-lived representative agent who can invest both in the domestic and the foreign countries. The agent solves the following intertemporal utility-maximisation problem:

$$\max_{\{c_t, h_t, k_{t+1}, \phi_{t+1}\}_{t \in T}} \sum_{t=0}^{\infty} \delta^t u(c_t, 1 - h_t) \tag{1}$$

subject to

$$c_t + k_{t+1} + \phi_{t+1} = w_t h_t + (1 - d)(k_t + \phi_t) + r_t k_t + \gamma r_t^n \phi_t, \tag{2}$$

where $c_t, h_t, k_{t+1}, \phi_{t+1} \geq 0$, and initial condition (k_0, ϕ_0) is given. Here, c_t, h_t, r_t and w_t are, respectively, consumption, hours worked, interest rate and wage in the EU15 country; k_t is capital rented to domestic producers; ϕ_t is capital rented to foreign producers; $\delta \in (0, 1)$ is the discount factor; $d \in (0, 1]$ is the depreciation rate of capital. The total time endowment is normalised to one and hence, the term $(1 - h_t)$ represents leisure. Finally, $\gamma \in [0, 1]$ is a fraction of the non-EU15 interest rate, r_t^n, which is paid on the EU15 capital stock held in the non-EU15 country, and it reflects border costs for the EU15 investors when investing in the non-EU15 country.[9]

The producer side of the EU15 country consists of a representative firm producing the output commodity from capital, K_t, and labour, H_t, and maximising period-by-period profits, π_t:

$$\pi_t = \max_{K_t, H_t} \left\{ F(K_t, H_t) - r_t K_t - w_t H_t \right\}, \tag{3}$$

where F has constant returns to scale, is strictly concave, continuously differentiable, strictly increasing with respect to both arguments and satisfies the appropriate Inada conditions.

3.2. Competitive equilibrium

A competitive equilibrium is defined as a sequence of the consumers' allocations, $\{c_t, h_t, k_{t+1}, \phi_{t+1}\}_{t \in T}$ and $\{c_t^n, h_t^n, k_{t+1}^n, \phi_{t+1}^n\}_{t \in T}$; a sequence of the producers' allocations, $\{K_t, H_t\}_{t \in T}$ and $\{K_t^n, H_t^n\}_{t \in T}$; and a sequence of prices $\{r_t, w_t\}_{t \in T}$ and $\{r_t^n, w_t^n\}_{t \in T}$ such that given the prices:

(i) for each country, the corresponding consumer's allocation solves the utility-maximisation problem (1), (2);
(ii) for each country, the corresponding producer's allocation solves the profit-maximisation problem (3);
(iii) all markets clear.

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[9] We shall assume that there are costs associated with exporting (barriers, tariffs, transportation) which are at least as high as border costs for foreign investment. Otherwise, rather than investing, foreigners will just export their commodities, which leads to a better profitability.

We restrict our attention to a first-order recursive equilibrium such that the countries make all their decisions according to time-invariant policy functions of the current state variables.

In order to derive the equilibrium conditions, we shall first note that, in equilibrium, both the EU15 and the non-EU15 consumers rent some of their capital to producers in their own countries, i.e., $k_{t+1} > 0$ and $k^n_{t+1} > 0$ for all t. Indeed, if consumers in both countries rented capital to foreign producers, they could have saved on border costs by interchanging some of their capital invested abroad on domestic capital.

With this result, the EU15 agent's problem (1), (2) yields the following set of First Order Conditions (FOCs):

$$u_2(c_t, 1 - h_t) = w_t u_1(c_t, 1 - h_t), \tag{4}$$

$$u_1(c_t, 1 - h_t) = \delta u_1(c_{t+1}, 1 - h_{t+1})(1 - d + r_{t+1}), \tag{5}$$

$$u_1(c_t, 1 - h_t) \geqslant \delta u_1(c_{t+1}, 1 - h_{t+1})(1 - d + \gamma r^n_{t+1}), \tag{6}$$

where condition (6) holds with equality if $\phi_{t+1} > 0$, and it holds with strict inequality if $\phi_{t+1} = 0$. Here, and further in the text, y_i denotes the first-order partial derivative of function y with respect to argument i. Condition (4) is the standard intratemporal FOC which says that the marginal rate of substitution between consumption and leisure is equal to wage. Equations (5) and (6) are the Kuhn–Tucker conditions. According to (5), if the agent decides to rent capital to foreign producers, $\phi_{t+1} > 0$, his investment decisions are such that the marginal rate of substitution between his consumption tomorrow and today is equal to the marginal rate of transformation in the home country. As follows from (6), when the agent decides not to invest in the foreign country, the marginal rate of substitution between his consumption tomorrow and today is larger than the marginal rate of transformation in the foreign country after paying border costs.

Further, according to (3), the EU15 firm's profit-maximisation conditions are:

$$r_t = F_1(K_t, H_t) \quad \text{and} \quad w_t = F_2(K_t, H_t). \tag{7}$$

Finally, the market clearing conditions for capital and labour in the EU15 country, respectively, are:

$$K_t = \frac{k_t v + \phi^n_t v^n}{v} \quad \text{and} \quad H_t = h_t. \tag{8}$$

That is, since capital is mobile and labour is immobile, the capital used in domestic production, K_t, can be rented from both domestic and foreign consumers, while the labour input, H_t, can include only domestic labour.

We shall assume that the EU15 country has larger initial endowment per capita than does the non-EU15 country. Under this assumption, there could exist only capital flows from the EU15 to the non-EU15 country but not vice versa, i.e., $\phi_t \geqslant 0$ and $\phi^n_t \equiv 0$ for all t. As a consequence, the only border costs that matter for our analysis are those affecting investment from the EU15 to the non-EU15 countries, γ; the border costs from the non-EU15 to the EU15 countries, γ^n, are irrelevant.

3.3. Environments

We analyse four different environments. The first three environments are defined within our baseline two-country setup by varying border costs. We specifically consider infinitely large border costs, positive finite border costs and zero border costs, which imply values of $\gamma = 0$, $\gamma \in (0, 1)$ and $\gamma = 1$, respectively. Zero (positive) border costs correspond to the case in which the EU15 and the non-EU15 countries form (do not form) an economic union. Our fourth environment comes from a three-country variant of the model. To be precise, we assume that, initially, there is one EU15 country and two identical non-EU15 countries. Subsequently, one of the non-EU15 countries forms an economic union with the EU15 country, eliminating border costs, $\gamma = 1$, whereas the other non-EU15 country remains outside the union continuing to have positive finite border costs, $\gamma \in (0, 1)$. We show that such a three-country model can be converted into our baseline two-country framework.

How can we justify the assumption that accession by a country to the EU reduces border costs? As the empirical literature shows, EU accession leads to a closer integration of an accession country with EU member states: it promotes market reforms, ensures political stability, reduces all kinds of transactions costs, enforces a common regulatory environment, etc. (see Section 2 for a discussion). We presume that all such effects simplify the operation of foreign investors in an accession country, which is formally captured by an increase in the rate of return on foreign

investment through an increase in the border-cost parameter γ. However, there are other important determinants of foreign investment that are not captured by our assumption of the reduction in border costs; for example, local market size and factor costs (Lankes and Venables, 1996) and the EU structural funds (Breuss et al., 2001, 2003). To simplify the analysis, we abstract from these issues.

Finally, we should point out that in our model, accession of a country to the EU occurs instantaneously: border costs between the EU15 and the accession country are fully eliminated at the moment of accession. In reality, the accession process is more sophisticated: firstly, a country applies to join the EU; secondly, the membership is granted; thirdly, the formal accession takes place; and finally, the country is gradually integrated in the EU institutions over the post-accession period. The effects of accession on border costs are therefore extended over a period of time. In particular, there is an anticipatory effect because rational agents foresee the accession and adjust their behaviour correspondingly. In this paper, we make no distinction between the anticipatory, immediate and ex post effects of the enlargement. As a result, the effects of capital flows in our model are likely to be more pronounced and concentrated in time than they are in the data.

3.3.1. Autarky

If border costs are infinitely large, $\gamma = 0$, then the EU15 country never invests in the non-EU15 country,

$$\phi_{t+1} = 0 \quad \text{for all } t, \tag{9}$$

which means that the two countries are in autarky.

3.3.2. No non-EU15 country joins the EU

Under positive finite border costs, $\gamma \in (0, 1)$, we find ϕ_{t+1} from conditions (5)–(7). Suppose that the Euler equation (6) holds with equality, which implies that $r_{t+1} = \gamma r_{t+1}^n$, so that by taking into account the market clearing condition (8), we have

$$F_1(k_{t+1}, h_{t+1}) = \gamma F_1\left(\frac{k_{t+1}^n v^n + \phi_{t+1} v}{v^n}, h_{t+1}^n\right). \tag{10}$$

If there is a positive value of ϕ_{t+1} satisfying (10), then it is a solution; otherwise the solution is $\phi_{t+1} = 0$. In the latter case, the EU15 country does not invest in the non-EU15 country because it is less profitable than investing in domestic production.

3.3.3. All non-EU15 countries join the EU

If the EU15 and the non-EU15 countries form an economic union, so that border costs disappear, $\gamma = 1$, capital moves from the former country to the latter country until both countries have the same interest rates, $r_{t+1} = r_{t+1}^n$. The optimal ϕ_{t+1} is therefore a solution to (10) under $\gamma = 1$.

3.3.4. Some non-EU15 countries accede the EU, and others do not

Let us denote with superscripts o and a variables of the old EU country (the one that constituted the EU before the EU enlargement, i.e., the EU15) and the new accession country, respectively. We continue to use superscript n to denote variables of the non-EU country, which corresponds now to the non-accession country. As was said, after the EU enlargement, border costs between the old EU and the accession countries become zero, $\gamma = 1$, and those between the enlarged EU and the non-accession countries remain positive, $\gamma \in [0, 1)$.

Although we now distinguish between three different countries, we can still analyse their interactions in the context of our two-country framework. This is possible because, in the absence of border costs, we can replace the old EU and the accession countries with a single representative country by using the aggregation-based construction described in Maliar and Maliar (2003). To be specific, let us assume that the enlarged EU is ruled by a social planner and let us define the social momentary utility function of the enlarged EU by

$$u(c_t, 1 - h_t) \equiv \max_{c_t^o, h_t^o, c_t^a, h_t^a} \left\{ \frac{1}{v^o + v^a} \left[v^o \lambda^o u\left(c_t^o, 1 - h_t^o\right) + v^a \lambda^a u\left(c_t^a, 1 - h_t^a\right) \right] \right.$$

$$\left. \text{s.t.} \quad \frac{c_t^o v^o + c_t^a v^a}{v^o + v^a} = c_t, \quad \frac{h_t^o v^o + h_t^a v^a}{v^o + v^a} = h_t \right\}, \tag{11}$$

where variables without subscripts are those of the enlarged EU in per capita terms, and λ^o and λ^a are welfare weights assigned by the planner to the representative consumers of the old EU and the accession countries, respectively. For the sake of convenience, we normalise the average welfare weight to unity by $\frac{\lambda^o v^o + \lambda^a v^a}{v^o + v^a} = 1$. The representative consumer of the enlarged EU solves the intertemporal utility-maximisation problem (1), (2), where initial condition is given by $(k_0, \phi_0) \equiv \left(\frac{k_0^o v^o + k_0^a v^a}{v^o + v^a}, \frac{\phi_0^o v^o + \phi_0^a v^a}{v^o + v^a} \right)$, with ϕ_0^o and ϕ_0^a being capital flows from the old EU and the accession countries to the non-accession countries, respectively. The production side of the enlarged EU consists of the representative firm, which solves the profit-maximisation problem (3). The population of the enlarged EU is $v \equiv v^o + v^a$.

As far as the welfare weights λ^o and λ^a are concerned, their values corresponding to given initial endowments of the old EU and the accession countries, (k_0^o, ϕ_0^o) and (k_0^a, ϕ_0^a), respectively, are identified by the lifetime budget constraints,

$$\sum_{\tau=0}^{\infty} \delta^\tau \frac{u_1(c_\tau^s, h_\tau^s)}{u_1(c_0^s, h_0^s)} \left(c_\tau^s - w_\tau h_\tau^s \right) = (1 - d + r_0)\left(k_0^s + \phi_0^s \right), \quad s \in \{o, a\}. \tag{12}$$

This constraint is obtained by using forward recursion of the budget constraint (2) and by imposing the transversality condition, see Maliar and Maliar (2001) for more details.

In general, constructing the social utility function and finding the equilibrium welfare weights are complicated tasks, which need to be performed by numerical methods.[10] However, if the economy is consistent with Gorman's (1953) aggregation, we can construct the social utility function analytically and derive a closed-form expression for the equilibrium welfare weights. We therefore study the quantitative implications of the model under the assumption of Gorman's (1953) type of preferences. In Appendix A, we describe the corresponding aggregation results as a part of our solution procedure.

Once the social utility function of the enlarged EU is constructed, we can characterise the equilibrium dynamics of the enlarged EU and the non-accession countries by the equilibrium conditions (4)–(8), and in particular, we can compute the amount of capital flowing from the enlarged EU to the non-accession country, ϕ_{t+1}, under $\gamma \in (0, 1)$ as described in Section 3.3.2. As a final remark, we shall mention that the two-country setup of Section 3.3.3 with no border costs can be equivalently restated as the planner's problem described above.

4. Numerical analysis

In this section, we first describe the methodology of our numerical study, and we then present simulation results.

4.1. Methodology

To assess the quantitative implications of the model, we need to choose functional forms for the utility and the production functions, and to calibrate the model's parameters. We assume the Constant Relative Risk Aversion (CRRA) utility function,

$$u(c_t, 1 - h_t) = \frac{(c_t^\mu (1 - h_t)^{1-\mu})^{1-\sigma} - 1}{1 - \sigma}, \quad \mu \in (0, 1), \ \sigma > 0, \tag{13}$$

where μ is the share of consumption relative to leisure in the utility function, and σ is the inverse of intertemporal elasticity of substitution, which reflects the consumer's taste for intertemporal consumption smoothing. The utility function (13) is homothetic, so that it is consistent with Gorman's (1953) aggregation.

The production function is Cobb–Douglas,

$$F(k_t, h_t) = k_t^\alpha h_t^{1-\alpha}, \quad \alpha \in (0, 1). \tag{14}$$

The assumptions (13) and (14) are standard to the macroeconomic literature.

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[10] Specifically, one can use the following iterative procedure: assume some welfare weights, compute the social utility function (11), solve for the individual and aggregate allocations and check the lifetime budget constraints (12); iterate on the weights until the planner's solution satisfies the lifetime budget constraints.

We choose the model's time period to be one quarter. We calibrate the parameters so that in the steady state, the autarkic variant of our model generates hours worked $h = 0.31$, as estimated in a microeconomic study by Juster and Stafford (1991), and it reproduces three basic observations on the euro area, as described in Smets and Wouters (2003), namely, the share of capital income in output $\alpha = \frac{rk}{y} = 0.3$, the consumption-to-output ratio $\frac{c}{y} = 0.73$ and the capital-to-output ratio $\frac{k}{y} = 8.8$, where variables without time subscripts denote steady state values. The statistics $\{h, \frac{c}{y}, \frac{k}{y}\}$ identify the values of the parameters $\{d, \delta, \mu\} = \{0.0257, 0.9938, 0.3307\}$, see Maliar and Maliar (2001).

Concerning the initial capital stock, we assume that the EU15 country starts from the steady state and that the non-EU15 country is initially endowed with 15% of the steady state capital, which roughly matches the GDP per capita difference between the EU15 and the non-EU15 countries in 2004, as reported in Table 1. As regards population sizes, on the date of the fifth enlargement, the populations of the EU15, the accession countries and the non-accession countries was 378.98 millions, 73.57 millions and 98.48 millions, respectively (see Table 1). To make the model approximately consistent with these figures, we set the population of the EU15, the accession countries and the non-accession countries in the model at 5, 1 and 1, respectively.

The value of the utility-function parameter σ and that of the border-cost parameter γ are not identified by our calibration procedure. In the benchmark case, we assume $\sigma = 2$ and $\gamma = 0.9$. The latter value implies that the effective interest rate faced by foreign investors is 10% lower than that faced by domestic investors. Furthermore, we perform sensitivity analysis with respect to these two parameters by considering the values of $\gamma = 0.5$ and $\sigma = 5$.

To solve the model, we employ a version of the Euler-equation method that finds a solution to the equilibrium conditions (4)–(8) on a grid of prespecified points for two state variables, domestic total capital and foreign total capital. Our program is written in Matlab. A detailed description of our solution method is provided in Appendix A.

4.2. Two-country model

We shall start by presenting the results for the two-country variant of the model. The EU15 country starts in the steady state while the non-EU15 country starts below the steady state. Under the autarkic scenario, the EU15 country remains in the steady state forever, while the non-EU15 country converges to the (same) steady state from below. Under the accession scenario, once borders are opened, there are capital flows from the EU15 to the non-EU15 country. The non-accession scenario differs from the accession scenario only by the presence of border costs.

In Fig. 1, we illustrate the transitional dynamics obtained under the benchmark parameterisation ($v^n = 1$, $\sigma = 2$, $\gamma = 0.9$) by plotting the key model's variables over the first 100 periods. In addition, in the first panel of Table 2, we provide some statistics characterising the transitional dynamics, namely, we report the short-run ($t = 0$) and long-run ($t \to \infty$) percentage differences between the values of the model's variables under the non-accession (accession) scenario and those under the autarkic scenario.

As seen from the figure, under the autarkic scenario (infinitely large border costs, $\gamma = 0$), there is a large initial difference in the interest rates between the EU15 and the non-EU15 countries, which is due to very different levels of initial savings. (Variable "savings" is defined as the total capital holdings of the country's residents, $k_t + \phi_t$; in autarky, savings are equal to k_t.) Consequently, if border costs are either entirely removed, as is the case under the accession scenario ($\gamma = 1$), or sufficiently reduced, as is the case under the non-accession scenario ($\gamma = 0.9$), the rich EU15 country reallocates a part of its capital stock to the poor non-EU15 accession or non-accession country, respectively. This effect can be appreciated by looking at the capital and the capital-outflow charts in the figure (variables "capital" and "capital outflow" are, respectively, defined as the capital stock installed in the country, $K_t = k_t + \phi_t^n \frac{v^n}{v}$, and the difference between the country's savings and capital, $k_t + \phi_t - K_t = \phi_t - \phi_t^n \frac{v^n}{v}$, which is equal to ϕ_t for the EU15 country and which is equal to $-\phi_t \frac{v}{v^n}$ for the non-EU15 country). It follows from Table 2 that in the short run, international capital flows are roughly of the same size under the accession and the non-accession scenarios: the EU15 country's capital decreases by about 15%, while the non-EU15 country's capital increases by about 500%. As a consequence of capital outflow, in the short run, the EU15 country (the non-EU15 country) faces a reduction (an increase) in wages, output and consumption.

While the model has similar short-run implications under the accession and the non-accession scenarios, it has very different long-run implications. Under the non-accession scenario, the EU15 capital fully exits the non-accession country in the long run. (According to Table 2, in the benchmark case, the exit of foreign capital occurs after 53 periods.) Consequently, all the effects associated with international capital flows are temporal, and both the EU15
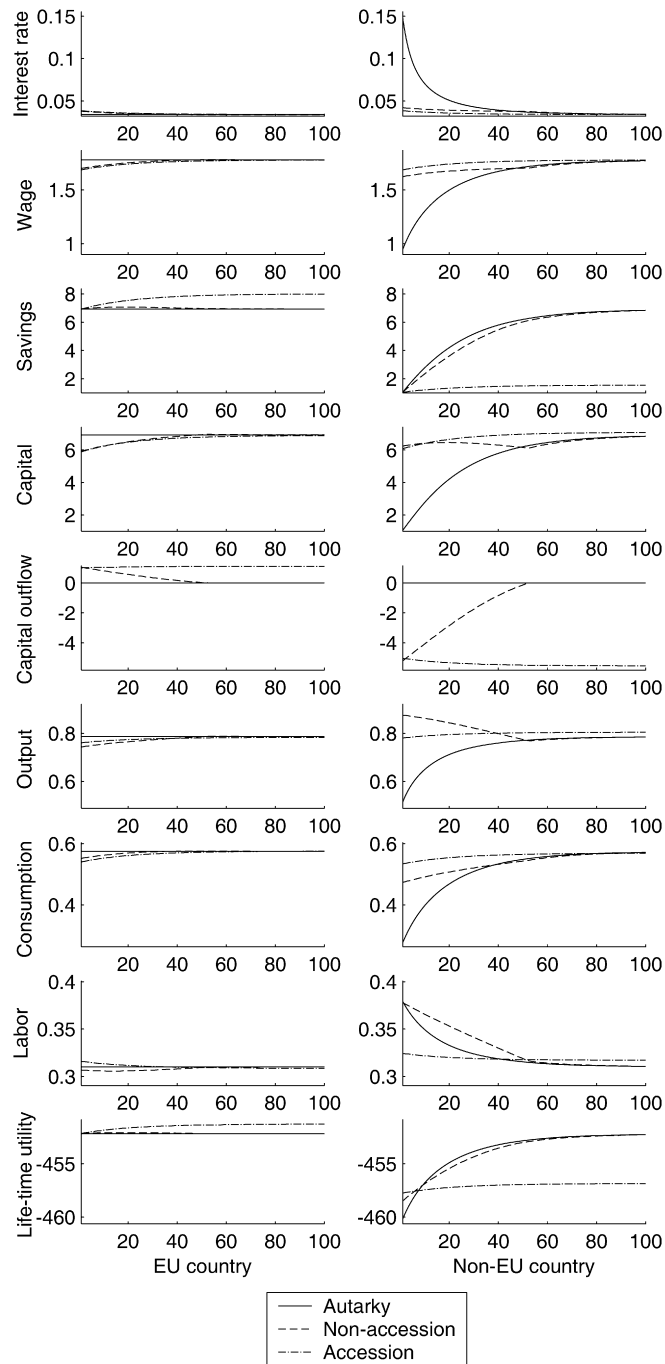
Fig. 1. Transitional dynamics in the two-country model: the benchmark case.

and the non-accession countries will end up in the same (autarkic) steady state. In contrast, under the accession scenario, the effects associated with international capital flows are permanent.[11] The EU15 country's investors become owners of most capital installed in the accession country taking away profit opportunities from the accession country's

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[11] In fact, our results under the accession scenario are similar to those obtained in a partial equilibrium setup where an infinitely small, developing economy is opened to capital flows from an infinitely large, developed rest of the world. Such a setup produces no transitional dynamics: the

Table 2
Selected statistics on transitional dynamics in the two-country model

(1) Scenario	(2) Country	(3) Interest rate	(4) Wage	(5) Savings	(6) Capital	(7) Capital outflows	(8) Output	(9) Consum.	(10) Labour	(11) Lifetime utility
Benchmark model: $v = 5$, $v^n = 1$, $\sigma = 2$, $\gamma = 0.9$										
NAC	EU, $t = 0$	11.224	−4.457	0	−15.018	17.673	−5.480	−3.997	−1.071	0.004
	EU, $t = \infty$	0	0	0	0	0	0	0	0	0
Foreigners leave	n-EU, $t = 0$	−71.557	71.399	0	500.612	−83.350	70.833	71.746	−0.331	0.373
after 53 periods	n-EU, $t = \infty$	0	0	0	0	0	0	0	0	0
AC	EU, $t = 0$	13.125	−5.148	0	−14.543	17.018	−3.327	−5.966	1.920	0.009
	EU, $t = \infty$	0	0	15.555	−0.455	16.082	−0.454	0.204	−0.454	0.204
Foreigners	n-EU, $t = 0$	−73.964	78.019	0	484.774	−82.899	52.254	93.756	−14.473	0.536
stay forever	n-EU, $t = \infty$	0	0	−77.774	2.270	−78.267	2.270	−1.020	2.270	−1.030
Sensitivity with respect to the border-cost parameter γ: $v = 5$, $v^n = 1$, $\sigma = 2$, $\gamma = 0.5$										
NAC	EU, $t = 0$	3.856	−1.609	0	−6.839	7.341	−3.246	−0.873	−1.665	0.000
	EU, $t = \infty$	0	0	0	0	0	0	0	0	0
Foreigners leave	n-EU, $t = 0$	−52.193	37.203	0	225.702	−69.297	55.706	25.902	13.485	0.080
after 11 periods	n-EU, $t = \infty$	0	0	0	0	0	0	0	0	0
AC	EU, $t = 0$	13.125	−5.148	0	−14.543	17.018	−3.327	−5.966	1.920	0.009
	EU, $t = \infty$	0	0	15.555	−0.455	16.082	−0.454	0.204	−0.454	0.204
Foreigners	n-EU, $t = 0$	−73.964	78.019	0	484.774	−82.899	52.254	93.756	−14.473	0.536
stay forever	n-EU, $t = \infty$	0	0	−77.774	2.270	−78.267	2.270	−1.020	2.270	−1.030
Sensitivity with respect to the utility-function parameter σ: $v = 5$, $v^n = 1$, $\sigma = 5$, $\gamma = 0.9$										
NAC	EU, $t = 0$	10.121	−4.047	0	−13.980	16.252	−5.274	−3.497	−1.278	0.020
	EU, $t = \infty$	0	0	0	0	0	0	0	0	0
Foreigners leave	n-EU, $t = 0$	−69.083	65.381	0	466.000	−82.332	74.992	60.608	5.811	2.474
after 84 periods	n-EU, $t = \infty$	0	0	0	0	0	0	0	0	0
AC	EU, $t = 0$	11.904	−4.706	0	−14.564	17.046	−4.394	−4.846	0.328	0.046
	EU, $t = \infty$	0	−0	16.031	−0.470	16.579	−0.468	0.209	−0.468	0.836
Foreigners	n-EU, $t = 0$	−71.724	71.833	0	485.453	−82.919	65.543	74.957	−3.661	3.525
stay forever	n-EU, $t = \infty$	0	0	−80.164	2.352	−80.620	2.342	−1.047	2.338	−4.315

Notes. "NAC" and "AC" are abbreviations for the non-accession and the accession scenarios, respectively. Statistics in columns (3)–(6) and (8)–(11) are percentage differences between the values of the variables under the given scenario and those in the associated autarkic economy. The statistic in column (7) is capital outflows from a country in percent of the country's capital stock.

investors forever. Since the EU15 residents hold not only the capital stock installed in their own country but also a large fraction of capital installed in the accession country, in the long run, the savings of the EU15 residents are about 15% higher than in autarky. As a consequence of higher capital income, the EU15 agents enjoy larger consumption and leisure than in autarky. On the contrary, the accession country's agents end up with smaller consumption and leisure in the long run because their savings are about 75% lower than in autarky.[12]

Why does the presence of non-zero border costs make the EU15 country eventually withdraw its capital from the non-accession country? Initially, there is a large difference between the interest rates in the EU15 and the non-accession countries, so that it is profitable for the EU15 agents to invest abroad in spite of border costs. However, over the process of economic development, the difference in the interest rates decreases and eventually becomes smaller than border costs, so that the EU15 agents are better off by investing only in their own country. Indeed, when the EU15 residents invest their capital in the non-accession country, they earn the interest rate which is γ times lower than the one faced by the non-accession country's investors, r_{t+1}^n, i.e., $r_{t+1} = \gamma r_{t+1}^n$. In particular, as the interest rate earned by the non-accession country's investors r_{t+1}^n goes down below r/γ, the interest rate earned by the EU15 investors r_{t+1}

developing economy experiences an infinitely large inflow of capital and goes to a steady state in one period. In our general-equilibrium setup with economies of finite sizes, we do observe transitional dynamics; however, the transitional patterns are fairly flat.

[12] Under the previous four EU enlargements, the difference in initial endowments between the EU and the accession countries (Denmark, Ireland, UK, Greece, Portugal, Spain, etc.) was much smaller than under the current EU enlargement. As a result, if the model is calibrated to the previous enlargements, all the effects discussed above are of much smaller magnitude. In particular, investors of the old EU-member states do not take over such a large share of the accession country's capital.

becomes lower than the steady state one, r. By this time, the EU15 investors should have withdrawn all their capital from the non-accession country, because in their own country, they can earn the interest rate, which is at least as high as the steady state one, r. After the exit of foreign capital, the non-accession country continues its development in autarky, and its interest rate, r_{t+1}^n, goes from r/γ to its limiting steady state value r. In contrast, under the accession scenario, there is no reason for the EU15 investors to withdraw their capital from the accession country because in the absence of border costs, both the EU15 and the accession country's investors face the same interest rate, $r_{t+1} = r_{t+1}^n$. Thus, the situation when the EU15 investors hold most of the accession country's capital perpetuates forever.

It is interesting to note that in the short run, the non-EU15 agents work more under the non-accession scenario than under the accession scenario, however, in the long run, the opposite is true. This tendency can be explained as follows: Under the non-accession scenario, agents have the possibility to buy out the domestic capital from foreigners. Hence, they work a lot until they gain ownership of all the domestic assets and use the resulting increment in their capital income to raise consumption and leisure forever. In contrast, under the accession scenario, the presence of foreign capital is permanent. As a consequence, agents of the accession country have a small capital income, so that, in the long run, they are to work more and consume less than in autarky (see Table 2). Furthermore, as is seen from the figure, output follows the same time patterns as does labour under both the non-accession and the accession scenarios.

Let us now turn to the welfare implications of the model. The relevant measure of welfare is lifetime utility of the representative agent computed in the period $t = 0$.[13] We shall first note that the EU enlargement has a relatively small effect on welfare of the EU15 country, namely, it increases lifetime utility only by 0.009% relative to autarky (see Table 2). The effect of the EU enlargement on welfare of the acceded non-EU country is however more sizable: here, lifetime utility increases by 0.536% relative to autarky. Under the non-accession scenario, the welfare gains are smaller for both the EU15 and the non-accession countries, and they, respectively, amount to 0.004% and 0.373%, relative to autarky. Investing in the non-EU15 country is beneficial for the EU15 investors because they can earn a higher interest rate and hence, a larger capital income. In turn, an inflow of foreign capital is beneficial for the non-EU15 country because it instantaneously leads to a higher wage and consequently, a larger labour income.

As follows from the above discussion, both the EU15 and the non-EU15 countries have the same ranking of the scenarios in period $t = 0$: they prefer the accession scenario to the non-accession one, and they prefer the non-accession scenario to the autarkic one. We should note, however, that the ranking of the scenarios changes for the non-EU15 country if, as a measure of welfare, we consider lifetime utility not in period $t = 0$ but in some period which is sufficiently advanced in the future. Specifically, after the first few periods, the non-accession and the autarkic scenarios start yielding higher welfare for the non-EU15 country than does the accession scenario. (Recall that under the accession scenario, the accession country faces a permanent reduction in capital income because it loses the ownership of most of its capital.) Thus, if the non-EU15 country's government had an objective to maximise long-run welfare instead of welfare in $t = 0$, it would decide not to join the EU. Concerning the EU15 country, we do not have such a ranking reversal since welfare for this country is always larger under the accession scenario than under the non-accession one. (Moreover, welfare gains for the EU15 country from the EU enlargement increase substantially over time, from 0.009% in the short run to 0.204% in the long run relative to autarky.) Thus, the EU15 country's government would be in favour of the EU enlargement independently of whether it maximised short-run or long-run welfare.

4.3. Three-country model

We now turn to the three-country variant of our model. In the benchmark case, we assume $v^o = 5$, $v^a = 1$, $\sigma = 2$ and $\gamma = 0.9$. We plot the obtained transitional dynamics in Fig. 2, and we present the corresponding numerical results in the first panel of Table 3. As can be seen from the figure, transitional dynamics of the old EU and the accession countries are qualitatively the same as those we had in the two-country model for the EU15 and the accession countries, respectively. Quantitatively, all the effects for the EU15 country are almost two times larger now than they were in the two-country case. This is because in the three-country setup, the EU15 country invests in both the accession and the non-accession countries with the total population equal to 2, whereas in the two-country setup, it

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[13] Since the utility values are arbitrary, the magnitude of utility changes is not an entirely appropriate measure of changes in welfare. In a stochastic stationary economy, an appropriate welfare measure would be an equivalent variation of consumption, see, e.g., Boyarchuk et al. (2005). Our economy is however non-stochastic and we cannot use this standard measure.
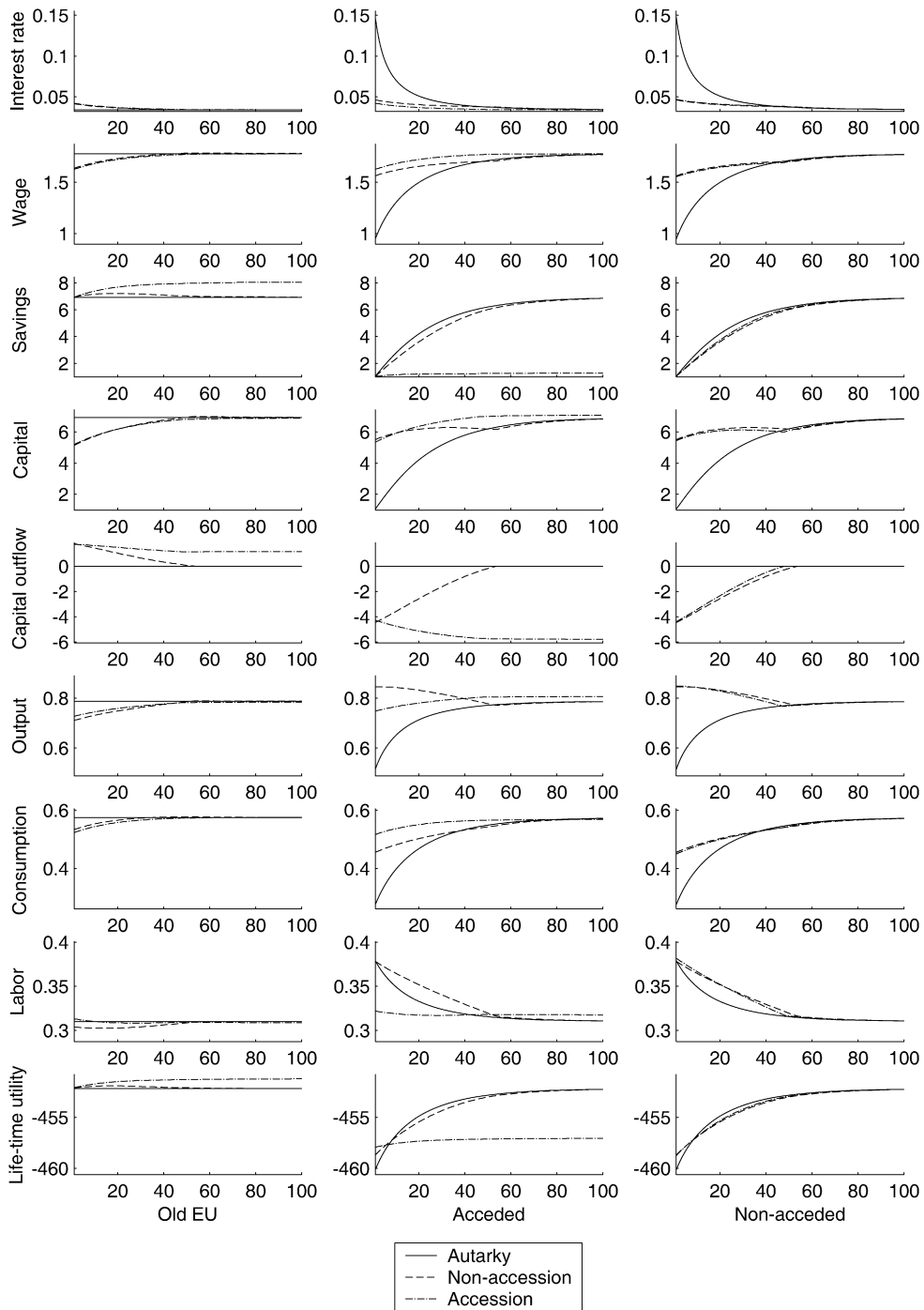
Fig. 2. Transitional dynamics in the three-country model: the benchmark case.

invested only in the non-EU15 (accession or non-accession) country with the population equal to 1. On the contrary, for the accession country, all the effects are somewhat reduced because in the presence of the third country, it receives less investment from the EU15 country.

The three-country model has a new important feature, compared to the two-country model, namely, it allows us to evaluate how accession of some countries to the EU affects the non-accession countries. It is clear that a country's

Table 3
Selected statistics on transitional dynamics in the three-country model

(1) Scenario	(2) Country	(3) Interest rate	(4) Wage	(5) Savings	(6) Capital	(7) Capital outflows	(8) Output	(9) Consum.	(10) Labour	(11) Lifetime utility
		Benchmark model: $v^o = 5$, $v^a = 1$, $v^n = 1$, $\sigma = 2$, $\gamma = 0.9$								
NAC	old EU, $t = 0$	21.502	−8.008	0	−25.793	34.757	−9.837	−7.187	−1.988	0.014
	old EU, $t = \infty$	0	0	0	0	0	0	0	0	0
Foreigners leave	accession, $t = 0$	−68.929	65.029	0	429.877	−81.128	64.641	65.266	−0.235	0.325
after 57 periods	accession, $t = \infty$	0	0	0	0	0	0	0	0	0
AC	old EU, $t = 0$	23.282	−8.580	0	−25.118	33.543	−7.684	−8.982	0.980	0.020
	old EU, $t = \infty$	0	0	16.251	−0.474	16.805	−0.474	0.213	−0.474	0.213
Foreigners	accession, $t = 0$	−71.626	71.578	0	413.188	−80.514	45.612	87.438	−15.134	0.492
stay forever	accession, $t = \infty$	0	0	−81.254	2.371	−81.688	2.371	−1.065	2.371	−1.077
$\Delta^{\max}$(NAC, AC) for n-EU		1.465	−0.621	3.467	−3.248	4.997	−1.910	−1.215	−1.353	−0.032
		Sensitivity with respect to the border-cost parameter γ: $v^o = 5$, $v^a = 1$, $v^n = 1$, $\sigma = 2$, $\gamma = 0.5$								
NAC	old EU, $t = 0$	7.395	−3.011	0	−12.539	14.336	−6.071	−1.637	−3.154	0.001
	old EU, $t = \infty$	0	0	0	0	0	0	0	0	0
Foreigners leave	accession, $t = 0$	−50.565	35.247	0	208.975	−67.635	52.742	24.561	12.936	0.073
after 11 periods	accession, $t = \infty$	0	0	0	0	0	0	0	0	0
AC	old EU, $t = 0$	16.346	−6.282	0	−18.929	23.348	−5.677	−6.555	0.646	0.098
	old EU, $t = \infty$	0	0	15.643	−0.456	16.173	−0.456	0.205	−0.456	0.205
Foreigners	accession, $t = 0$	−73.222	75.890	0	455.109	−81.986	48.645	92.531	−15.490	0.530
stay forever	accession, $t = \infty$	0	0	−78.213	2.282	−78.699	2.282	−1.025	2.282	−1.036
$\Delta^{\max}$(NAC, AC) for n-EU		8.335	−3.373	4.156	−12.594	12.091	−5.716	−3.439	−2.782	−0.019
		Sensitivity with respect to the utility-function parameter σ: $v^o = 5$, $v^a = 1$, $v^n = 1$, $\sigma = 5$, $\gamma = 0.9$								
NAC	old EU, $t = 0$	19.354	−7.302	0	−24.177	31.885	−9.502	−6.314	−2.373	0.072
	old EU, $t = \infty$	0	0	0	0	0	0	0	0	0
Foreigners leave	accession, $t = 0$	−66.491	59.772	0	402.941	−80.117	68.533	55.420	5.484	2.183
after 88 periods	accession, $t = \infty$	0	0	0	0	0	0	0	0	0
AC	old EU, $t = 0$	21.021	−7.852	0	−24.446	32.356	−8.563	−7.532	−0.773	0.108
	old EU, $t = \infty$	0.001	−0.001	16.980	−0.496	17.563	−0.495	0.222	−0.494	0.884
Foreigners	accession, $t = 0$	−69.420	66.160	0	418.773	−80.724	58.640	69.895	−4.526	3.284
stay forever	accession, $t = \infty$	−0.010	0.004	−84.906	2.486	−85.272	2.476	−1.106	2.472	−4.569
$\Delta^{\max}$(NAC, AC) for n-EU		1.397	−0.593	3.911	−2.775	5.352	−1.468	−0.921	−0.914	−0.159

Notes. "NAC" and "AC" are abbreviations for the non-accession and the accession scenarios, respectively. Statistics in columns (3)–(6) and (8)–(11) are percentage differences between the values of the variables under the given scenario and those in the associated autarkic economy. The statistic in column (7) is capital outflows from a country in percents of the country's capital stock. Statistic "$\Delta^{\max}$(NAC, AC) for non-EU" is a maximum percentage difference between the values of the variables of the non-EU country under the non-accession and the accession scenarios.

accession to the EU makes it more attractive for the EU15 investors since border costs disappear. As a consequence, the EU15 country shifts a part of its foreign investment from the non-accession country to the accession country, which causes a reduction in capital, wages, labour, output and consumption in the non-accession country. To evaluate the magnitude of such a reduction in the non-accession country's variables, in Table 3, we provide a maximum percentage difference between the values of each non-accession country's variable when the other non-EU15 country joins and the corresponding values when it does not join the EU, $\Delta^{\max}(x_t^{AC}, x_t^{NAC})$. As can be seen, the reduction effect is relatively modest: the value of $\Delta^{\max}$ ranges from 0.62% for wages to about 5% for capital inflows. The decrease in welfare of the non-accession country due to the accession of the other non-EU15 country is fairly small: it does not exceed 0.032%. Thus, we conclude that the EU accession of some transition countries is unlikely to significantly affect the economies of non-accession countries.

4.4. Sensitivity experiments

We next examine the sensitivity of the model's predictions to changes in the parameters which are not uniquely identified by our calibration procedure, namely, the border cost, γ, and the inverse of the intertemporal elasticity of substitution, σ. The statistics for these sensitivity experiments for the two-country and the three-country models are

reported in Tables 2 and 3, respectively. The transition patterns in the sensitivity experiments proved to be similar to those we had under the benchmark parameterisation, and we have therefore not given the corresponding figures.

In the first sensitivity experiment, we consider a doubling in the size of border costs by varying the border-cost parameter from $\gamma = 0.9$ to $\gamma = 0.5$. (It is clear that this change does not affect the results under the accession scenario where, by definition, $\gamma = 1$.) Under the non-accession scenario, the increase in border costs leads to a large reduction in capital flows and the magnitude of all associated effects. In particular, the number of periods for which the EU15 capital stays in the non-accession country decreases from 53 in the benchmark case to 11 now.

In the second experiment, we vary the inverse of the intertemporal elasticity of substitution from $\sigma = 2$ to $\sigma = 5$. A stronger agent's desire to smooth the consumption path slows down capital accumulation and thus, slows down the convergence to a steady state compared to the benchmark case: now, the EU15 capital remains in the non-accession country for 84 periods. Therefore, the parameters γ and σ play a similar role in the equilibrium dynamics: their variations considerably affect the speed of convergence but not the variables' initial and asymptotic values.

An interesting implication of the model in both sensitivity experiments compared to the benchmark case is that hours worked by the non-accession country are greater than in autarky. In the first experiment, this occurs because with large border costs, $\gamma = 0.5$, the presence of foreign capital is very short (just 11 periods) and the agents want to take advantage of the associated temporary increase in wages. In the second experiment, this occurs because highly risk-averse agents opt for a more gradual increase in consumption and leisure compared to the benchmark case. Also, we shall note that under $\sigma = 5$, an increase in lifetime utility of the non-EU country at $t = 0$ due to foreign investment is about 8 times larger than under the benchmark value $\sigma = 2$. This is because agents with a higher degree of risk aversion dislike more variations in consumption and thus, gain more when initially low consumption and leisure are increased by means of foreign investment.

Finally, in Table 3, we provide the sensitivity results for the three-country model. Here, we have roughly the same regularities for the old EU and the accession countries, as we did for the EU15 and the accession countries, respectively, in the corresponding two-country settings. As far as the third (non-accession) country is concerned, the differences between its variables under the accession and non-accession scenarios are the largest in the experiment with large border costs, $\gamma = 0.5$, ranging from 3.4% for wages to 12.6% for capital stock. Overall, the results obtained in the sensitivity experiments are similar to those we had in the benchmark experiments. This is true for both the two-country and the three-country variants of the model. We therefore conclude that the predictions of the model are robust to the modifications considered.

5. Concluding remarks

In this paper, we develop a dynamic general equilibrium model with the aim of studying the impact of EU enlargement on the economies of the EU15, the accession and the non-accession countries. We focus on one particular aspect of EU enlargement, which is the abolition of border costs for investing from the EU15 to the accession country. In a calibrated version of the model, we find that the effects associated with capital flows from rich EU15 countries to poor transition countries are very large: in the short-run, the EU15 investors can become owners of 70–80% of the total capital stock of the transition countries independently of whether such countries join the EU or not. How does this prediction agree with empirical evidence from transition economies? In the data, the presence of foreign capital in transition economies during the pre-accession period was not as large as predicted by the model but still fairly ample. For example, in 1999, the share of firms under foreign control in manufacturing employment in the Czech Republic, Poland and Hungary was 16.2, 18.6 and 46.5%, respectively; and, in 2000, the FDI stock in the Czech Republic, Hungary and Estonia was 42.6, 43.4 and 53.2% of their GDP, respectively; see Henriot (2003).

The crucial difference between the non-accession and the accession scenarios in our model consists of the long-run outcomes: the presence of foreigners is only temporary in a non-accession country, whereas it is permanent in an accession country. This fact should be taken into account by policy makers: for example, an accession country might wish to artificially introduce some border costs in order to protect itself against an excessive presence of foreign capital in the long run. An interesting extension of our model would therefore be to endogenise border costs by making it a policy variable of an accession country.

Our model implies that, for the non-EU15 countries, the short-run ranking of welfare is different to the log-run one. To be specific, in period $t = 0$, the non-EU15 countries prefer the accession scenario to the non-accession one, and they prefer the non-accession scenario to the autarkic one. However, after a few periods pass, the non-accession and the

autarkic scenarios start yielding higher welfare for the non-EU15 country than does the accession scenario. (Recall that under the accession scenario, the accession country faces a permanent reduction in capital income because it looses the ownership of most of its capital.) Thus, if the non-EU15 country's government had an objective to maximise long-run welfare instead of welfare in $t = 0$ (for example, because the government does not discount future as consumers do), it would decide not to join to the EU. Concerning the EU15 countries, we do not have such a ranking reversal; the welfare for such countries is always larger under the accession scenario than under the non-accession one. Thus, governments of EU15 countries would be in favour of the EU enlargement independently of whether they maximise short-run or long-run welfare.

Needless to say, our results should be treated with caution since our model abstracts from several potentially important issues. First, in our model, an accession country adopts the EU environment at the moment of accession (meaning that border costs are instantaneously and fully eliminated), while in reality, an accession country experiences complicated and gradual changes in its environment over the pre- and post-accession periods. Secondly, we assume that foreign and domestic capital are perfectly substitutable in production, while empirical evidence indicates that foreign capital creates positive spillovers in the domestic production, see, e.g., Görg and Strobl (2001). Thirdly, in our model, a high return on capital in transition countries is the only reason for foreign investment, while the empirical literature argues that foreign investment can also be a mean of extending control for reasons of corporate strategy, see, e.g., Graham and Krugman (1989), Markusen and Venables (1998), Ekholm et al. (2003). Finally, we are restricted to modelling the effect of the EU enlargement on border costs of foreign investment, while the EU enlargement has also a significant effect on migration, trade, etc. We leave extension of the model along these lines for future research.

Acknowledgments

Appendix A

In this appendix, we first elaborate the algorithm for solving our two-country model, and we then describe how to restore the equilibrium allocation in the considered three-country setup.

A.1. Two-country model

In order to compute the equilibrium decision rules in the two-country model, we do not make an explicit distinction between the EU15 and the non-EU15 countries (except in the population sizes) and refer to the two countries in our model as countries 1 and 2. Since we compute the decision rules for different initial conditions, each country can be either rich or poor. The latter implies that investment can go from country 1 to country 2 or visa versa, depending on the initial conditions assumed. For the sake of computations, we assume that both countries face identical border costs equal to γ. However, as we already said in Section 3.2, the border costs of investing from a poor to a rich country are irrelevant because investment never goes in this direction.

As formulated in Section 3, our two-country model has four state variables, namely, $\{k_t^1, \phi_t^1, k_t^2, \phi_t^2\}$. It turns out that for $t \geqslant 1$, we can reduce the number of state variables from four to two. Indeed, according to the Kuhn–Tucker conditions (5), (6), for $t \geqslant 1$, we can rewrite the budget constraint (2) as follows:

$$c_t^i + \kappa_{t+1}^i = w_t^i h_t^i + (1 - d)\kappa_t^i + r_t^i \kappa_t^i, \tag{15}$$

where $\kappa_t^i \equiv k_t^i + \phi_t^i$ is the total capital stock held by the consumer of the country $i \in \{1, 2\}$. Condition (15) follows from the budget constraint (2) because under the non-accession scenario, $\gamma \in (0, 1)$, we have $r_t = \gamma r_t^n$; under the autarkic scenario, $\gamma = 0$, we have $\phi = 0$, so that $r_t^i \kappa_t^i = r_t^i k_t^i$; under the accession scenario, $\gamma = 1$, we have $r_t = r_t^n$. For $t = 0$, the representation (15) does not need to hold because the given initial condition (k_0^i, ϕ_0^i), $i \in \{1, 2\}$, does not necessarily satisfy the Kuhn–Tucker conditions (5), (6). In order to deal with this issue, we shall restrict our attention

to sets of initial conditions that satisfy Kuhn–Tucker conditions (5), (6), so that the representation (15) also holds at $t = 0$. This assumption is reasonable: if it was not satisfied, countries would behave suboptimally before $t = 0$.

We therefore solve for a recursive equilibrium, in which the countries make their decisions according to time-invariant functions of the current state variables (κ_t^1, κ_t^2). Our solution method is close to that used in Maliar and Maliar (2006) and Boyarchuk et al. (2005), however, in the present paper we parameterise not the asset functions but the labour functions. In our model, parameterising the labour function is more convenient than parameterising other functions such as the consumption or the asset functions because we can explicitly resolve the intratemporal FOCs (see Maliar and Maliar, 2005 for a discussion). By definition, labour functions determine the optimal working hours in the two countries,

$$h_t^i = \Im^i\left(\kappa_t^1, \kappa_t^2\right), \quad i \in \{1, 2\}. \tag{16}$$

The labour functions are computed on a two-dimensional grid, such that, in each dimension, there are 100 equally-spaced points in the range $[k_{\min}, k_{\max}]$, with $k_{\min} = 0.01k$ and $k_{\max} = 1.5k$, where k is the steady state capital stock. For the initial iteration, we assume that the consumer in each country works 0.31 of its total time endowment, as in the steady state, i.e., $\Im^i(\kappa_t^1, \kappa_t^2) = 0.31$.

To solve for the equilibrium prices (the interest rates and wages), we first distinguish all grid points where country 1 invests in country 2. If this is the case, then $r_t^1 = \gamma r_t^2$, so that under the assumption of the Cobb–Douglas production function (14), we have

$$\left(\kappa_t^1 - \phi_t^1\right)^{\alpha-1}\left(h_t^1\right)^{1-\alpha} = \gamma \left(\frac{\kappa_t^2 v^2 + \phi_t^1 v^1}{v^2}\right)^{\alpha-1} \left(h_t^2\right)^{1-\alpha}. \tag{17}$$

Solving (17) with respect to ϕ_t^1, we obtain

$$\phi_t^1 = \kappa_t^1 \left[1 - \frac{1 + \frac{\kappa_t^2 v^2}{\kappa_t^1 v^1}}{1 + \gamma^{\frac{1}{1-\alpha}} \frac{h_t^2 v^2}{h_t^1 v^1}} \right]. \tag{18}$$

According to the Kuhn–Tucker conditions (5), (6), if $\phi_t^1 > 0$, then it is a solution. In the same way, we can distinguish all grid points where $\phi_t^2 > 0$, so that country 2 invests in country 1. In the remaining grid points, we have $\phi_t^1 = 0$ and $\phi_t^2 = 0$, i.e., no country invests in the other country. Once ϕ_t^1 and ϕ_t^2 are known, we can compute $k_t^i = \kappa_t^i - \phi_t^i$, for $i \in \{1, 2\}$, and then, find the corresponding interest rates from (7). Given the interest rates, we compute wages, $w_t^i = (1 - \alpha)(r_t^i/\alpha)^{\frac{\alpha}{\alpha-1}}$, for $i \in \{1, 2\}$.

We subsequently compute consumption in the two countries from the intratemporal FOC (4), which, under the CRRA utility function (13) assumed, can be written as

$$c_t^i = \frac{\mu(1 - h_t^i)w_t^i}{(1 - \mu)}, \quad i \in \{1, 2\}. \tag{19}$$

We then restore the next-period savings, κ_{t+1}^1 and κ_{t+1}^2, from the budget constraint (15).

As a next step, we perform the same calculations for period $t + 1$, as we have done for period t, given the $(t + 1)$-period values of the state variables, $(\kappa_{t+1}^1, \kappa_{t+1}^2)$. To evaluate the labour functions (16) in the points $(\kappa_{t+1}^1, \kappa_{t+1}^2)$, we use linear polynomial interpolation, namely, Matlab's routine "interp2". As a result of the above calculations, we obtain $\{h_{t+1}^i, \phi_{t+1}^i, k_{t+1}^i, r_{t+1}^i, w_{t+1}^i, c_{t+1}^i\}$.

We can now check whether the assumed labour functions in (16) satisfy the Euler equations of the two countries. For this purpose, we combine the Euler equation (5) with the intratemporal FOCs (4) to eliminate consumption, so that under the assumption of the CRRA utility function (13), we have

$$\hat{h}_t^i = 1 - \left(1 - h_{t+1}^i\right)\left[\delta\left(1 - d + r_{t+1}^i\right)\right]^{-\frac{1}{\sigma}} \left(\frac{w_{t+1}^i}{w_t^i}\right)^{\frac{1+\mu\sigma-\mu}{\sigma}}. \tag{20}$$

By computing $\hat{h}_t^i$ in each point of the grid, we define the new labour functions $\widehat{\Im}^i(\kappa_t^1, \kappa_t^2) \equiv \hat{h}_t^i$, for $i \in \{1, 2\}$. If the functions $\widetilde{\Im}^i(\kappa_t^1, \kappa_t^2)$ and $\Im^i(\kappa_t^1, \kappa_t^2)$ are equal with a given degree of precision, then the equilibrium is found and we

stop the iterations. Otherwise, we continue iterations by updating the labour function for the next iteration as follows:

$$\widetilde{\Im}^i\left(\kappa_t^1, \kappa_t^2\right) = \eta\widehat{\Im}^i\left(\kappa_t^1, \kappa_t^2\right) + (1 - \eta)\Im^i\left(\kappa_t^1, \kappa_t^2\right), \tag{21}$$

where $\eta \in (0, 1]$. We use a convergence criterion that the labour functions differ on two subsequent iterations by less than 10^{-9} according to the least square norm.

A.2. Three-country model

In order to compute a solution to the three-country setup of Section 3.3.4, we first construct a representative consumer for the enlarged EU. This can be shown by using the definition (11), that if consumers have identical CRRA utility functions (13), then the social utility function coincides with the consumers' utility function, up to a multiplicative constant which does not affect equilibrium (see Proposition 2 in Maliar and Maliar, 2003). Under this aggregation result, we can replace the two countries of the enlarged EU with one composite EU country and compute the equilibrium allocation and prices in the enlarged EU and the non-accession countries by solving the two-country model, as discussed above.

Given the allocation and prices of the enlarged EU, $\{c_t, h_t, k_{t+1}, \phi_{t+1}\}_{t \in T}$ and $\{r_t, w_t\}_{t \in T}$, respectively, we now restore the equilibrium allocations of the old EU and the accession countries. The definition (11) implies that the individual and the aggregate allocations for consumption and labour are related by

$$c_t^s = c_t f^s, \qquad h_t^s = 1 - (1 - h_t) f^s, \quad s \in \{o, a\}, \tag{22}$$

where f^s is a function of welfare weight, such that $f^s \equiv \frac{(\lambda^s)^{1/\sigma}}{(\lambda^o)^{1/\sigma} v^o + (\lambda^a)^{1/\sigma} v^a}$; see Maliar and Maliar (2003) for details of derivations. To identify the welfare weights corresponding to the given distribution of initial endowments, we substitute c_t^s and h_t^s from (22) into the lifetime budget constraint (12) to obtain

$$f^s = \frac{\kappa_0^s(1 - d + r_0) + \sum_{\tau=0}^{\infty} \delta^\tau \frac{u_1(c_\tau, h_\tau)}{u_1(c_0, h_0)} w_\tau}{\frac{\kappa_0^o v^o + \kappa_0^a v^a}{v^o + v^a}(1 - d + r_0) + \sum_{\tau=0}^{\infty} \delta^\tau \frac{u_1(c_\tau, h_\tau)}{u_1(c_0, h_0)} w_\tau}, \quad s \in \{o, a\}, \tag{23}$$

where $u_1(c_\tau, h_\tau) = (c_\tau)^{\mu(1-\sigma)-1}(1 - h_\tau)^{(1-\mu)(1-\sigma)}$. We approximate the infinite summations in (23) by summations of the length 10,000, which yields an accurate approximation for the welfare weights. Once the welfare weights are known, we compute consumption and working hours of countries o and a according to (22). We then restore the total savings of the two countries, κ_{t+1}^o and κ_{t+1}^a, by using the budget constraints (15), and we use the equilibrium interest rate, r_t, to compute the capital stock employed in the two countries, K_{t+1}^o and K_{t+1}^a. We finally solve for the capital stock held abroad by the two countries, ϕ_{t+1}^o and ϕ_{t+1}^a, by using the definition $\kappa_t^s \equiv k_t^s + \phi_t^s$, $s \in \{o, a\}$, and condition (8).

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