A discusión

THE EU EASTERN ENLARGEMENT AND FDI: THE IMPLICATIONS FROM A NEOCLASSICAL GROWTH MODEL

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ABSTRACT

This paper studies how the EU Eastern enlargement can affect the economies of the old and the new EU members and the non-acceded countries in the context of a multi-country neoclassical growth model where Foreign Direct Investment (FDI) is subject to border costs. We assume that in the moment of the EU enlargement border costs are eliminated between the old and the new EU member states but they remain unchanged between the old EU member states and the nonacceded 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 acceded countries, investors from the old EU member states become permanent owners of about 3/4 of capital, while in the nonacceded countries, they are forced out of business by local producers.

Keywords: Foreign direct investment; EU enlargement; Neoclassical growth model; Transition economies; Three-country model

1 Introduction

On May 1, 2004, eight Central East European (CEE) transition countries, Cyprus and Malta joined the EU, which had been composed of 15 developed countries.[1] This EU enlargement is an unprecedented attempt of political and economic integration by its scope, diversity and possible consequences. The channels through which the EU enlargement can affect the economies in the region are various: monetary union, FDI, migration, trade, etc.[2] In this paper, we focus on one of such channels, FDI. We argue that this channel is important because there is a large 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.[3]

Concerning the previous EU enlargements, the empirical literature finds that poor countries acceded the EU experienced a subsequent increase in FDI inflows, e.g., Baldwin, Francois and Portes (1997), Grabbe (2001). Furthermore, in the wake of the 2004 EU enlargement, there were large differences in FDI stocks between the acceding and the non-acceding transition countries, see, e.g., Egger and Pfaffermayr (2002) and Henriot (2003). In the paper, we argue that the above FDI patterns arise because an accession of a country to the EU reduces the costs that the EU15 agents incur when investing in such a country (we refer to such costs as "border costs").

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 newly acceded countries. We assume that border costs between the EU15 and the acceded countries are eliminated after the EU accession. With this model, we ask: How can the EU enlargement affect output, consumption, labor and welfare of the EU15 and the acceded countries?

We then consider a three-country setup, where the three countries correspond to the EU15, the acceded and the non-acceded groups of countries. We assume that in the moment of accession, the border costs are entirely

[1]Further 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]The non-EU15 countries are those that do not enter the EU15. Similarly, the non-EU25 countries will be those that do not enter the EU25.

eliminated between the EU15 and the acceded countries but they remain unchanged between the EU15 and the non-acceded countries. In the context of the three-country model, we address the following two questions. First, how can the introduction of poor non-acceded countries affect the model's predictions about the EU15 and the acceded countries? Second, how can the EU accession of some transition countries affect the remaining (i.e., non-acceded) transition countries?

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. 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 had 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 cast 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 newly acceded and the non-acceded 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 the 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 (acceded or non-acceded) countries leads to massive capital flows from the former to the latter countries; this decreases (increases) wages, output and consumption in the EU15 (the non-EU15) countries. The long-run consequences of the non-accession and the accession scenarios are however very different: under the former scenario, residents of the non-acceded countries eventually buy out all the domestic capital from EU15 investors, while under the latter scenario, EU15 investors keep holding a part of the acceded country's capital forever. Quantitatively, the last effect can be very large: in our benchmark model, EU15 investors end up owning more than 75% of the acceded country's capital.

Why does the presence of non-zero border costs under the non-accession scenario make the EU15 country eventually withdraw its FDI from the non-acceded country? This is because domestic investors, who face no border costs, overcompete foreign investors in the long-run. To be precise, as the non-acceded country develops, the difference in the MPC between the EU15 and the non-acceded countries goes down and becomes insufficient to cover the border costs. At this point, investing in the non-acceded country is no longer profitable for foreigners but it is still profitable for residents. As a result, residents gradually buy out all the domestic capital from foreigners. In contrast, under the accession scenario, there are no border costs, so that EU15 investors face the same rate of return on capital as do investors of the acceded country and hence, have no incentives to withdraw their capital from the acceded country. Therefore, the situation when EU15 investors hold most of the acceded country's capital perpetuates forever.

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

Our analysis is related to the following FDI literature. First, our model has the endowment motive for FDI, which is parallel to the one in Helpman (1984), and Helpman and Krugman (1985) where multinational corporations exploit factor-price differentials across countries by means of vertical (resource-seeking) FDI. Secondly, we share with Markusen and Venables (1998) the result that local producers can eventually force out foreign producers, however, we have a different underlying mechanism for this result: in our model, the advantage of domestic producers lies in the absence of border costs, while in their model, it lies in the possibility of creating vertical linkages with other domestic producers. Thirdly, our border costs can be viewed as a measure of distance (in a broad sense) between countries, and they are similar to the distance measures used in the FDI gravity literature, e.g., trade freight costs and tariffs in Brainard (1997). Fourthly, the three-country variant of our model is similar to the three-country model of the export-platform FDI constructed in Ekholm, Forslid and Markusen (2003), although there are also important differences between the two models: their model is richer than ours in that they have both FDI and trade, while we are limited to FDI, however, their analysis is partial-equilibrium and static, while our analysis is general-equilibrium and dynamic. Finally, our study is related to recent empirical literature investigating the determinants of FDI in transition countries.[4]

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

2 EU enlargements, FDI and border costs

The history of the European Union (EU) begins in 1951, when six European countries (Belgium, France, Germany, Italy, Luxemburg and Netherlands) establish the European Coal and Steel Community. Over the 1951-2004 period, the EU experienced five enlargements: it is joined by Denmark, Ireland and the UK in 1973; by Greece in 1981; by Portugal and Spain in 1986; by Austria, Finland and Sweden in 1995; and finally, by Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovak Republic and Slovenia in 2004. In Table 1, for each enlargement, we provide the population size, the total GDP, and the GDP per capita of the EU and the acceded groups of countries. For the V-th enlargement, we consider two different groups, one includes all acceded countries and the other is composed of only transition acceded countries; the two groups differ in the presence of Cyprus and Malta. Furthermore, In Table 1, we report the statistics for three alternative groups of the non-EU25 countries: the first group consists of both the developed European countries (Norway, Switzerland and Turkey) and the transition countries (Albania, Armenia, Azerbaijan, Be-

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

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	EU6 (*Belgium, France, Germany, Italy, Luxembourg, Netherlands*)	208.18	16.8	1.00
	Acceded (*Denmark, Ireland, UK*)	64.11	12.53	0.80
II 01.01.1981	EU9 *(EU6, Denmark, Ireland, UK)*	277.83	19.33	1.00
	Acceded (Greece)	9.64	10.70	0.56
III 01.01.1986	EU10 (*EU9, Greece*)	289.45	20.80	1.00
	Acceded (*Portugal, Spain*)	48.42	11.08	0.52
IV 01.01.1995	EU12 (*EU10, Portugal, Spain*)	348.60	23.74	1.00
	Acceded (*Austria, Finland, Sweden*)	21.90	27.03	1.20
V 01.05.2004	EU15 (*EU12, Austria, Finland, Sweden*)	378.98	27.20	1.00
	Acceded all (*Cyprus, Malta, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Rep., Slovenia*)	74.34	4.65	0.18
	Acceded only transition (*Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Rep., Slovenia*)	73.57	4.55	0.17
	Non-acceded all *(Norway, Switzerland, Turkey, Albania, Bosnia and Herzegovina, Croatia, FYR Macedonia, Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyz Rep., Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, Bulgaria, Romania)*	405.80	3.30	0.13
	Non-acceded only transition *(Albania, Bosnia and Herzegovina, Croatia, FYR Macedonia, Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyz Rep., Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, Bulgaria, Romania)*	324.41	1.91	0.07
	Non-acceded only transition EU25-neighbours *(Albania, Croatia, FYR Macedonia, Belarus, Ukraine, Bulgaria, Romania)*	98.48	1.51	0.06

Notes: Statistics are computed for the date of the corresponding EU enlargement.
The statistics “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.

larus, Bosnia and Herzegovina, Bulgaria, Croatia, FYR Macedonia, Georgia, Kazakhstan, Kyrgyz Republic, Moldova, Romania; Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan); the second group consists only of the above transition countries; and finally, the third group includes only the transition countries that are the EU-neighbors (i.e., have common borders with the EU25 member states). The first and the third groups are constructed to obtain an upper and lower bounds of the non-EU25 population.

As is seen from Table 1, at the moment of accession, the countries acceded the EU had on average lower GDP per capita than the old EU member states did. (The IV-th enlargement is an exception here since Austria, Finland and Sweden had higher GDP per capita than the EU's average). In the case of the V-th enlargement, the output difference between the EU15 and the acceded countries is particularly large: at the moment of accession, the average acceded country produced only 18% of what the average EU15 country did.

The empirical literature finds that the EU enlargements were accompanied by considerable FDI inflows to the acceding countries, see, e.g., Baldwin, Francois and Portes (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 FDI inflows. As far as the V-th enlargement is concerned, Egger and Pfaffermayr (2002) document the large anticipatory effects of the EU enlargement on FDI: the Eastern European countries that in 1994-1995 applied to join the EU had a significant increase in FDI inflows over the 1995-1998 period. Furthermore, Åslund and Warner (2002) report that in 2000, the CEE group of countries (which includes the acceded transition countries, and Bulgaria and Romania) had the FDI in percentage of GDP equal to 5.9%, which is almost four times larger than that of the Commonwealth of Independent States (CIS) group of countries equal to 1.6%.

To understand why the acceded countries experience an increase in FDI, we shall first review some findings of empirical literature on the determinants of FDI. In the transition context, Lankes and Venables (1996) provide evidence from a survey of senior managers of 117 western manufacturing firms and conclude that a firm's decision to undertake a FDI project depends on the host country's progress in economic transition, local market size, factor costs, access to EU markets, political stability and regulatory environment. Grabbe (2001) emphasizes the importance of factors such 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 Shengen border regimes and greater integration of the acceded countries with the EU member states. EIU and E&Y (2002) argue that the main FDI determinants are a country's risk, transaction costs, market size and the quality of infrastructure. Deichmann et al. (2003) identify a significant impact of social capital, labor skills, infrastructure, trade policy and market reforms on a country's FDI appeal. Carstensen and Toubal (2004) come to the conclusion that different attractiveness of Central European versus Eastern European countries for FDI is explained mainly by differences in capital endowments and uncertainty of the legal, political and economic environments.[5]

The empirical literature on FDI determinants suggests why the EU accession magnifies FDI inflows in acceded countries. Specifically, to be able to join the EU, a country should make a large step toward integration with the EU member states: it should adopt the EU's common political, economic and legislative institutions, the common visa and border-control policies, etc. In other words, an acceding country should become similar to the EU member states. The integration with the EU reduces the country risk, promotes market reforms, decreases the costs of acquiring information, reduces the transaction costs, etc. Since the border costs go down, the country becomes more attractive for FDI. Now, the EU investors face the common and well-understood EU environment, rather than operate in unfamiliar (sometimes, even hostile) conditions of non-EU countries where institutions and policies are chosen in an idiosyncratic fashion.

To see whether the acceded countries indeed become increasingly similar to the EU15 member states, as opposed to the non-acceded countries, we investigate the evolution of the economic-freedom index for three groups of countries distinguished in Table 1 (EU15, 10 Acceded and 21 Non-acceded) 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; its value ranges from 1 to 5 (with the lowest value being the best).[6] We interpret the difference between the groups' economic-freedom

[5] Empirical evidence from non-transition countries is similar, namely, the main factors affecting the FDI are the economic, political and institutional stability in host economies, see, e.g., Culem (1988), Lucas (1993), Biswas (2002).

[6] To be more specific, the economic-freedom index is computed on the basis of 50 variables divided in 10 broad categories, which are as follows: 1) trade policy; 2) fiscal burden of government; 3) government intervention in the economy; 4) monetary policy; 5) capital

indices to be a measure of closeness of their economic environments.

In Figure 1, we plot the mean and the within-group standard deviation of the economic-freedom indices for each of the three groups considered. Over the sample period, the indices of the EU15, the acceded and the non-acceded groups are always the lowest, the middle and the highest, respectively. Initially, the indices of the acceded and the non-acceded groups were close, and their within-group standard deviations overlapped over a large region. In turn, the indices of the EU15 and the acceded groups were initially relatively far, and their within-group standard deviations did not overlap. Over the 1996-2004 period, the index of the acceded group gradually moved from that of the non-acceded group in the direction to that of the EU15 group. By 2004, the initial tendencies were reversed: now, the indices of the acceded and the EU15 groups are close, and their within-group standard deviations overlap over a large region, while the indices of the acceded and the non-acceded groups are relatively far, and their within-group standard deviations do not overlap.

We also evaluate the differences between the groups' indices with formal statistical tools. To be specific, for each possible three grouped pairs and for each period, we perform the Mean Comparison (MC) t-test of the hypothesis that the means of the two groups are equal. We do so under two alternative assumptions, one is that the two groups have the same within-group variances and the other is that they have different within-group variances. Additionally, we perform the Variance Comparison (VC) F-test of the hypothesis that the variances of the two groups are equal. In Table 2, we provide the p-values of the tests, and in Figure 2, we illustrate the results of the MC t-test under the assumption of equal variances.

As we see from the table, the results of the MC t-test are similar under the assumptions of equal and unequal variances. The hypothesis that the means of the acceded and the non-acceded groups are equal cannot be rejected at a 5% significance level in the initial 1996 year, however, it can be rejected in all subsequent years. In turn, the hypothesis that the means of the EU15 and the acceded groups are equal can be rejected at a 5% significance level during the 1996-2003 period, but it cannot be rejected in the last year, 2004. Finally, the hypothesis that the mean of the non-acceded and the EU15 groups are equal can be rejected at less than a 0.01% significance level in all

flows and foreign investment; 6) banking and finance; 7) wages and prices; 8) property rights; 9) regulation; 10) informal market activity.

Figure 1. The evolution of the economic freedom indices.

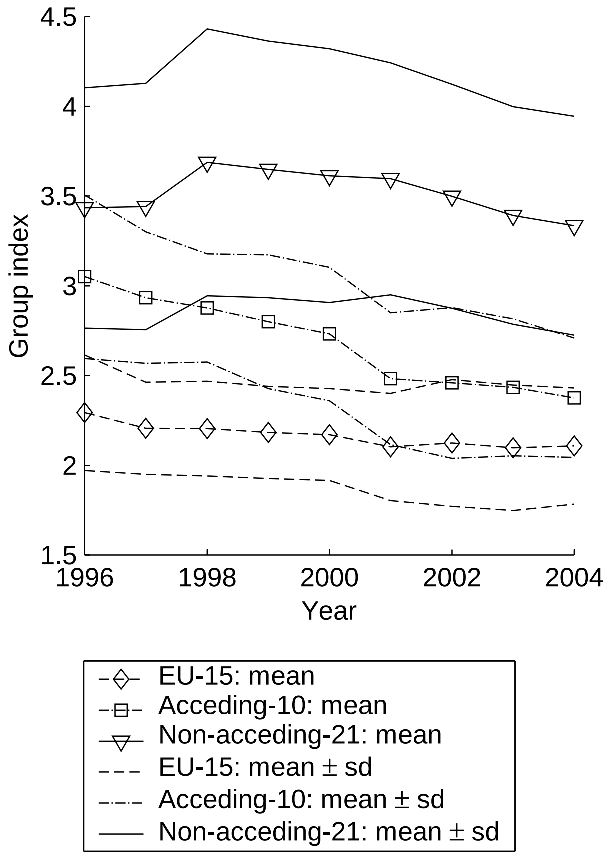


Figure 2. P-values for the tests of the equality of means of the economic freedom indices.

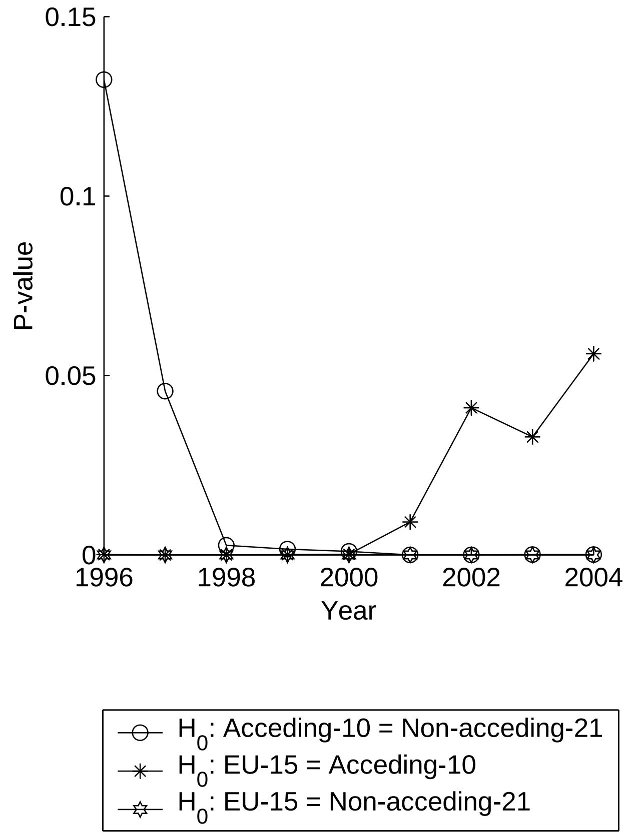


Table 2. Mean Comparison (MC) and Variance Comparison (VC) tests for the EU15, the acceded and the non-acceded countries.

	Test	1996	1997	1998	1999	2000	2001	2002	2003	2004
MC t test with equal variances	Ho: mean(Acceded) = mean(Non-acceded)									
	p-value	0.1324	0.0456	0.0027	0.0016	0.001	0	0	0.0001	0.0001
	Ho: mean(EU15) = mean(Acceded)									
	p-value	0.0001	0	0	0.0001	0.0002	0.0092	0.041	0.0329	0.0561
	Ho: mean(Non-acceded) = mean(EU15)									
	p-value	0	0	0	0	0	0	0	0	0
MC t test with unequal variances	Ho: mean(Acceded) = mean(Non-acceded)									
	p-value	0.1099	0.0297	0.0002	0.0002	0.0001	0	0	0	0
	Ho: mean(EU15) = mean(Acceded)									
	p-value	0.0004	0.0001	0	0.0004	0.0009	0.0146	0.052	0.0385	0.0600
	Ho: mean(Non-acceded) = mean(EU15)									
	p-value	0	0	0	0	0	0	0	0	0
Variance ratio F-test	Ho: variance(Acceded) = variance(Non-acceded)									
	p-value	0.2252	0.0519	0.0046	0.0337	0.0351	0.0623	0.1742	0.1157	0.0449
	Ho: variance(EU15) = variance(Acceded)									
	p-value	0.2693	0.242	0.6816	0.238	0.2339	0.5055	0.5765	0.7855	0.9278
	Ho: variance(Non-acceded) = variance(EU15)									
	p-value	0.0114	0.0008	0.0002	0.0002	0.0002	0.0038	0.0259	0.0321	0.0145

years. As far as the VC test is concerned, the third panel of Table 2 shows that we can never reject the hypothesis of equal variances for the EU15 and the acceded groups, we can always reject this hypothesis for the EU15 and the non-acceded groups and we have a mixed pattern for the acceded and the non-acceded groups.

Overall, the results of the tests confirm the conclusions obtained from the visual analysis of Figure 1: first, the acceded and non-acceded countries were similar to each other and different from the EU15 countries, however, over the transition period, the acceded countries become increasingly similar to the EU15 countries and increasingly different from the non-acceded countries.

In the next section, we present a dynamic general equilibrium model in which the increasing institutional similarity between the EU15 and the acceded countries reduces border costs of FDI. We use the model to assess the consequences of the EU enlargement for the economies of the EU15, the acceded and the non-acceded countries.

3 The model

Time is discrete, and the horizon is infinite, $t \in T$, where $T = \{0, 1, 2, ...\}$. There are two countries which are referred to as the EU15 country and the non-EU15 country and 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 they can differ in their population and initial endowments. Variables of 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, however, labor 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's 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-maximization problem:

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

subject to

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

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 normalized 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, that 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.

The producer's side of the EU15 country consists of a representative firm producing the output commodity from capital, K_t, and labor, H_t, and maximizing period-by-period profits

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

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

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 notice 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 $k_{t+1}^n > 0$ and 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):

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

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

$$u_1(c_t, 1 - h_t) \geq \delta u_1(c_{t+1}, 1 - h_{t+1})\left(1 - d + \gamma r_{t+1}^n\right), \tag{6}$$

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.

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

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

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

$$K_t = \frac{k_t v + \phi_t^n v^n}{v} \qquad \text{and} \qquad H_t = h_t. \tag{8}$$

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

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., $\phi_t \geq 0$ and $\phi_t^n \equiv 0$ 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 analyze 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 the values of $\gamma = 0$, $\gamma \in (0, 1)$ and $\gamma = 1$, respectively. Zero (positive) border costs correspond to the case when 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 are 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 cast into our baseline two-country framework.

In our simple model, the accession of a country to the EU occurs instantaneously: border costs between the EU15 and the acceded country are fully eliminated at the moment of accession. In reality, the accession process is more sophisticated: first, a country applies to join the EU; secondly, the membership is awarded; thirdly, the formal accession takes place; and finally, the country is gradually integrated in the EU institutions over the post-accession period. Therefore, the effects of accession on border costs are extended in time. In particular, there might be an anticipatory effect because rational agents foresee the accession and adjust their behavior correspondingly. In the paper, we make no distinction between the anticipatory, immediate and ex-post effects of the enlargement.

3.3.1 Autarky

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

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

which means that the two countries are in autarky.

3.3.2 No non-EU15 country accedes the EU

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

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

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 the domestic production.

3.3.3 All non-EU15 countries accede 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, $r_{t+1} = r^n_{t+1}$. 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 newly acceded country, respectively. We continue to use superscript n for denoting variables of the non-EU country, which corresponds now to the non-acceded country. As was said, after the EU enlargement, border costs between the old EU and the acceded countries become zero, $\gamma = 1$, and those between the old EU and the non-acceded countries remain positive, $\gamma \in [0, 1)$.

Although we have now three different countries, we can still analyze 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 acceded 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

$$u(c_t, 1-h_t) \equiv \max_{c^o_t, h^o_t, c^a_t, h^a_t} \left\{ \frac{1}{v^o + v^a}\left[v^o\lambda^o u(c^o_t, 1-h^o_t) + v^a\lambda^a u(c^a_t, 1-h^a_t)\right] \right.$$
$$\left. \text{s.t.} \quad \frac{c^o_t v^o + c^a_t v^a}{v^o + v^a} = c_t, \ \frac{h^o_t v^o + h^a_t v^a}{v^o + v^a} = h_t \right\}, \tag{11}$$

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 acceded countries, respectively. For the sake of convenience, we normalize 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-maximization 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 acceded countries to the non-acceded countries, respectively. The production side of the enlarged EU consists of the representative firm, which solves the profit-maximization 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 acceded countries, (k_0^o, ϕ_0^o) and (k_0^a, ϕ_0^a), respectively, are identified by the life-time budget constraints,

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

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 are to be performed by numerical methods.[7] 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 characterize the equilibrium dynamics of the enlarged EU and the non-acceded countries by the equilibrium conditions (4) − (8), and in particular, we can compute the amount of capital flowing from the enlarged EU to the

[7] To be specific, 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 life-time budget constraints (12); iterate on the weights until the planner's solution satisfies the life-time budget constraints.

non-acceded country, ϕ_{t+1}, under $\gamma \in (0,1)$ as is 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 are 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,

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

This function is homothetic, so that it is consistent with Gorman's (1953) aggregation. The production function is Cobb-Douglas,

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

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

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 $\left\{h, \frac{c}{y}, \frac{k}{y}\right\}$ 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 the population sizes regard, on the date of the V-th enlargement, the population of the EU15 was 378.98 millions, that of the acceded countries was 73.57 millions and that of the non-acceded countries was in the range from 98.48 to 405.80 millions depending on how the non-acceded group is defined (see Table 1). To make the model approximately consistent with these figures, we assume that the EU15 population is equal to 5, that the population of the acceded countries is equal to 1 and that the population of the non-acceded countries ranges from 1 to 5.

The value of the risk-aversion coefficient 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 $\gamma = 0.8$ and $\sigma = 5$.

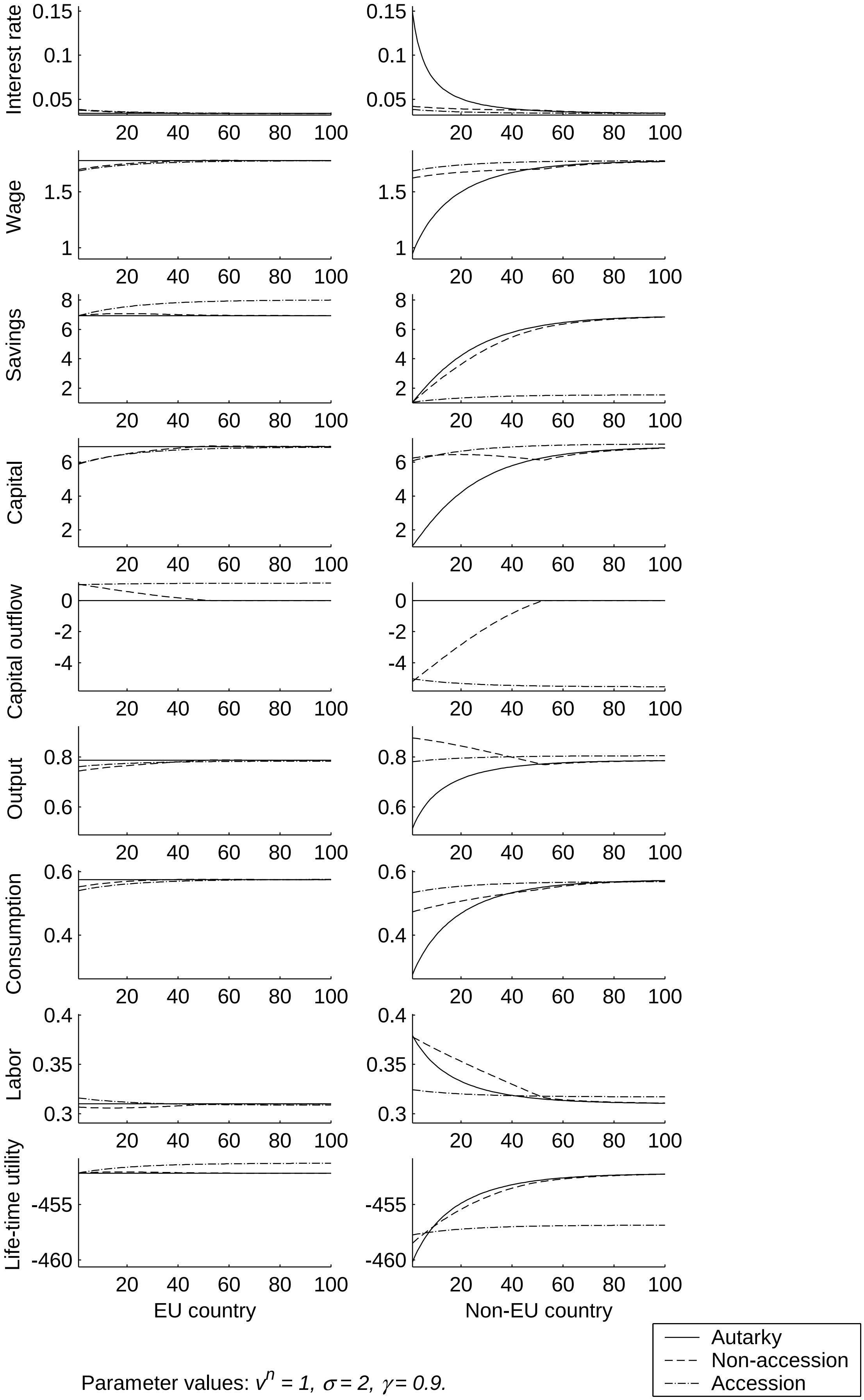
To solve the model, we employ a version of the Euler-equation method that finds a solution to the equilibrium conditions $(4) - (8)$ on a grid of prespecified points. Our program is written in Matlab. A detailed description of our solution method is provided in Appendix B.

4.2 Two-country model

We shall start by presenting the results for the two-country variant of the model. In Figure 3, we illustrate the transitional dynamics obtained under the benchmark parameterization ($v^n = 1$, $\sigma = 2$, $\gamma = 0.9$) by plotting the key model's variables over the first 100 periods. In addition, in the first panel of Table 3, we provide some statistics characterizing the transitional dynamics, namely, we report the short run ($t = 0$) and the 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 it is 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

Figure 3. Transitional dynamics in the two-country model: the benchmark case.



Parameter values: $v^n = 1$, $\sigma = 2$, $\gamma = 0.9$.

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

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Scenario	Country	Interest rate	Wage	Savings	Capital	Capital outflows	Output	Consum.	Labor	Life-time utility
Benchmark model: $v = 5, v^n = 1, \sigma = 2, \gamma = 0.9$.										
NAC	EU15, t=0	11.224	-4.457	0	-15.018	17.673	-5.480	-3.997	-1.071	0.004
	EU15, t=∞	0	0	0	0	0	0	0	0	0
Foreigners leave	n-EU15, t=0	-71.557	71.399	0	500.612	-83.350	70.833	71.746	-0.331	0.373
after 53 periods	n-EU15, t=∞	0	0	0	0	0	0	0	0	0
AC	EU15, t=0	13.125	-5.148	0	-14.543	17.018	-3.327	-5.966	1.920	0.009
	EU15, t=∞	0	0	15.555	-0.455	16.082	-0.454	0.204	-0.454	0.204
Foreigners	n-EU15, t=0	-73.964	78.019	0	484.774	-82.899	52.254	93.756	-14.473	0.536
stay forever	n-EU15, t=∞	0	0	-77.774	2.270	-78.267	2.270	-1.020	2.270	-1.030
Sensitivity with respect to the population size v^n: $v = 5, v^n = 6, \sigma = 2, \gamma = 0.9$										
NAC	EU15, t=0	55.452	-17.227	0	-49.265	97.101	-21.131	-15.473	-4.716	0.075
	EU15, t=∞	0	0	0	0	0	0	0	0	0
Foreigners leave	n-EU15, t=0	-60.247	48.490	0	273.692	-73.240	48.555	48.450	0.044	0.206
after 58 periods	n-EU15, t=∞	0	0	0	0	0	0	0	0	0
AC	EU15, t=0	64.303	-19.169	0	-47.295	89.736	-13.405	-21.758	7.131	0.157
	EU15, t=∞	0	0	67.629	-1.974	71.004	-1.974	0.887	-1.974	0.879
Foreigners	n-EU15, t=0	-62.185	51.705	0	262.752	-72.433	37.175	60.580	-9.578	0.285
stay forever	n-EU15, t=∞	0	0	-56.357	1.645	-57.064	1.645	-0.739	1.645	-0.745
Sensitivity with respect to the border-cost parameter γ: $v = 5, v^n = 1, \sigma = 2, \gamma = 0.8$										
NAC	EU15, t=0	9.252	-3.721	0	-13.502	15.609	-5.499	-2.922	-1.847	0.002
	EU15, t=∞	0	0	0	0	0	0	0	0	0
Foreigners leave	n-EU15, t=0	-68.569	64.217	0	450.056	-81.820	72.888	58.921	5.280	0.283
after 35 periods	n-EU15, t=∞	0	0	0	0	0	0	0	0	0
AC	EU15, t=0	13.125	-5.148	0	-14.543	17.018	-3.327	-5.966	1.920	0.009
	EU15, t=∞	0	0	15.555	-0.455	16.082	-0.454	0.204	-0.454	0.204
Foreigners	n-EU15, t=0	-73.964	78.019	0	484.774	-82.899	52.254	93.756	-14.473	0.536
stay forever	n-EU15, t=∞	0	0	-77.774	2.270	-78.267	2.270	-1.020	2.270	-1.030
Sensitivity with respect to the risk-aversion coefficient σ: $v = 5, v^n = 1, \sigma = 5, \gamma = 0.9, \kappa_0^n=0.15k$.										
NAC	EU15, t=0	10.121	-4.047	0	-13.980	16.252	-5.274	-3.497	-1.278	0.020
	EU15, t=∞	0	0	0	0	0	0	0	0	0
Foreigners leave	n-EU15, t=0	-69.083	65.381	0	466.000	-82.332	74.992	60.608	5.811	2.474
after 84 periods	n-EU15, t=∞	0	0	0	0	0	0	0	0	0
AC	EU15, t=0	11.904	-4.706	0	-14.564	17.046	-4.394	-4.846	0.328	0.046
	EU15, t=∞	0	-0	16.031	-0.470	16.579	-0.468	0.209	-0.468	0.836
Foreigners	n-EU15, t=0	-71.724	71.833	0	485.453	-82.919	65.543	74.957	-3.661	3.525
stay forever	n-EU15, t=∞	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 varaibles under the given scenario and those in the associated autarkic economy. Statistic in column (7) is capital outflows from a country in percent of the country's capital stock.

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 under the accession scenario ($\gamma = 1$) or sufficiently reduced, as is under the non-accession scenario ($\gamma = 0.9$), the rich EU15 country re-allocates a part of its capital stock to the poor non-EU15 acceded or non-acceded 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). As follows from Table 3, 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-acceded country in the long-run. (According to Table 3, in the benchmark case, the exit of foreigners occurs after 53 periods). Consequently, all the effects associated with international capital flows are temporal, and both the EU15 and the non-acceded 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.[8] The EU15 country's investors become owners of most capital installed in the acceded country taking away profit opportunities from the acceded country's 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 acceded country, in the long-run, savings of the EU15 residents are about 15% higher

[8] 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 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.

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 acceded country's agents end up with smaller consumption and leisure in the long-run because their savings are about 75% lower than in autarky.[9]

Why does the presence of non-zero border costs make the EU15 country eventually withdraw its capital from the non-acceded country? Initially, there is a large difference between the autarkic interest rates in the EU15 and the non-acceded 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 autarkic interest rates goes down 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 its capital in the non-acceded country, they earn the interest rate which is γ times lower than the one faced by the non-acceded country's investors, r^n_{t+1}, i.e., $r_{t+1} = \gamma r^n_{t+1}$. In particular, as the interest rate earned by the non-acceded country's investors r^n_{t+1} goes down below r/γ, the interest rate earned by the EU15 investors r_{t+1} becomes lower than the steady state one, r. By this time, the EU15 investors should have withdrawn all their capital from the non-acceded 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 foreigners, the non-acceded country continues its development in autarky, and its interest rate, r^n_{t+1}, 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 acceded country because in the absence of border costs, both the EU15 and the acceded country's investors face the same interest rate, $r_{t+1} = r^n_{t+1}$. Thus, the situation when the EU15 investors hold most of the acceded 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

[9] Under the previous four EU enlargements, the difference in initial endowments between the EU and the acceded countries (Denmark, Ireland, UK, Greece, Portugal, Spain, etc.) was much smaller than that 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 acceded country's capital.

to buy out the domestic capital from foreigners. Hence, they work a lot until they get the 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 acceded 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 3). Furthermore, as is seen from the figure, output follows the same time patterns as does labor 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 life-time utility of the representative agent computed in period $t = 0$. We shall first notice that the EU enlargement has a relatively small effect on welfare of the EU15 country, namely, it increases life-time utility only by 0.009% relative to autarky (see Table 3). The effect of the EU enlargement on welfare of the acceded non-EU country is however more sizable: here, life-time 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-acceded 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 labor income.

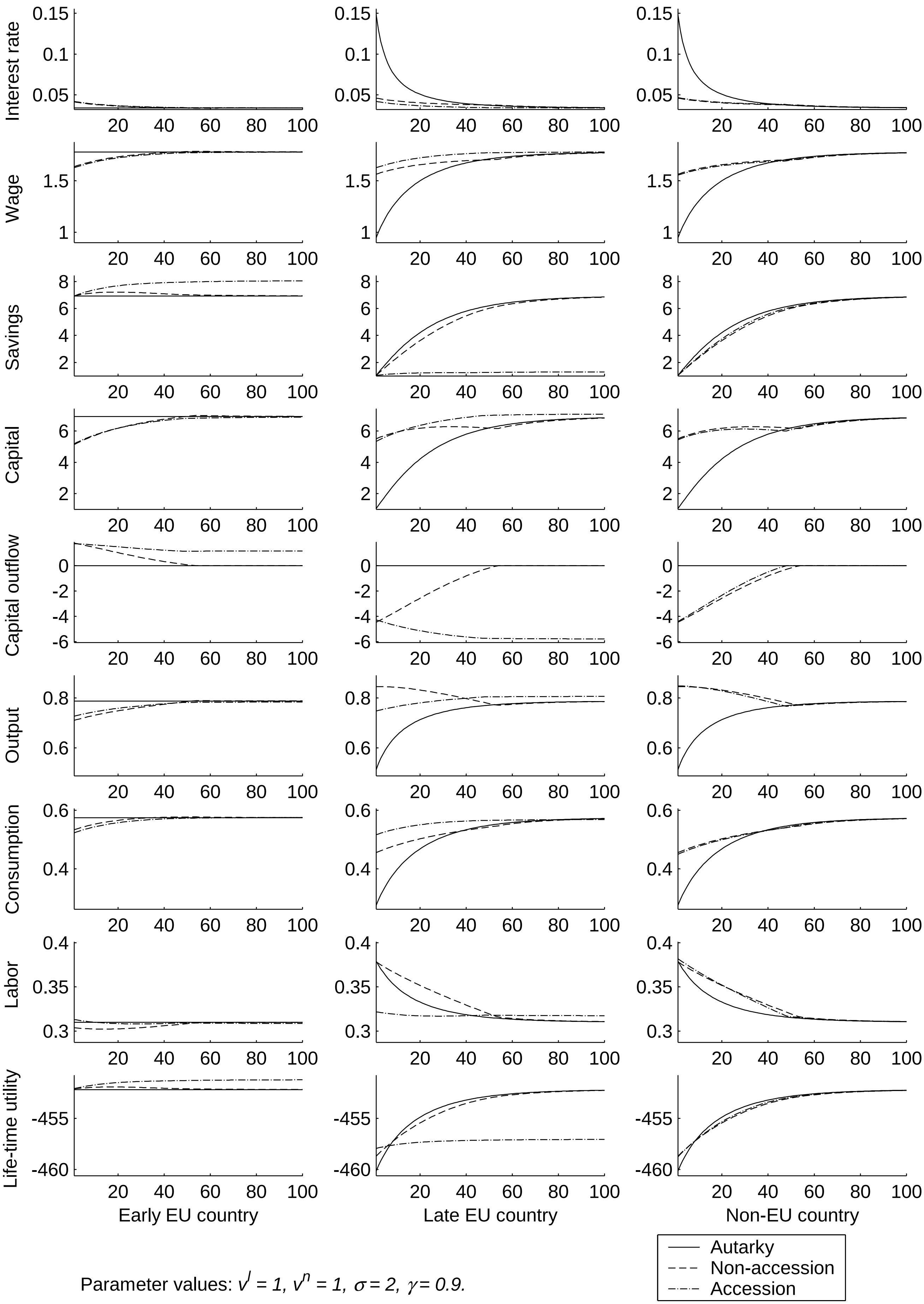
As follows from the above discussion, both the EU15 and the non-EU15 countries have the same rankings of the scenarios in period $t = 0$: they prefer the accession scenario to the non-accession one, and they prefer the non-accession scenario to the autarkic one. We shall notice, however, that the ranking of the scenarios changes for the non-EU15 country if, as a measure of welfare, we consider life-time 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 acceded 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 maximize long-run welfare instead of welfare in $t = 0$, it would decide not to accede to 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 favor of the EU enlargement independently of whether it maximized 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 $v^o = 1$, $v^a = 1$, $\sigma = 2$ and $\gamma = 0.9$. We plot the obtained transitional dynamics in Figure 4, and we present the corresponding numerical results in the first panel of Table 4. As is seen from the figure, transitional dynamics of the old EU and the acceded countries are qualitatively the same as those we had in the two-country model for the EU15 and the acceded 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 acceded and the non-acceded countries with the total population equal to 2, whereas in the two-country setup, it invested only in the non-EU15 (acceded or non-acceded) country with the population equal to 1. On the contrary, for the acceded 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 the accession of some countries to the EU affects the non-acceded countries. It is clear that a country's 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-acceded country to the acceded country, which causes a reduction in capital, wages, labor, output and consumption in the non-acceded country. To evaluate the magnitude of such a reduction in the non-acceded country's variables, in Table 4, we provide a maximum percentage difference between the values of each non-acceded country's variable when the other non-EU15 country accedes and the corresponding values when it does not accede the EU, $\Delta^{\max}\left(x_t^{AC}, x_t^{NAC}\right)$. 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

Figure 4. Transitional dynamics in the three-country model: the benchmark case.



Parameter values: $v^l = 1,\ v^n = 1,\ \sigma = 2,\ \gamma = 0.9.$

Table 4. 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) Labor	(11) Life-time utility
Benchmark model: *$v = 5, v^\ell = 1, v^n = 1, \sigma = 2, \gamma = 0.9$*										
NAC	o-EU, t=0	21.502	-8.008	0	-25.793	34.757	-9.837	-7.187	-1.988	0.014
	o-EU, t=∞	0	0	0	0	0	0	0	0	0
Foreigners leave	acceded, t=0	-68.929	65.029	0	429.877	-81.128	64.641	65.266	-0.235	0.325
after 57 periods	acceded, t=∞	0	0	0	0	0	0	0	0	0
AC	o-EU, t=0	23.282	-8.580	0	-25.118	33.543	-7.684	-8.982	0.980	0.020
	o-EU, t=∞	0	0	16.251	-0.474	16.805	-0.474	0.213	-0.474	0.213
Foreigners	acceded, t=0	-71.626	71.578	0	413.188	-80.514	45.612	87.438	-15.134	0.492
stay forever	acceded, t=∞	0	0	-81.254	2.371	-81.688	2.371	-1.065	2.371	-1.077
Δ^{max}(NAC,AC) for non-acceded		1.465	-0.621	3.467	-3.248	4.997	-1.910	-1.215	-1.353	0.032
Sensitivity with respect to the population size v^n: *$v = 5, v^\ell = 1, v^n = 5, \sigma = 2, \gamma = 0.9$*										
NAC	o-EU, t=0	55.452	-17.227	0	-49.265	97.101	-21.131	-15.474	-4.716	0.075
	o-EU, t=∞	0	0	0	0	0	0	0	0	0
Foreigners leave	acceded, t=0	-60.247	48.490	0	273.692	-73.240	48.555	48.450	0.044	0.206
after 58 periods	acceded, t=∞	0	0	0	0	0	0	0	0	0
AC	o-EU, t=0	56.889	-17.553	0	-48.395	93.779	-19.037	-16.886	-1.800	0.085
	o-EU, t=∞	0	0	18.385	-0.537	19.023	-0.537	0.241	-0.537	0.241
Foreigners	acceded, t=0	-63.891	54.737	0	255.377	-71.861	28.323	70.871	-17.071	0.385
stay forever	acceded, t=∞	0	0	-91.922	2.683	-92.134	2.683	-1.205	2.683	-1.220
Δ^{max}(NAC,AC) for non-acceded		0.925	-0.394	2.653	-2.285	3.696	-1.388	-0.847	-1.002	0.026
Sensitivity with respect to the border-cost parameter γ: *$v = 5, v^\ell = 1, v^n = 1, \sigma = 2, \gamma = 0.8$*										
NAC	o-EU, t=0	17.774	-6.771	0	-23.570	30.839	-9.986	-5.327	-3.448	0.008
	o-EU, t=∞	0	0	0	0	0	0	0	0	0
Foreigners leave	acceded, t=0	-66.117	59.015	0	392.837	-79.709	66.987	54.145	5.014	0.248
after 31 periods	acceded, t=∞	0	0	0	0	0	0	0	0	0
AC	o-EU, t=0	21.427	-7.984	0	-23.939	31.474	-7.642	-8.137	0.371	0.016
	o-EU, t=∞	0	0	16.0185	-0.4673	16.5632	-0.4673	0.2099	-0.4673	0.2095
Foreigners	acceded, t=0	-72.053	72.697	0	421.182	-80.813	45.655	89.214	-15.659	0.506
stay forever	acceded, t=∞	0	0	-80.093	2.336	-80.547	2.336	-1.050	2.336	-1.061
Δ^{max}(NAC,AC) for non-acceded		3.102	-1.301	2.458	-5.553	6.794	-2.849	-1.992	-1.667	0.020
Sensitivity with respect to the risk-aversion coefficient σ: *$v = 5, v^\ell = 1, v^n = 1, \sigma = 5, \gamma = 0.9$*										
NAC	o-EU, t=0	19.354	-7.302	0	-24.177	31.885	-9.502	-6.314	-2.373	0.072
	o-EU, t=∞	0	0	0	0	0	0	0	0	0
Foreigners leave	acceded, t=0	-66.491	59.772	0	402.941	-80.117	68.533	55.420	5.484	2.183
after 88 periods	acceded, t=∞	0	0	0	0	0	0	0	0	0
AC	o-EU, t=0	21.021	-7.852	0	-24.446	32.356	-8.563	-7.532	-0.773	0.108
	o-EU, t=∞	0.001	-0.001	16.980	-0.496	17.563	-0.495	0.222	-0.494	0.884
Foreigners	acceded, t=0	-69.420	66.160	0	418.773	-80.724	58.640	69.895	-4.526	3.284
stay forever	acceded, t=∞	-0.010	0.004	-84.906	2.486	-85.272	2.476	-1.106	2.472	-4.569
Δ^{max}(NAC,AC) for non-acceded		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 varaibles under the given scenario and those in the associated autarkic economy. Statistic in column (7) is capital outflows from a country in percent of the country's capital stock. Statistic "Δ^{max}(NAC,AC) for non-acceded" is a maximum percentage difference between the values of the variables of the non-acceded country under the non-accession and the accession scenarios.

of the non-acceded 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-acceded 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 population size of the non-EU15 country, v^n, the border cost, γ, and the coefficient of risk aversion, σ. The statistics for these sensitivity experiments for the two-country and the three-country models are reported in Tables 3 and 4, respectively. The transition patterns in the sensitivity experiments proved to be similar to those we had under the benchmark parameterization, so that we do not provide the corresponding figures.

We begin by presenting sensitivity results for the two-country model. Our first experiment consists in increasing the population size of the non-EU15 country from $v^n = 1$ to $v^n = 5$. (The latter value of v^n corresponds to an upper bound of the non-EU15 population, which is obtained when all European developed non-acceded countries and all transition (both acceded and non-acceded) countries are included in the non-EU15 group, see Table 1). As follows from Table 3, this modification leads to a considerable initial increase in international capital flows: now, the EU15 country invests abroad almost 50% of its total capital stock, while in the benchmark case, it invested around 15%. A short-run cost of such capital outflows for the EU15 country is enormous: now, its consumption drops by 16% and 22% relative to autarky under the non-accession and the accession scenarios, respectively, while in the benchmark case, the corresponding figures were 4% and 6%. Overall, the EU15 country however gains from investing into the non-EU15 country, and its welfare gains are even larger now than in the benchmark case. In particular, under the accession scenario, the EU15 country ends up with savings, which are 68% larger than in autarky, while in the benchmark case, this figure was 16%. For the non-EU15 country, regularities are opposite to the above described regularities for the EU15 country: the larger is the size of the non-EU15 country, the smaller are immediate benefits and the smaller are the long-run costs from international capital flows. This is because a larger size of the non-EU15 country implies a smaller amount of foreign investment in per capita terms, for a given size of the EU15 country.

In the second sensitivity experiment, we consider a two-time increase in the size of border costs by varying the border-cost parameter from $\gamma = 0.9$ to $\gamma = 0.8$. (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 considered relatively large increase in border costs has only a minor effect on the statistics in the table. A noteworthy exception is the number of periods for which the EU15 capital stays in the non-acceded country: it decreases from 53 in the benchmark case to 35 now.

In the third experiment, we vary the inverse of the intertemporal elasticity of substitution from $\sigma = 1$ to $\sigma = 5$. A stronger agent's desire to smooth 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-acceded country for 84 periods. Therefore, the parameters γ and σ play a similar role in the equilibrium dynamics: their variations affect considerably the speed of convergence but not the variables' initial and asymptotic values.

Finally, in Table 4, we provide the sensitivity results for the three-country model. Here, we have roughly the same regularities for the old EU and the acceded countries, as we did for the EU15 and the acceded countries, respectively, in the corresponding two-country settings. As far as the third (non-acceded) country is concerned, the differences between its variables under the accession and the non-accession scenarios are the largest in the experiment with large border costs, $\gamma = 0.8$, ranging from 1.3% for wages to 6.8% for capital inflows. 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 the EU enlargement on the economies of the EU15, the acceded and the non-acceded countries. We focus on one particular aspect of the EU enlargement, which is the abolition of border costs for investing from the EU15 to the acceded 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 accede 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 so 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 Czech Republic, Poland and Hungary was 16.2%, 18.6% and 46.5%, respectively; and, in 2000, the FDI stock in 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 in the long-run outcomes: the presence of foreigners is only temporary in a non-acceded country, whereas it is permanent in an acceded country. This fact should be taken into account by policy makers, for example, an acceded 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 be therefore to endogenize border costs by making it a policy variable of acceded country.

Needless to say, our results should be treated with caution since our model abstracts from several potentially important issues. First, in our model, an acceded country adopts the EU environment at the moment of accession (meaning that border costs are instantaneously and fully eliminated), while in reality, an acceded 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 FDI, while the empirical literature argues that FDI can also be a means of extending control for corporate-strategy reasons, see, e.g., Graham and Krugman (1989), Markusen and Venables (1998), Ekholm et al. (2003). Finally, we are restricted to modeling the effect of the EU enlargement on border costs of FDI, while the EU enlargement has also a significant effect on migration, trade, etc. The extension of the model along these lines is left for future research.

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6 Appendix

In this section, 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.

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 of 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 λ. 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 is 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 $t \geq 1$, we can reduce the number of state variables from four to two. Indeed, according to the Kuhn-Tucker conditions (5), (6), for $t \geq 1$, we can re-write 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 consumer of the country $i \in \{1,2\}$. 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). To deal with this issue, we shall restrict our attention to such sets of initial conditions that satisfy the 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 the used in Maliar and Maliar (2004b), however, in the present paper we parameterize not the asset functions but the labor functions. In our model, parameterizing the labor function is more convenient than parameterizing other functions such as the consumption or the asset functions because we can explicitly resolve the intratemporal FOCs, see Maliar and Maliar (2004a) for a discussion. By definition, labor functions determine the optimal working hours in the two countries,

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

The labor 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 is 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, $w_t^i = (1-\alpha)\left(r_t^i/\alpha\right)^{\frac{\alpha}{\alpha-1}}$, 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

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

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, $\left(\kappa_{t+1}^1, \kappa_{t+1}^2\right)$. To evaluate the labor functions (16) in the points $\left(\kappa_{t+1}^1, \kappa_{t+1}^2\right)$, we use linear polynomial interpolation, namely, Matlab's routine "interp2". As a result of the above calculations, we obtain $\left\{h_{t+1}^i, \phi_{t+1}^i, k_{t+1}^i, r_{t+1}^i, w_{t+1}^i, c_{t+1}^i\right\}$.

We can now check whether the assumed labor 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

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

By computing $\widehat{h}_t^i$ in each point of the grid, we define the new labor functions $\widehat{\Im}^i(\kappa_t^1, \kappa_t^2) \equiv \widehat{h}_t^i$, 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 labor 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 labor functions differ on two subsequent iterations by less than 10^{-9} according to the least-square norm.

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. It 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-acceded countries by solving the two-country model, as is 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 acceded countries. The definition (11) implies that the individual and the aggregate allocations for consumption and labor are related by

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

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 life-time budget constraint (12) to obtain

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

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 10000, 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).