universität wien

MASTERARBEIT / MASTER'S THESIS

Titel der Masterarbeit / Title of the Master's Thesis

„Welfare Optimization of the Migration Decision"

verfasst von / submitted by

Michaela Preclíková

angestrebter akademischer Grad / in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

Wien, 2023 / Vienna, 2023

Studienkennzahl lt. Studienblatt / degree programme code as it appears on the student record sheet:	UA 066 913
Studienrichtung lt. Studienblatt / degree programme as it appears on the student record sheet:	Masterstudium Volkswirtschaftslehre
Betreut von / Supervisor:	Ass.-Prof. Dr. sc. ETH Alexandra Brausmann

Acknowledgements

I would like to express my deepest gratitude to my supervisor Ass.-Prof. Dr. sc. ETH Alexandra Brausmann for her time, guidance, help and valuable comments. I would also like to thank her for the opportunity to work on the project that gave rise to my thesis topic.

Furthermore, I would like to thank my partner for his helpful comments and advice and my family, friends and colleagues for their support.

Abstract

This thesis presents an alternative that addresses the high influx of undocumented migrants into the EU by offering them the possibility of a temporary stay in a host country settlement. This option provides them with employment and access to basic services while the EU authorities process their asylum applications. We develop a model of the migrant's optimization behaviour and compare and analyze the options of direct migration to the EU, moving to a host settlement, and deciding not to migrate at all. Offering more certainty and employment prospects makes moving to an intermediate host country the optimal option for a wide range of migration costs. Direct migration is preferable for very low EU and source country wage ratios and for individuals who accumulate sufficient savings before migration. Increased border protection leads to more costly migration and makes staying in the country of origin more attractive.

Kurzfassung

In dieser Masterarbeit wird ein Lösungsansatz zur Problematik des großen Zustroms von irregulären Migranten in die EU vorgestellt, indem ihnen die Möglichkeit eines vorübergehenden Aufenthalts in einem Gastgeberland geboten wird. Diese Option bietet ihnen Beschäftigung und Zugang zu grundlegenden Dienstleistungen, während die EU-Behörden ihre Asylanträge bearbeiten. Wir entwickeln ein Modell des Optimierungsverhaltens von Migranten und vergleichen und analysieren die Optionen, direkt in die EU zu migrieren, zuerst in ein Aufnahmeland zu ziehen oder überhaupt nicht zu migrieren. Aufgrund größerer Sicherheit und besserer Beschäftigungsaussichten ist der vorübergehende Aufenthalt in einem Gastgeberland die optimale Option für ein breites Spektrum an Migrationskosten. Die direkte Migration ist die optimale Option, wenn das Lohnverhältnis zwischen der EU und dem Herkunftsland sehr niedrig ist und wenn die Person vor der Migration genügend Ersparnisse angesammelt hat. Ein verstärkter Grenzschutz führt zu einer teureren Migration und macht einen Verbleib im Herkunftsland attraktiver.

Contents

List of Figures

1. Introduction

The influx of asylum seekers to Europe has been increasing in the last 15 years, reaching its peak in 2015 with over 1.3 million asylum applications in the EU (Council of the EU, n.d.). Since 2017, the number declined and has fluctuated between 400,000 and 800,000. Most applications come from the Middle East and North Africa, mainly people fleeing their countries because of war, persecution or security problems.[1] The combined share of asylum applicants from Syrians, Afghans, and Iraqis was 40% in 2021 (European Commission, 2022).

Immigrants trying to reach Europe often travel through illegal channels and without proper documentation. Based on 2018 interviews with new migrants in Italy, Greece and Spain, 84% said they had relied on human smugglers (Frontex, 2019). The journey from the country of origin to Europe is a dangerous one, as more than 25,000 migrants have died or disappeared while crossing the Mediterranean since 2014 (IOM, 2023). Illegal border crossings also make vulnerable migrants targets for human trafficking. Upon entering the EU, irregular migrants find themselves in limbo, waiting for decisions from lengthy immigration procedures and legal processes. Along with uncertainty and lack of control over their future, this leads to their poor well-being and worse prospects for the future (see, e.g., Heeren et al., 2012; Hainmueller et al., 2016; Esaiasson et al., 2022).

Illegal immigration has become a major political issue, with the EU recording more than 1.8 million illegal border crossings in 2015 (Statista, 2022). The constant influx of asylum seekers into Europe poses a number of challenges for EU countries, such as relocation of people, funding, security issues, re-evaluating asylum policy or addressing the growing anti-immigration sentiment among European citizens. The EU authorities have been trying to tackle the issue of the massive illegal inflow by supporting border enforcement and prevent irregular border crossings by for example implementing the EU-Turkey deal in 2016. Although the number of asylum applications and illegal entries has declined since 2016, many people have been stranded on Greek islands, while Amnesty International (2022) and IRC (2022) have also raised questions about the safety of asylum seekers in Turkey.

One of the reasons for the high number of illegal entries is currently the lack of a

[1] It is important to consider that only a small proportion of these people apply for asylum in developed countries. In 2021, 72% of the world's refugees were in countries neighbouring their place of origin, and 83% were hosted in low- and middle-income countries (UNHCR, 2021). The countries hosting the most refugees in 2021 were Turkey (3.8 million), Colombia (1.8 million), Uganda (1.5 million), Pakistan (1.5 million) and Germany (1.3 million).

legal and safe route to Europe (see, e.g., Collyer, 2010). Therefore, one way of decreasing the migration inflow to Europe is to offer migrants a different, yet very attractive alternative. A proposed solution to the issue stems from the project "An alternative to 'Fortress Europe'" (Vienna Forum for Democracy and Human Rights, 2022). The idea is to build intermediate host settlements in one or several of the North African countries where migrants stay until their asylum and residency applications are processed by the EU authorities. These settlements do not only serve as a transit place for the individuals, but provide migrants with basic services, housing, employment, security and education possibilities. Additionally, the authorities ensure a much safer journey from the country of origin to the intermediate host country.

We hypothesize that the alternative brings benefits not only for the migrants themselves (by offering them a secure migration option and employment) but also for the EU by decreasing the number of direct and illegal migration, and for the host country by increasing its labour force in specific targeted sectors. From the migrants' perspective, this option does not expose their lives to danger and insecurity and is also linked to the prospect of income and possible resettlement in the EU. The aim of this thesis is to identify which economic incentives can make a host settlement more attractive than direct migration to the EU. We propose a model that combines issues such as the decision to migrate in the first place, irregular migration, uncertainty and transit migration, and builds on several existing models that address these issues.

In our setting, migrants[2] have the following options: to make the risky journey to the EU, to migrate to the host country, or not to migrate at all. We develop a life-cycle migration model and investigate which option is more preferable under which conditions. These micro-models consider migration as an investment decision by the individual who evaluates the costs and benefits of the options (see, e.g., Sjaastad, 1962; Harris and Todaro, 1970; Polachek and Horvath, 2012). Migrants maximize the present value of their lifetime welfare and choose the option with the highest expected net returns. While the same argument applies to refugee migration, the primary force behind their movement is any kind of danger, violent acts or insecurity in their home country rather than economic motivation (Engel and Ibáñez, 2007; Czaika, 2009). Nevertheless, asylum seekers also have economic motives, and distinguishing between purely political and purely economic motives for migration is often difficult.

People leaving their country for security reasons have to consider various factors to decide whether to travel through legal or illegal channels (see, e.g., Schaeffer, 2010;

[2]For the sake of clarity, it is necessary to distinguish between these three terms: migrant, asylum seeker and refugee. Amnesty International (2022) defines an asylum seeker as "a person who has left their country and is seeking protection from persecution and serious human rights violations in another country". The same applies to refugees, but they are already legally recognized and entitled to international protection, while asylum seekers are still waiting for recognition status. Even though we primarily focus on asylum seekers in our work, we mainly use the term "migrant" for simplification purposes, as it includes all people who have left their country of origin.

De Haas, 2011). The paper by Djajić (2014) studies the optimal choice of an asylum seeker trying to reach a developed country either with the help of human smugglers or by applying for legal relocation with the UNHCR. He concludes that undocumented migration is preferred by individuals with larger initial savings, in the case of higher wages in the final destination country or lower migration costs. Intuitively, improved conditions in the refugee camps or lower probability of successful undocumented migration make the documented migration more attractive.

Refugee migration rarely takes the form of direct migration and often involves multiple transit countries (see, e.g., Collyer, 2010; Djajić and Michael, 2014; Kuschminder et al., 2015). This thesis extends the theoretical literature about transit migration and compares under which circumstances the choice of a transit country - in our case host country - is preferred over direct migration.[3] We use a similar setting to Djajić (2017) who develops a three-stage model to optimize the behaviour of a transit migrant and studies how variation in wages and migration costs shape the individual's choice.

We find that direct migration to the EU is optimal only when migration costs are low and the ratio between the wage in the EU and the wage in the home country is relatively small. If a migrant faces high migration costs, it is preferable to stay in the home country and not migrate at all. Otherwise, the proposed idea of temporary settlement in the host country outweighs the other alternatives. This reflects the fact that migration to a host settlement is less risky than direct migration, which is associated with more uncertainty. Besides, the migrant also has the opportunity to work in the host country, which also favours this option.

The thesis is structured as follows. Section 2 describes the model and solves the optimization problem of the migrant for all given options. In this part, we assume equal interest rates across countries. In Section 3, we extend the model while assuming different interest rates across countries. Section 4 solves numerically derived consumption paths and expected discounted lifetime welfare of the migrant and compares the outcome for all given alternatives. The main objective of this sections is to show which option is preferred under given parameters, such as wages, probability of acceptance to the EU or cost of migration. Section 5 sums our findings and suggests ideas for further research.

[3]See Kennan and Walker (2011) or Artuc and Ozden (2018) for a dynamic model of transit migration.

2. Model

In our model, the migrant faces three options to choose from. Firstly, she has an option of undertaking a direct and illegal journey to the final destination in the EU, option A. This option is risky and involves two types of uncertainties.[4] The first uncertainty relates to whether she can successfully complete the journey to the EU. This includes all the difficulties migrant faces, from dependence on human smugglers to travelling in dangerous conditions. Once she manages to reach Europe, she is placed in an asylum centre where she awaits a decision on whether she will be granted legal asylum in a European country. The second uncertainty she faces is thus the probability with which the authorities accept her application. In the centre, the migrant waits for her asylum application to be processed, a process that usually takes several years. If the result is positive, the migrant moves to the destination country, starts working there and earns a given wage. Otherwise, we assume for simplicity that she is sent back to the country of origin.[5]

Secondly, the migrant is also given an option B and can move to a host country settlement (for example in Morocco, Tunisia or Libya).[6] The migrant can work there at a given wage and is provided with free housing, health care, education and other services. The journey to the host country and access to the job market there are associated with no risk thanks to the EU and host country authorities. In the meantime, the authorities process the migrant's application to the EU. If the result is positive, she moves to the final destination country in the EU and starts working there at a given wage. Otherwise, she is sent back to her home country. Lastly, the migrant can also choose option C, which means not migrating at all. In this case, she spends her lifetime in the home country.

The migrant chooses the option that brings her the highest utility. In order to compare the alternatives, we solve for the optimal consumption rates and derive the expected lifetime welfare in each scenario.[7] Firstly, we look at the simplest case and assume that

[4] In reality, the migrant clearly faces more uncertainties and risks, but for simplicity we do not include them in the model.

[5] The migrant is in reality not sent back immediately as it takes longer, but she can also reapply for asylum or flee.

[6] Countries in North Africa already serve as transit countries for migrants on their way to Europe, many of whom settle there for long-term periods (Collyer and De Haas, 2012).

[7] We abstract from the optimal timing of migrations, as for example in Djajić and Vinogradova (2014) or Djajić (2017), by assuming that conditional on the decision to migrate, the migrant leaves the source country immediately. If her initial assets are insufficient to cover the cost of migration, she borrows the necessary funds from the network of family and friends or from a smuggling organization and repays the debt at the prevailing interest rate, see below.

the rate of time preference and all the interest rates equal across countries. We study the same optimization problem under different assumption in Section 3.

2.1. Option A: direct migration to the EU

The probability of undergoing the journey and successfully crossing into Europe is given by π. In this case, the migrant is placed into an asylum centre at time $t = 0$ and it takes τ units of time for the authorities to process the application and make a decision about the asylum status. Until the time period τ, the migrant has a fixed level of consumption $\bar{c}$, which is provided to asylum seekers in the asylum centre. The authorities accept the migrant's application with probability p. The migrant then moves to the final destination country in the EU, earns a given wage w^* and consumes c_t^* until the end of her planning horizon T (e.g. retirement). The authorities decide otherwise with the probability $(1 - p)$ that the migrant is sent back to the home country where she earns a wage of $\tilde{w} < w^*$ and consumes $\tilde{c}_t$ until the time T. With the probability $(1 - \pi)$ the migrant fails to enter into the EU, for example because of problems with smugglers or other travel difficulties. In this case, we assume that she returns back to the home country for the whole period and consumes $\tilde{c}_t^{nc}$, taking into account the sunk cost of migration.[8]

The migrant maximizes her expected discounted lifetime welfare by choosing optimal consumption rates c_t^*, $\tilde{c}_t$ and $\tilde{c}_t^{nc}$

$$\begin{aligned}\max_{c_t^*,\tilde{c}_t,\tilde{c}_t^{nc}} U^A = \pi \left\{ \int_0^\tau u(\bar{c}) e^{-\rho t} dt + p \int_\tau^T u(c_t^*) e^{-\rho t} dt + (1-p) \int_\tau^T u(\tilde{c}_t) e^{-\rho t} dt \right\} + \\ + (1-\pi) \left\{ \int_0^T u(\tilde{c}_t^{nc}) e^{-\rho t} dt \right\},\end{aligned} \tag{2.1}$$

where ρ stands for the constant rate of time preference. The uncertainty about successful crossing to the EU is resolved at time $t = 0$. The uncertainty about her asylum status is resolved at time $t = \tau$. Since she makes no decisions between time $t = 0$ and $t = \tau$, she considers three states of the world.

2.1.1. Successful crossing to the EU and granted asylum (with probability πp)

After successfully arriving in the EU, the migrant waits in an asylum centre for a decision on her asylum application. Her consumption in the asylum centre is exogenously given by $\bar{c}$. From time τ until T, the migrant resides in an EU country where she chooses the optimal consumption rate c_t^*

$$\max_{c_t^*} U(c_t^*) = \int_\tau^T u(c_t^*) e^{-\rho(t-\tau)} dt \tag{2.2}$$

[8] We do not model death on the journey.

subject to a budget constraint

$$\int_{\tau}^{T} (w^* - c_t^*) e^{-r^*(t-\tau)} dt = (\tilde{K} - A_0) e^{r\tau}, \tag{2.3}$$

where r represents the interest rate in the home country and r^* is the interest rate in the EU. $\tilde{K}$ denotes the cost of migration from the home country to the EU paid at the time of migration $t = 0$. A_0 stands for the pre-migration asset holdings. We define the net cost of migration as $K = \tilde{K} - A_0$ and assume that the migrant keeps her net assets (resp., debt) in the home country and earns (resp., pays) interest at the home-country rate r.

We assume the constant relative risk aversion (CRRA) utility function $u(c_t) = \frac{c_t^{1-\theta}}{1-\theta}$ and the first derivative of the function is $u'(c_t) = c_t^{-\theta}$. Assuming that $r = r^* = \rho$, the optimal consumption rate is constant for any time t. We substitute the constant consumption rate in the budget constraint and integrate to obtain the migrant's optimal consumption rate c^*[9]

$$c^* = w^* - \frac{r^* K}{e^{-r^*\tau} - e^{-r^* T}}. \tag{2.4}$$

The discounted utility in this case is then given by

$$U(c^*) = \pi \; p u(c^*) \left(\frac{e^{-\rho\tau} - e^{-\rho T}}{\rho} \right). \tag{2.5}$$

2.1.2. Successful crossing to the EU and asylum is not granted (with probability $\pi(1-p)$)

With probability $\pi(1-p)$, the migrant is not granted asylum and must return to her home country. She faces a similar optimization problem as before, chooses optimal consumption rate $\tilde{c}$, but with a different wage $\tilde{w}$

$$\max_{\tilde{c}_t} U(\tilde{c}_t) = \int_{\tau}^{T} u(\tilde{c}_t) e^{-\rho(t-\tau)} dt \tag{2.6}$$

subject to

$$\int_{\tau}^{T} (\tilde{w} - \tilde{c}_t) e^{-r(t-\tau)} dt = K e^{r\tau}, \tag{2.7}$$

where r stands for the home-country interest rate. As follows from the FOC and the assumption $r = r^* = \rho$, the consumption rate $\tilde{c}$ is constant and lower than in the first case, since interest rates equal across countries and $w^* > \tilde{w}$:

$$\tilde{c} = \tilde{w} - \frac{rK}{e^{-r\tau} - e^{-rT}}. \tag{2.8}$$

The discounted welfare of the migrant in this scenario is as follows:

$$U(\tilde{c}) = \pi(1-p) u(\tilde{c}) \left(\frac{e^{-\rho\tau} - e^{-\rho T}}{\rho} \right). \tag{2.9}$$

[9]All derivations for the case of equal interest rates across countries are given in the Appendix A.1.

2.1.3. Crossing to the EU is not successful (with probability $(1-\pi)$)

If the attempt to enter the EU fails, the migrant, even though she has paid the migration costs, spends her whole life in the home country earning a wage $\tilde{w}$. She maximizes her lifetime utility by choosing the optimal consumption rate $\tilde{c}_{nc}$

$$\max_{\tilde{c}_t} U(\tilde{c}_t^{nc}) = \int_0^T u(\tilde{c}_t^{nc})e^{-\rho t}dt \tag{2.10}$$

subject to

$$\int_0^T (\tilde{w} - \tilde{c}_t^{nc})e^{-rt}dt = K. \tag{2.11}$$

Using our assumption $r = r^* = \rho$ for solving the maximization problem, the optimal consumption rate is constant at the rate

$$\tilde{c}^{nc} = \tilde{w} - \frac{rK}{1-e^{-rT}} \tag{2.12}$$

with the expected welfare being

$$U(\tilde{c}^{nc}) = (1-\pi)u(\tilde{c}^{nc})\left(\frac{1-e^{-\rho T}}{\rho}\right). \tag{2.13}$$

Consider that consumption rates are constant and the assumption of equal time preference and interest rates across countries $r = r^* = \rho$ holds. The expected present value of lifetime welfare in the case of direct migration to the EU then takes the following form:

$$\begin{aligned} U^A =& \pi\left\{u(\bar{c})\left(\frac{1-e^{-\rho\tau}}{\rho}\right) + pu(c^*)\left(\frac{e^{-\rho\tau}-e^{-\rho T}}{\rho}\right) + (1-p)u(\tilde{c})\left(\frac{e^{-\rho\tau}-e^{-\rho T}}{\rho}\right)\right\} + \\ &+ (1-\pi)u(\tilde{c}^{nc})\left(\frac{1-e^{-\rho T}}{\rho}\right). \end{aligned} \tag{2.14}$$

2.2. Option B: migration to the host country

The migrant arrives to the host country at time $t = 0$ at no risk, starts working at a given wage w and consumes c_t. Again, the authorities take τ units of time to make a decision about the asylum. The application to the EU is accepted with a probability p, the migrant moves to the final destination country, works there at a given wage w^* and consumes c_t^*. The authorities come to a negative result with a probability $(1-p)$, in which case the migrant is sent back to her home country and earns $\tilde{w}$ and consumes $\tilde{c}_t$.[10].

In the first period, the migrant maximizes her welfare by optimizing the consumption rate

[10]Within the framework of the project, the migrant has the possibility to stay permanently in the host country if her asylum application is rejected. We investigate this possibility in the appendix A.3

in the host country c_t while facing uncertainty about her asylum claim. Thus, she must optimize c_t by maximizing expected welfare and accounting for the possible outcomes in the later periods. This path will be followed until time $t = \tau$, when the uncertainty is resolved. Since interest rates equal the rate of time preference, the consumption rate is always constant, i.e., $c_t = c$ for any time t. During the stay in the host country, the migrant accumulates savings (resp. debt) until time $t = \tau$,

$$A_\tau = \int_0^\tau (w - c)e^{rt}dt = (w - c)\frac{e^{r\tau} - 1}{r}, \tag{2.15}$$

where r denotes the host country risk-free rate of interest. At time $t = \tau$, the uncertainty is resolved and the migrant learns about the state of the world.

2.2.1. Asylum is granted (with probability p)

She faces the following optimization problem

$$\max_{c_t^*} U(c_t^*) = \int_\tau^T u(c_t^*)e^{-\rho(t-\tau)}dt \tag{2.16}$$

subject to

$$A_\tau - Ke^{r\tau} + \int_\tau^T (w^* - c_t^*)e^{-r^*(t-\tau)}dt = 0, \tag{2.17}$$

where r^* is the EU interest rate, A_τ denotes the accumulated savings from the host country and K is the net cost of migration. We discount the assets and the welfare to time τ. It follows from the FOC and the assumption $r = r^* = \rho$ that the consumption rate is constant for any time t at the rate

$$c^* = w^* - \frac{r^*(K - A_\tau e^{-r\tau})}{e^{-r^*\tau} - e^{-r^*T}} \tag{2.18}$$

and the respective expected discounted welfare takes then the following form:

$$U(c^*) = pu(c^*)\left(\frac{e^{-\rho\tau} - e^{-\rho T}}{\rho}\right). \tag{2.19}$$

2.2.2. Asylum is not granted (with probability $(1 - p)$)

We approach similarly as in the case before. The migrant solves her problem

$$\max_{\tilde{c}_t} U(\tilde{c}_t) = \int_\tau^T u(\tilde{c}_t)e^{-\rho(t-\tau)}dt \tag{2.20}$$

subject to the budget constraint

$$A_\tau - Ke^{r\tau} + \int_\tau^T (\tilde{w} - \tilde{c}_t)e^{-r(t-\tau)} = 0, \tag{2.21}$$

where r represents the home country interest rate. The optimal consumption rate $\tilde{c}$ is constant and is given by

$$\tilde{c} = \tilde{w} - \frac{r(K - A_\tau e^{-r\tau})}{e^{-r\tau} - e^{-rT}}. \tag{2.22}$$

The discounted welfare of the period is given by

$$U(\tilde{c}) = (1-p)u(\tilde{c})\left(\frac{e^{-\rho\tau} - e^{-\rho T}}{\rho}\right). \tag{2.23}$$

We can now derive the consumption of the first period, c_t, because we know the possible consumption rates in later periods. At time $t = 0$, her optimization problem is given by

$$\max_c \; U(c) = \int_0^\tau u(c)e^{-\rho t}dt + p\int_\tau^T u(c^*(c))e^{-\rho t}dt + (1-p)\int_\tau^T u(\tilde{c}(c))e^{-\rho t}dt \tag{2.24}$$

where the consumption rates c^* and $\tilde{c}$ are functions of c. By differentiating (2.24) with respect to c, we find

$$c = \left[pc^{*-\theta} + (1-p)\tilde{c}^{-\theta}\right]^{-\frac{1}{\theta}}. \tag{2.25}$$

The expected present value welfare of the first period is then

$$U(c) = u(c)\left(\frac{1 - e^{-\rho\tau}}{\rho}\right). \tag{2.26}$$

When the assumption $r = r^* = \rho$ holds, all consumption rates are constant and the expected lifetime welfare is given by

$$U^B = u(c)\left(\frac{1 - e^{-\rho\tau}}{\rho}\right) + pu(c^*)\left(\frac{e^{-\rho\tau} - e^{-\rho T}}{\rho}\right) + (1-p)u(\tilde{c})\left(\frac{e^{-\rho\tau} - e^{-\rho T}}{\rho}\right) \tag{2.27}$$

where c^* and $\tilde{c}$ are functions of c.

2.3. Option C: no migration

If the migrant decides to stay in the country of origin, she earns a given wage $\tilde{w}$ and consumes $\tilde{c}_t$. There is no cost associated with migration as she decides not to undertake the migration process, i.e., $\tilde{K} = 0$.

The migrant maximizes her lifetime utility

$$\max_{\tilde{c}_t} U(\tilde{c}_t) = \int_0^T u(\tilde{c}_t)e^{-\rho t}dt \tag{2.28}$$

given the following budget constraint

$$A_0 + \int_0^T (\tilde{w} - \tilde{c}_t)e^{-rt}dt = 0, \tag{2.29}$$

where ρ stands for the discount rate, r represents the interest rate in the home country and A_0 denotes the initial asset holdings. Optimal consumption $\tilde{c}$ then takes the following form:

$$\tilde{c} = \tilde{w} + \frac{A_0 r}{1 - e^{-rT}}. \tag{2.30}$$

The migrant's expected lifetime welfare is given by

$$U^C = u(\tilde{c}) \left(\frac{1 - e^{-\rho T}}{\rho} \right). \tag{2.31}$$

3. Different rates across countries

In this section, we alter the assumption about the interest rates and assume that $r > r^* = \rho$, i.e., the interest rate r in the home and host countries is greater than the interest rate r^* in the EU.[11] We again derive the optimal consumption rates for all options and the lifetime welfare values.

3.1. Option A: direct migration to the EU

The migrant solves the following maximization problem:

$$\max_{c_t^*, \tilde{c}_t, \tilde{c}^{nc}} U^A = \pi \left\{ \int_0^\tau u(\bar{c}) e^{-\rho t} dt + p \int_\tau^T u(c_t^*) e^{-\rho t} dt + (1-p) \int_\tau^T u(\tilde{c}_t) e^{-\rho t} dt \right\} + \\ + (1-\pi) \left\{ \int_0^T u(\tilde{c}_t^{nc}) e^{-\rho t} dt \right\}. \tag{3.1}$$

She considers three states of the world and maximizes her expected discounted lifetime welfare by choosing optimal consumption rates c_t^*, $\tilde{c}_t$ and $\tilde{c}_t^{nc}$.

3.1.1. Successful crossing to the EU and granted asylum (with probability πp)

If the migrant receives a positive asylum decision, she faces the following problem:

$$\max_{c_t^*} U(c_t^*) = \int_\tau^T u(c_t^*) e^{-\rho(t-\tau)} dt \tag{3.2}$$

subject to

$$\int_\tau^T (w^* - c_t^*) e^{-r^*(t-\tau)} dt = K e^{r\tau}. \tag{3.3}$$

Solving the maximization problem yields a constant optimal consumption rate, which now includes an expression that takes into account differences between interest rates[12]

$$c^* = w^* - \frac{r^* K e^{\tau(r-r^*)}}{e^{-r^*\tau} - e^{-r^*T}}. \tag{3.4}$$

[11] Koser (2008) reports that average annual remittances were 52% of the fees to the smugglers and Kyle and Liang (2001) indicate that the monthly interest on the loan from a smuggler is 10-12%. Paper by Djajić and Vinogradova (2014) about undocumented migration also assumes $r > r^*$ when a migrant takes out a loan from a smuggling organization. In our case, we do not distinguish whether the migrant receives the loan from the smuggler or from the family network, and the interest rate may therefore differ. Nevertheless, it is more realistic to assume $r > r^*$, also given the low interest rates in the EU countries.

[12] All derivations for different interest rates across countries are shown in the Appendix A.2.

The expected discounted utility of this period is given by

$$U(c^*) = \pi p u(c^*) \left(\frac{e^{-\rho\tau} - e^{-\rho T}}{\rho} \right). \tag{3.5}$$

3.1.2. Successful crossing to the EU and asylum is not granted (with probability $\pi(1-p)$)

The migrant maximizes her welfare after her asylum application has been rejected

$$\max_{\tilde{c}_t} U(\tilde{c}_t) = \int_{\tau}^{T} u(\tilde{c}_t) e^{-\rho(t-\tau)} dt \tag{3.6}$$

subject to

$$\int_{\tau}^{T} (\tilde{w} - \tilde{c}_t) e^{-r(t-\tau)} dt = K e^{r\tau}. \tag{3.7}$$

The consumption path takes the following form, $\tilde{c}_t = \tilde{c}_\tau e^{g(t-\tau)}$, where $g \equiv \frac{r-\rho}{\theta}$. We plug the consumption rate in the budget constraint (3.7) to solve for $\tilde{c}_\tau$

$$\tilde{c}_\tau = e^{g\tau} \left(\frac{\tilde{w} \left(\frac{e^{-r\tau} - e^{-rT}}{r} \right) - K}{\frac{e^{(g-r)T} - e^{(g-r)\tau}}{g-r}} \right) \tag{3.8}$$

and to derive the expected present value of welfare for this option

$$U(\tilde{c}_t) = (1-p) u(\tilde{c}_\tau e^{-g\tau}) \left(\frac{e^{(g-r)T} - e^{(g-r)\tau}}{g-r} \right). \tag{3.9}$$

3.1.3. Unsuccessful crossing to the EU (with probability $(1-\pi)$)

The migrant solves the following problem when the journey to the EU proves unsuccessful and she spends her lifetime in her home country

$$\max_{\tilde{c}_t} U(\tilde{c}_t^{nc}) = \int_{0}^{T} u(\tilde{c}_t^{nc}) e^{-\rho t} dt \tag{3.10}$$

subject to

$$\int_{0}^{T} (\tilde{w} - \tilde{c}_t^{nc}) e^{-rt} dt = K. \tag{3.11}$$

Similarly as before, the consumption rate $\tilde{c}_t^{nc}$ is increasing with time $\tilde{c}_t^{nc} = \tilde{c}_0^{nc} e^{gt}$. We plug the expression from the expression above to the budget constraint (3.11) and derive $\tilde{c}_0^{nc}$:

$$\tilde{c}_0^{nc} = \left(\frac{\tilde{w} \left(\frac{1 - e^{-rT}}{r} \right) - K}{\frac{e^{(g-r)T} - 1}{g-r}} \right). \tag{3.12}$$

The expected present value of welfare for this period is given by

$$U(\tilde{c}_t^{nc}) = (1-\pi)u(\tilde{c}_0^{nc})\left(\frac{e^{(g-r)T}-1}{g-r}\right). \tag{3.13}$$

Summing over all periods and cases, the expected present value of lifetime welfare takes the following form:

$$\begin{aligned} U^A =& \pi\left\{u(\bar{c})\left(\frac{1-e^{-\rho\tau}}{\rho}\right)+pu(c^*)\left(\frac{e^{-\rho\tau}-e^{-\rho T}}{\rho}\right)+\right. \\ &\left.+(1-p)u(\tilde{c}_\tau e^{-g\tau})\left(\frac{e^{(g-r)T}-e^{(g-r)\tau}}{g-r}\right)\right\}+(1-\pi)u(\tilde{c}_0^{nc})\left(\frac{e^{(g-r)T}-1}{g-r}\right). \end{aligned} \tag{3.14}$$

3.2. Option B: migration to the host country

As in Section 2.2, where we assumed the same interest rates in all countries, the migrant faces uncertainty about the future. Therefore, we first optimize the outcomes in possible later periods so that we can then solve for the first period.

We start by solving for A_τ, the accumulated savings from the host country

$$A_\tau = \int_0^\tau (w - c_0 e^{gt})e^{rt}dt = w\left(\frac{e^{r\tau}-1}{r}\right) - c_0\left(\frac{e^{(g+r)\tau}-1}{g+r}\right), \tag{3.15}$$

where r is the host country interest rate, $g \equiv \frac{r-\rho}{\theta}$ and the consumption path in the first period is increasing with time at the rate $c_t = c_0 e^{gt}$ due to the assumption about interest rates. The migrant considers two options at time $t = \tau$ when the uncertainty about the EU asylum is resolved.

3.2.1. Asylum is granted (with probability p)

In the event of a positive decision on the asylum application, the migrant solves the following problem

$$\max_{c_t^*} U(c_t^*) = \int_\tau^T u(c_t^*)e^{-\rho(t-\tau)}dt \tag{3.16}$$

subject to the budget constraint

$$A_\tau - Ke^{r\tau} + \int_\tau^T (w^* - c_t^*)e^{-r^*(t-\tau)}dt = 0, \tag{3.17}$$

where r^* denotes the EU interest rate. It follows from the FOC and the assumption $r^* = \rho$ that consumption rate is constant and is given by

$$c^* = w^* - \frac{r^*(Ke^{r\tau} - A_\tau)}{1 - e^{r^*(\tau - T)}} \tag{3.18}$$

and the expected discounted welfare for the period is

$$U(c^*) = pu(c^*)\left(\frac{e^{-\rho\tau} - e^{-\rho T}}{\rho}\right). \tag{3.19}$$

3.2.2. Asylum is not granted (with probability $(1-p)$)

The migrant faces the following problem if she is refused entry to the EU

$$\max_{\tilde{c}_t} \; U(\tilde{c}_t) = \int_{\tau}^{T} u(\tilde{c}_t)e^{-\rho(t-\tau)}dt \tag{3.20}$$

subject to

$$A_\tau - Ke^{r\tau} + \int_{\tau}^{T} (\tilde{w} - \tilde{c}_t)e^{-r(t-\tau)}dt = 0. \tag{3.21}$$

The FOC shows that the consumption rate increases over time at the rate $\tilde{c}_t = \tilde{c}_\tau e^{g(t-\tau)}$, where

$$\tilde{c}_\tau = \left[\tilde{w}\left(\frac{1 - e^{-r(T-\tau)}}{r}\right) - Ke^{r\tau} + A_\tau\right]\left(\frac{g-r}{e^{(g-r)(T-\tau)} - 1}\right) \tag{3.22}$$

and the expected present value of welfare over the period is

$$U(\tilde{c}_t) = (1-p)u(\tilde{c}_\tau e^{-g\tau})\left(\frac{e^{(g-r)T} - e^{(g-r)\tau}}{g-r}\right). \tag{3.23}$$

We now solve a maximization problem for the optimal initial consumption rate in the first period while considering possible outcomes in later periods

$$U^B = \int_0^{\tau} u(c_t(c_0))e^{-\rho t}dt + p\int_{\tau}^{T} u(c^*(c_0))e^{-\rho t}dt + (1-p)\int_{\tau}^{T} u(\tilde{c}_t(c_0))e^{-\rho t}dt \tag{3.24}$$

where the consumption rates c^* and $\tilde{c}_t$ are functions of c_0. By differentiating (3.24) with respect to c_0, we obtain

$$c_0 = \left[\left(pc^{*-\theta} + (1-p)\tilde{c}_\tau^{-\theta}\right)\left(\frac{e^{-\rho\tau}\left(e^{(g+r)\tau} - 1\right)(g-r)}{(g+r)\left(e^{(g-r)\tau} - 1\right)}\right)\right]^{-\frac{1}{\theta}}. \tag{3.25}$$

Adding up all possible periods gives the expected present value of lifetime welfare:

$$\begin{aligned} U^B = {} & u(c_0)\left(\frac{e^{(g-r)\tau} - 1}{g-r}\right) + pu(c^*)\left(\frac{e^{-\rho\tau} - e^{-\rho T}}{\rho}\right) + \\ & + (1-p)u(\tilde{c}_\tau e^{-g\tau})\left(\frac{e^{(g-r)T} - e^{(g-r)\tau}}{g-r}\right). \end{aligned} \tag{3.26}$$

3.3. Option C: no migration

The migrant maximizes her lifetime welfare by choosing to spend her entire lifetime in her home country

$$\max_{\tilde{c}_t} U(\tilde{c}_t) = \int_0^T u(\tilde{c}_t) e^{-\rho t} dt \tag{3.27}$$

subject to

$$A_0 + \int_0^T (\tilde{w} - \tilde{c}_t) e^{-rt} dt = 0. \tag{3.28}$$

According to the FOC, the consumption rate grows over time at the rate $\tilde{c}_t = \tilde{c}_0 e^{gt}$, where

$$\tilde{c}_0 = \left(\frac{\tilde{w}\left(\frac{1-e^{-rT}}{r}\right) + A_0}{\frac{e^{(g-r)T}-1}{g-r}} \right). \tag{3.29}$$

The total lifetime welfare takes the following form:

$$U^C = u(\tilde{c}_0) \left(\frac{e^{(g-r)T} - 1}{g - r} \right). \tag{3.30}$$

4. Comparison of the options

In this section, we focus mainly on comparing the three alternatives and identifying the migrant's preferred option, i.e., the option that brings her the highest expected discounted lifetime utility. We analyse how the change in parameters affects the migration decision and which option is preferable under the given conditions. We solve all lifetime utilities numerically to demonstrate the comparison of alternatives. We use some simplifying but fairly realistic assumptions for the parameters. The cost of migration, $\tilde{K}$, is one of the key variables in our model, as it can be largely influenced by border enforcement and EU immigration policy. By allowing more migrants to enter the EU and reducing the cost of entry, the cost of migration will be reduced. We do not fix the value of $\tilde{K}$ because we are interested in the role of this variable in our model and how strongly its changes affect preferences.

According to Eurostat (2022), more than 80% of the first-asylum seekers were under 35 years of age. For this reason, we set the planning horizon for migrants at $T = 40$ years. The waiting time for an asylum decision is assumed to be $\tau = 3$ years.[13] The weekly wage in the home country is normalised to $\tilde{w} = 1$. Based on World Bank (2020), the wage is the lowest in the home country and the highest in the final destination country, $w^* > w > \tilde{w}$. We take into account that migrants in the EU tend to earn lower than average wages and set the EU wage to $w^* = 10$. We assume that the host country wage is 20% of the EU wage, $w = 0.2w^*$.[14] We assume $r = r^* = \rho = 2\%$ per annum in the case of equal interest rates across countries and the rate of time preference. In the alternative case, migrants can borrow or lend in their host and home countries at a higher interest rate than in the EU country, such that $\rho = r^* = 2\%$ per annum and $r = 10\%$ per annum. Based on the latest data on recognition rates in the EU, the probability of being granted asylum is set at $p = 0.4$.[15] We further assume the probability of a successful transition to the EU of $\pi = 0.5$, the initial asset holdings are set to $A_0 = 0$, consumption in the asylum centre corresponds to the home country wage, $\bar{c} = \tilde{w}$, and the elasticity of intertemporal substitution of consumption is $\theta = 0.95$.

[13]Data from the UK and Austria show that decisions are taken on average between 1-3 years (Hewett, 2021; Asylkoordination Österreich, 2022).

[14]The net national income per capita in 2020 (in USD) was on average \$1,648 in source countries (\$475 in Afghanistan, \$1,999 in Bangladesh, \$3,046 in Iraq, \$1,070 in Pakistan), \$3,197 in potential host countries (\$3,640 in Libya, \$3,263 in Tunisia, \$2,687 in Morocco) and \$29,660 in final destination countries (\$38,426 in Germany, \$31,682 in France, \$22,545 in Spain, \$25,986 in Italy).

[15]The EU recognition rate in the first instance was 42% in 2020, 34% in 2021 and 39% in 2022 (European Union Agency for Asylum, 2021, 2022, 2023).

4.1. Equal interest rates across countries

Firstly, we look at the simpler case where interest rates equal across countries. Figure 4.1 shows the relationship between net migration costs and lifetime welfare for all alternatives, with the other parameters kept at their benchmark levels. Curve A represents the expected discounted utility of direct migration to the EU, curve B the expected discounted utility of migration to the host country and curve C the expected discounted utility of not migrating. As $r = r^* = \rho$, the consumption rates of all options remain constant in each period. We assume that $\tilde{K}$ is the same for option A and option B, although it is plausible to assume lower costs for the less risky option. As $\tilde{w} = 1$, we can think of the net cost of migration as years of work at the home country wage. This helps us to understand how much migration costs in relation to the wage level in the source country. The net cost of migration is defined as $K = \tilde{K} - A_0$, and a negative value of K essentially means having savings.

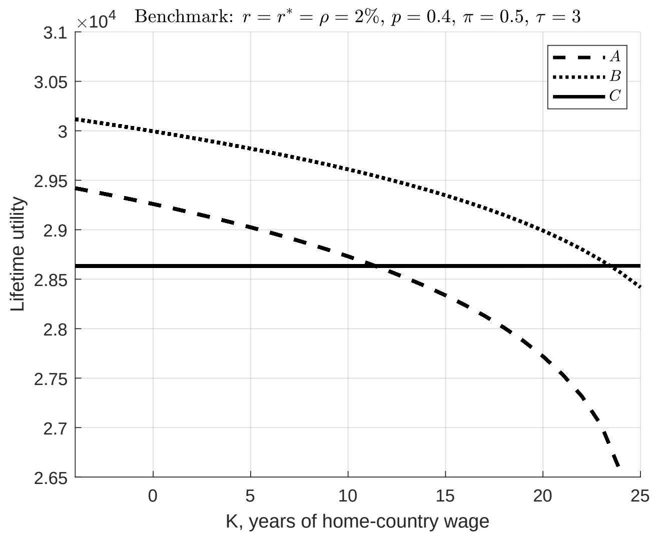

Figure 4.1.: Optimal lifetime utilities over net migration cost, $r = 2\%$ p.a.

Both option A and option B are decreasing functions of K because paying off high migration costs means that the migrant must reduce her consumption and thus her expected lifetime utility. Given these parameters, the migrant favours option B over option A for all given values of K as $U^B > U^A$. Direct migration is associated with two uncertainties, which makes option B more appealing compared to option A. Note that in our setting 10 years of wages in her home country is equivalent to 1 year of wages in the EU. Therefore, she prefers the option that offers a greater chance of getting into the EU and receiving asylum there, because she then benefits from a higher wage. In addition, she benefits from the wage level in the host country that is higher than the amount she receives during her stay in the asylum centre. Option C is independent of K and hence constant. The migrant considers staying in the source country more attractive than migration only if the costs of migration are very high.

In Figure 4.2 we look at the conditions under which the migrant is indifferent among the given alternatives. The horizontal axis represents the ratio between the migration cost and the wage in the home country, the vertical axis the ratio between the EU and the home country wage. The curves represent combinations of $K/\tilde{w}$ and $w^*/\tilde{w}$ for which both options provide her with the same expected utility, making her indifferent between them. All parameters are set to their benchmark values.

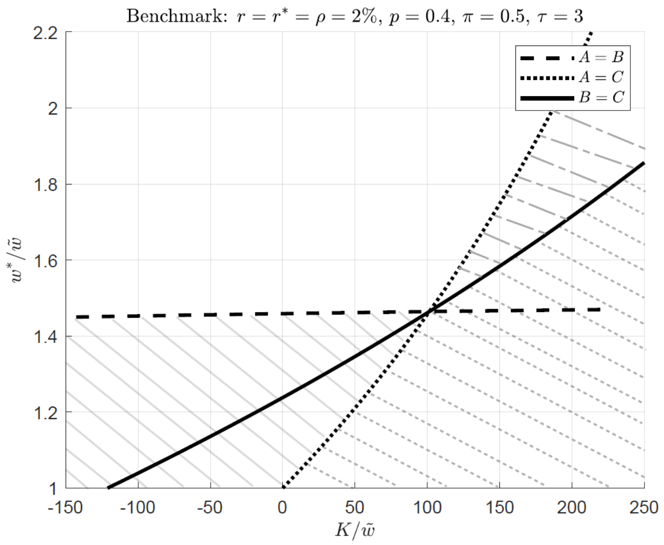

Figure 4.2.: Equal lifetime utilities, $r = r^* = \rho$.

The path where $A = C$ shows all the points where direct migration to the EU brings the same utility level as not migrating at all. Moving to the left and above the curve $A = C$, option A is preferable to option C. As long as migration is not too costly and the migrant can benefit from higher wages abroad, $U^A > U^C$. Conversely, in the area to the right and below the curve, K increases and the migrant is better off not undertaking the migration process. A similar interpretation holds for the path where $B = C$, i.e., where a move to the host country yields the same utility as staying in the country of origin. For any combination of $w^*/\tilde{w}$ and $K/\tilde{w}$ in the region above the path $B = C$, option B is more favorable than option C and vice versa. Note that U^C is in fact independent of K and w^*, but changes in these variables affect the values of both U^A and U^B compared to U^C.

A path where option A and option B have equal levels of utility, i.e., $U^A = U^B$, seems almost perfectly elastic with respect to the wages ratio. For each point above the curve, $U^A < U^B$, which means that direct migration to the EU is less favourable than migration to the host country and vice versa. We have seen in Figure 4.1 that for our given set of parameters, option B is always better than option A and there is no intersection between them. This means that the only way to find a path where $U^A = U^B$ holds is to lower w^*/w to the point where option B is just as attractive as the other option. Both options yield the same lifetime utility for only a small range of wage ratios, irrespective of migration costs. This results in a graph illustrating the path at a very low and unrealistic EU to home country wage ratio.

The graph helps us determine which option the migrant prefers for given combinations of w^* and K. Staying in the source country is optimal in the dotted region under the curves $A = C$ and $B = C$. This suggests that an individual chooses not to migrate if wages abroad are relatively low, she faces high migration costs and is subsequently burdened with paying them. In the area marked by the diagonal lines below the $A = B$ curve and to the left of the $A = C$ curve, the migrant chooses to migrate directly to the EU. This option is optimal only for small w^* and K, i.e., if the migrant leaves with savings or if migration costs are very low.

Once EU wages rise, migration to the host country becomes more profitable. The non-dashed part of the graph shows the combinations of K and w^* where the migrant switches from option A to option B when option B is available. As a result, more migrants are opting for the legal route through the host settlement, which reduces illegal migration. We see that increasing K reduces the attractiveness of direct migration, but migration to the host country is still optimal at relatively low wages and a large range of costs, which speaks in favor of our proposed solution. Option B is also optimal in the area with dash-dotted lines. This region shows combinations of K and w^* where the migrant chooses to migrate when option B is available because she would rather not migrate if option B did not exist.

4.2. Different interest rates across countries

In this part, we assume $r > r^* = \rho$ such that both the home and host country interest rates are $r = 10\%$ p.a. and the EU interest rate is equal to the time preference rate $r^* = \rho = 2\%$ p.a. Figure 4.3 shows similar results to the case of the equal interest rates while holding the parameters at their benchmark values. Option B is preferred over option A for any migration cost, but when K increases, migration no longer pays. In this case, the migrant switches from option A and option B to C at lower cost values than in the first example, respectively. This change is due to the increase in the interest rate in the home country. The interest rate is higher than the time preference rate and the individual now has an increasing rate of consumption over time. In other words, she smooths consumption by saving in the early periods and consuming later.

Figure 4.4 shows the combination of $w^*/\tilde{w}$ and $K/\tilde{w}$ for which the options have the same lifetime utilities. We use the same parameter values as in Figure 4.2, except that we set the interest rate to $r = 10\%$ in both the home and host countries. Since option A is an increasing function of w^* and a decreasing function of K, this option is preferred in the

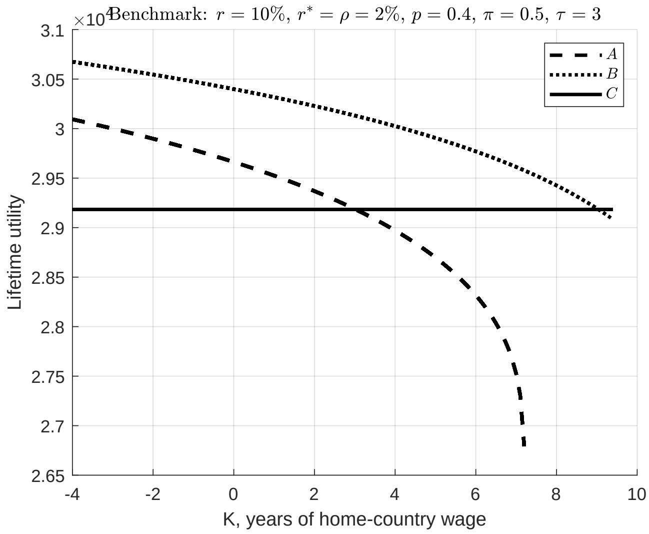

Figure 4.3.: Optimal lifetime utilities over migration costs, $r = 10\%$ p.a.

area to the left of the $A = C$ curve where the welfare of direct migration and no migration is equal. On the other hand, with low wage ratios and rising migration costs, it is more attractive to stay in the home country. The same interpretation applies to the curve $B = C$, where option B is more advantageous in the area to the left of the curve and vice versa. The path $A = B$ shows the combinations of cost and wage ratios for which $U^A = U^B$ holds. In the area above the path, migration to the host country dominates over direct migration, and $U^A > U^B$ in the area below the path. The migrant gains more utility from option B at a high wage ratio and higher migration costs relative to option A. Again, the line is relatively flat because the utility values of the two options intersect only at low $w^*/\tilde{w}$ ratios.

The dotted area indicates the area where no migration is optimal and the diagonal lines represent the part where direct migration is preferred. The change in home and host country interest rates increases the attractiveness of staying in the home country at very low migration costs, even for an individual with savings, as she can benefit from higher r in the source country without having to pay of migration costs. Migration is now more costly and only the individual with sufficient savings opts for direct migration. Note that direct migration poses a higher risk, and if migration to the EU fails, she has to return and still pay back the costs of migration. The repayment in the home country takes longer than in the EU because she only earns $w < w^*$, so she migrates with enough savings to avoid this particular long repayment process.

Migration to the host country is optimal in the unshaded area, which represents migrants who prefer migrating to the host country over direct migration when option B is offered. The same applies to the dash-dotted region, which represents additional migrants who would not migrate if option B were not possible. At higher wage rates, the migrant prefers

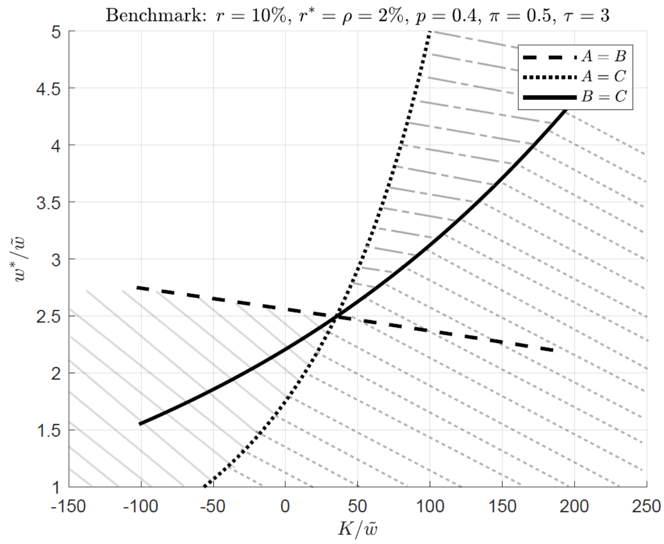

Figure 4.4.: Equal lifetime utilities, $r > r^* = \rho$.

option B because the costs of migration are easier to repay. However, moving to the host country with rising K is only optimal if the EU wage also increases, otherwise migration is not worthwhile.

Our analysis confirms what policymakers apply when tackling high migration numbers, namely that increasing K, for example by spending more on border security, reduces the attractiveness of migration and is likely to attract fewer individuals. We also conclude that wealthier individuals with more savings choose the riskier option, option A, if wages are relatively low in the EU. These individuals switch to the safer option once w^* increases. The safer option is also more attractive to poorer individuals who need to borrow to pay for migration costs, but only if they earn enough in the EU to pay for migration costs.

4.3. Consumption rates over time

Since $r > r^* = \rho$, we no longer have only constant consumption rates, and in this section we are interested in their development over time. The figures illustrate the consumption rates on the y-axis and the time in years on the x-axis. We set the cost of migration at 5-year home country wage, $\tilde{K} = 5 \cdot 52$. Option A involves four possible consumption paths and their development is shown in Figure 4.5. Firstly, if a migrant reaches the EU, she receives a constant subsidy for consumption for τ units of time in the asylum centre and has no opportunity to save in this period. Once the EU grants her asylum, her consumption increases significantly and remains constant until the end of her planning horizon. If rejected, she returns to her country of origin at time τ. Her consumption drops upon return, but then increases over time. Secondly, the migrant fails to enter the EU. She spends her whole life in her home country, while her consumption rate increases over time. In Figure 4.6 we analyse how the consumption rates for option B evolve over time. The migrant spends τ units of time in the host country settlement and enjoys an increasing consumption over time there. In the event of a move to the EU, her consumption jumps up and remains constant until time T. In case of denial of asylum, her consumption decreases initially, but later increases over time.

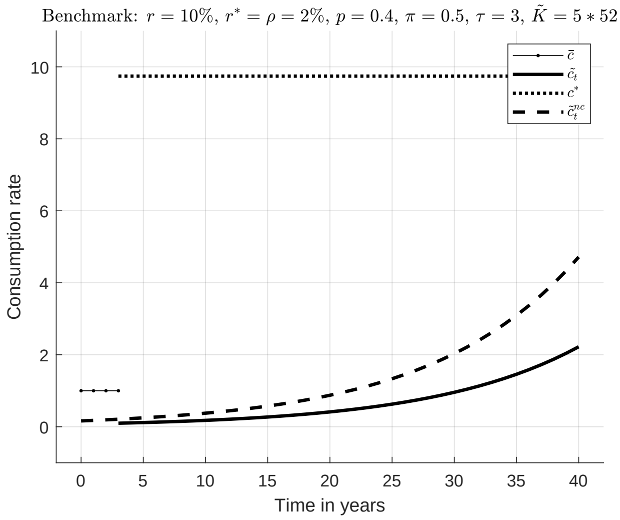

Figure 4.5.: Consumption rates over time, option A.

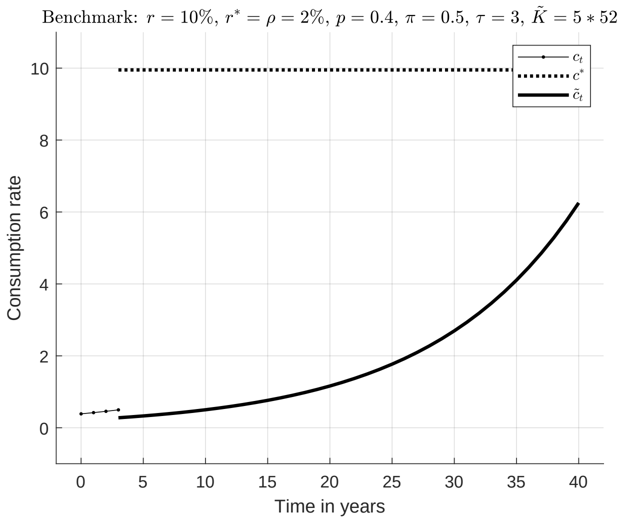

Figure 4.6.: Consumption rates over time, option B.

Our assumption $r > \rho$ explains why consumption rates increase over time. When the interest rate is higher than the time preference rate, the migrant aims to save more and consume less in the first periods in order to accumulate savings that she can enjoy later. However, this reasoning does not hold for the period she is in the EU, where the interest rate is equal to her time preference and she is indifferent between consumption and savings. Thus, her consumption is smoothed and constant throughout the period.

4.4. Changes in wages

One of the key parameters of our model that we want to analyze in more detail is the wages in the host country and in the EU, as they significantly affect the migrant's utility and her subsequent choice. First, we look at wage changes in the host country. The wage in the host country is defined as a share of the EU wage, $w = \sigma w^*$, and affects only option B. In Figure 4.7, we look at scenarios where the host country wage corresponds to 10%, 20% and 50% of the EU wage, respectively. An increase in σ, which in turn increases the wage in the host country, improves the lifetime utility of option B and vice versa.

It is interesting to see that even though the migrant obtains this wage for quite a short period of 3 years, the increase in the utility is quite substantial. It is due to the fact that she consumes only a small amount in the first period, as we saw in Figure 4.6, and accumulates savings during the first period and then receives interest r on these savings. Based on actual data about wages, we assumed $\sigma = 20\%$ in the previous examples and it is then questionable whether an increase in this parameter is realistic.

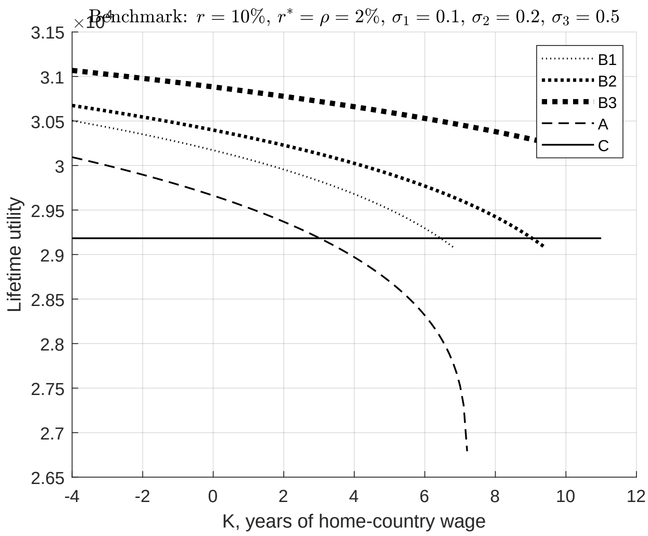

Figure 4.7.: Variation in σ.

Second, we analyze the changes in the EU wage. As we can see in Figure 4.8, both options A and B are increasing functions of w^* and positive parameter change leads to welfare gains for both options, but the effect is more pronounced for option B. The first reason is that option A contains two types of uncertainties and the migrant is more likely to end up back in the home country, while option B contains only one uncertainty. Therefore, option B is associated with a higher probability of settling in the EU and receiving a given wage there. The second reason is that the wage in the host country also increases because it is a fraction of the EU wage. Thus, the change in w^* affects the migrant positively in two periods and makes the change in lifetime utility larger than in option A. It is clear that the uncertainties in our model have a large impact on the expected utility of the migrant, as an increase in the EU wage yields only a moderate increase in expected utility for option A. This is because the migrant has to account for uncertainty about whether she will safely make the journey to the EU, unlike in option B, which guarantees a safe journey to the host country.

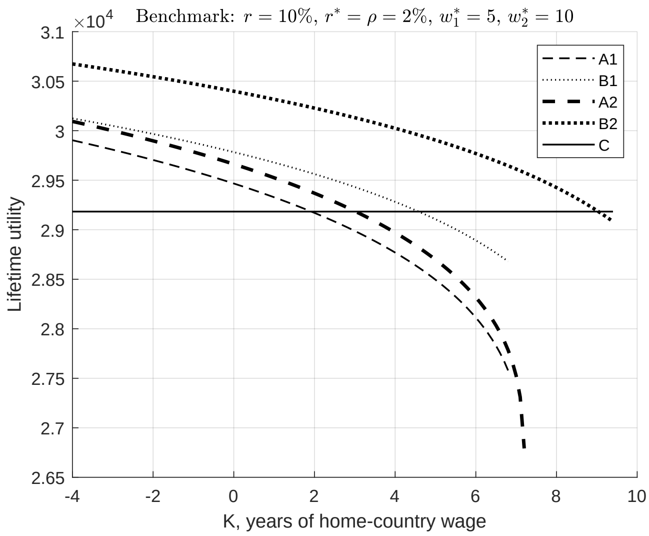

Figure 4.8.: Variation in the EU wage.

4.5. Interest rates and rate of time preference

So far, we have assumed that $r = 10\%$ and $r^* = \rho = 2\%$.[16] In this section we want to analyse how the utility level changes with variations in these rates. First, we change the values of r^* and ρ, keeping $r = 10\%$. Our simulations use relatively low values of r^* based on average interest rates in the EU. Figure 4.9 shows expected lifetime utilities as a function of net migration costs for values $r_1^* = \rho_1 = 1\%$ and $r_2^* = \rho_2 = 2\%$. The graph implies that the lifetime utility increases with decreasing values of r^* and ρ for all options. Recall that the consumption rate of a migrant in a period when $r > \rho$ is increasing over time. At lower values of ρ, the migrant is more patient and therefore prefers to postpone

[16]All interest rate values are given per annum.

consumption to a later period. As a result, she saves more in the early periods at interest r, which contributes to higher utility.

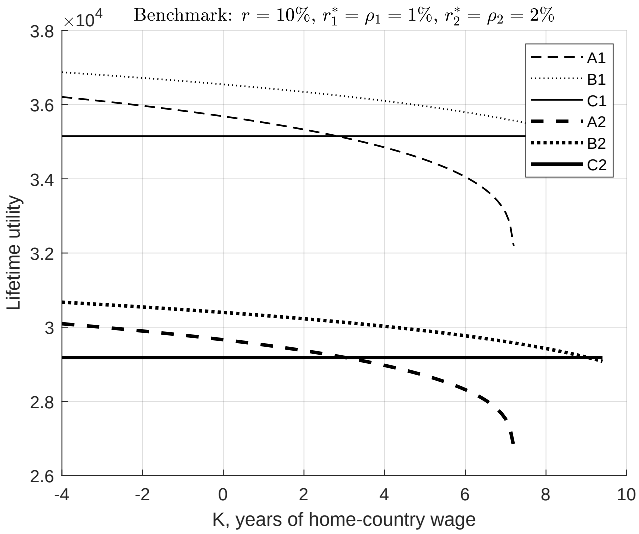

Figure 4.9.: Variation in r^* and ρ.

Second, we fix $r^* = \rho = 2\%$ and change the values of the home and host country interest rate to $r_1 = 10\%$ and $r_2 = 20\%$, respectively. As we can see in Figure 4.10, an increase in r has a positive effect on the utility values of all options. The explanation of this effect lies again in the assumption $r > \rho$. The level of utility jumps at higher r because it is now even more profitable for the migrant to save in the early periods, lend the savings at the rate r and consume later. Also, the curves shift with increasing r, causing changes in migrant's preferences for different levels of K. If the migrant decides to stay in her home country, she takes advantage of the high interest rate of r and lends at this high rate. In contrast, migration is very costly at high rate of r. For $K > 0$, the migrant borrows money in her home country and has to pay interest there. Therefore, option C is more profitable than the other options already at very low values of K.

4.6. EU border enforcement and immigration policy

In our model, expected lifetime utility is mainly influenced by EU immigration policies such as strengthening border controls or implementing quotas for migrants. These can affect the rate of asylum recognition (p), the overall travel security rate (π), the cost of migration ($\tilde{K}$), the resources available to asylum centres ($\bar{c}$) or the length of asylum decisions (τ). Changes in these parameters have a significant impact on migrants, who must take them into account when making migration decisions.

Firstly, we look at variations of both p and π. We leave the other parameters at

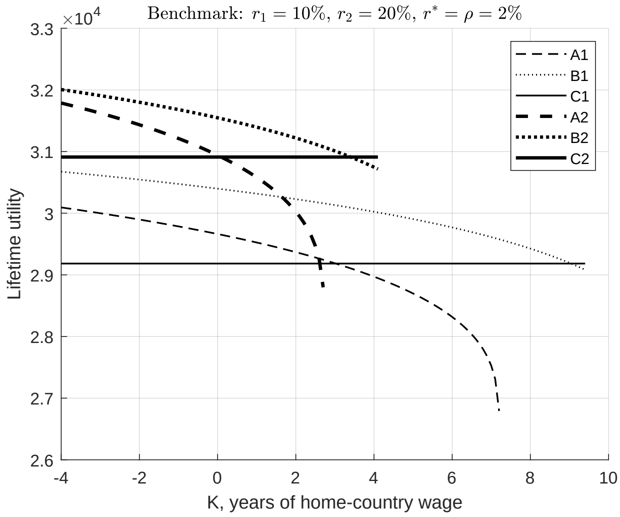

Figure 4.10.: Variation in r.

their benchmark values and assume the more general case $r > r^* = \rho$. Figure 4.11 shows the expected utility values for the range of K. We show two different scenarios for the probability of obtaining asylum in the EU: a low acceptance rate $p_1 = 0.2$ and a high acceptance rate $p = 0.8$. Since both U^A and U^B are increasing functions of p, the utility of both options increases with higher values of p. Option C remains constant as it is independent of p.

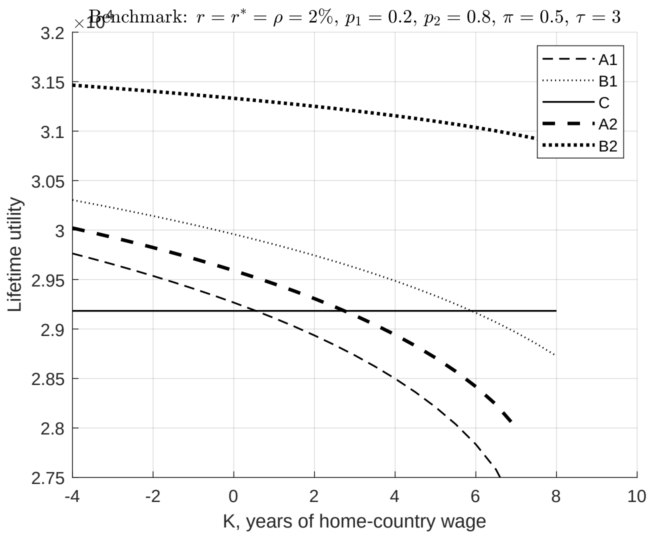

Figure 4.11.: Variation in probability p.

Consistent with our previous results, option B is always preferred over option A regardless of the migration cost, but we see that option B is more responsive to the parameter change. Options A and B intersect with option C at lower levels of migration costs as p falls. If a migrant expects a relatively low level of recognition in the EU, and at the same time has to pay high K, she rather refrains from migrating and stays in her source country.

Secondly, we discuss the results of differences in the probability of successful transition in the EU for $\pi_1 = 0$, $\pi_2 = 0.5$ and $\pi_3 = 1$. As we can see in Figure 4.12, changing this parameter impacts only option A, while the others remain unaffected. The parameter π indicates the probability of successfully crossing the EU border, which can also be translated as the level of safety of the journey. Higher values of π make the journey safer and thus increase the expected lifetime utility of direct migration. Nevertheless, for any probability π, option B still provides greater utility than option A.

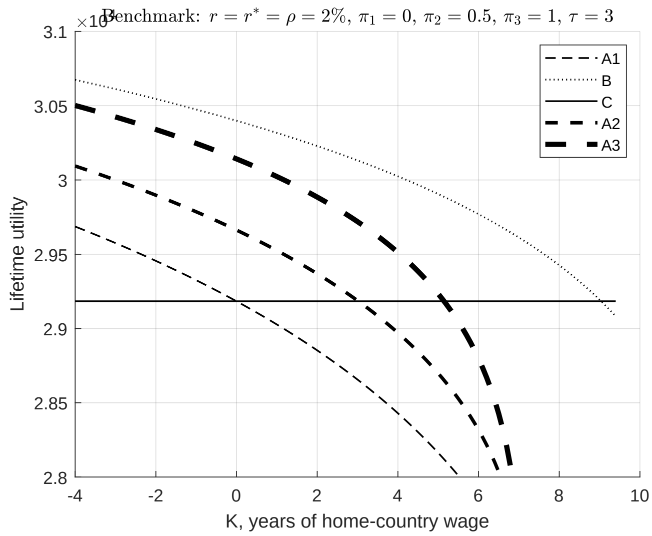

Figure 4.12.: Variation in probability π.

Next, we focus on the parameter τ and its possible consequences. In the previous examples, we set the length of the asylum decision to 3 years. Now we examine how the result develops with a shorter duration of 6 months and a longer duration of 5 years, i.e., $\tau_1 = 0.5 \cdot 52$ and $\tau_2 = 5 \cdot 52$. Figure 4.13 illustrates the lifetime utility over K, where the thinner lines represent τ_1 and the thicker lines represent τ_2. Option A provides more benefits for shorter length of time in comparison to the longer duration. Therefore, migrants prefer to spend the least amount of time possible in the asylum centre. The reason for this is that they only receive a constant consumption subsidy and cannot accumulate savings during this period. Interestingly, at high values of K, it is more profitable for a migrant to wait longer for an asylum decision if they choose option B. Due to $r > \rho$, she consumes less during the first periods and accumulates savings while waiting for the asylum decision in the host country. Later, she lends the savings at the interest rate r and enjoys them in the later periods.

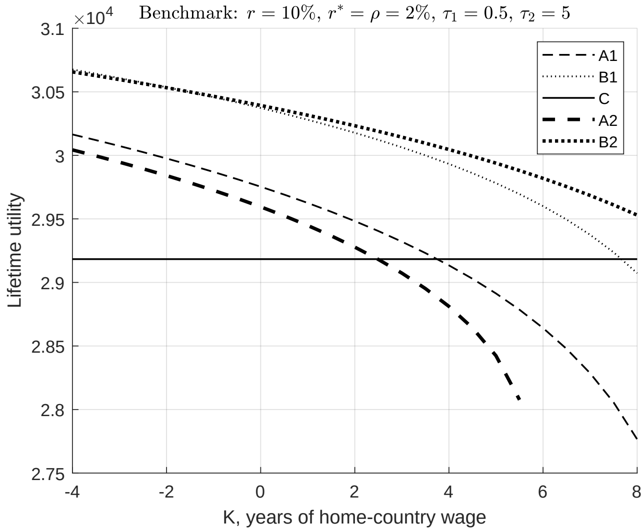

Figure 4.13.: Length of the asylum decision process τ.

Lastly, we discuss the change in $\bar{c}$ and its implications. The value of consumption in the asylum centre affects only option A from time $t = 0$ to $t = \tau$. The utility U^A is obviously an increasing function of $\bar{c}$, thus increasing the value improves lifetime welfare. However, this effect is not big enough in magnitude to change preferences.

As might be expected, loosening border controls and improving migration policies bring greater welfare to migrants. In all our scenarios, moving to the host country is preferred to direct migration and also to no migration unless the costs are very high. One key finding is that a poorer migrant who has to repay a large amount of K prefers to stay in the host country longer before receiving an asylum decision. This is good for the migrants, who can earn money to pay off their debt, and for the EU institutions, because they are not under pressure to make quick asylum decisions.

5. Conclusion

The high influx of undocumented migrants arriving in the EU seeking asylum is not sustainable and poses a challenge to the EU authorities, the EU receiving countries and the migrants themselves. We propose a solution to tackle this issue by offering migrants a safer option to move temporarily to a host settlement with the prospect of earning income while waiting for an asylum decision. In order to determine whether a potential migrant would be interested in this option at all, we model three scenarios from the migrant's perspective and explain how their preferences change under which conditions.

The main contribution of this thesis is the modelling of an innovative solution to the current migration problem and its comparison with existing options. In particular, we incorporate uncertainties into our expected utility maximization model, which is based on models concerning transit and undocumented migration, and extend the model with more realistic assumptions about interest rates and the time preference rate.

We find that direct migration to the EU is the optimal choice only if migration costs are very low or negative, i.e., the migrant has savings, and if the wage in the EU is relatively low compared to the wage in the home country. Otherwise, the results speak in favour of our proposed solution and moving to the host country is always preferred to direct migration to the EU. One reason for this is that migrants prefer less uncertainty when choosing between migration options and that option A poses a high risk of returning home, with the costs of migration being paid for by low wages in the home country. Interestingly, option A is not optimal even if we assume that the journey to the EU is perfectly safe and the migrant faces only uncertainty about her asylum claim. This stems from the circumstances that occur in the first period, as receiving a consumption subsidy in an asylum centre without the possibility to save makes this option less attractive. The ratio of wages in the migrant's home and destination country also plays an important role. If the costs of migration are high, a migrant will only make the journey if it is profitable and if she can earn a higher wage abroad. The wealth of the individual also matters, as it is easier for richer people to accumulate savings to pay for migration. If her savings exceed or equal the cost of migration, she does not necessarily have to migrate to a relatively rich country to achieve a high income because she does not have to repay the costs.

Our findings also provide interesting but rather intuitive insights for EU immigration policy. If policymakers try to reduce the influx of newcomers, they can increase border controls to make it more expensive for migrants to cross the border. As a result, they prefer not to migrate and stay in their home country. On the other hand, approving more asylum applications and improving conditions in asylum centres is encouraging more migrants to leave their country of origin and migrate to the EU. Another parameter that EU policy can influence is the length of asylum decisions. Migrants who have opted for direct migration to the EU want to know the decision as soon as possible so that they can move out of the asylum centre, where they only receive a subsistence allowance. In contrast, migrants who move to a host settlement find it more advantageous if the decision takes longer, as they can already earn a certain wage in the settlement and have the opportunity to accumulate savings.

Our model uses a few simplifying assumptions that can be relaxed by several extensions of the model. For example, it is possible to include the pre-migration period or to let the migrant stay permanently in the host country, as we examine in the Appendix A.3. It would also be interesting to include the possibility of return migration to the source country, as often happens in reality. From a theoretical point of view, the proposed idea of temporary settlement in the host country is preferable to direct migration, but it is more of a political question how realistic this scenario is.

Bibliography

Amnesty International. EU: Anniversary of Turkey deal offers warning against further dangerous migration deals, Aug 2022. URL https://www.amnesty.org/en/latest/press-release/2021/03/eu-anniversary-of-turkey-deal-offers-warning-against-further-dangerous-migration-deals/.

E. Artuc and C. Ozden. Transit migration: all roads lead to America. *The Economic Journal*, 128(612):F306–F334, 2018.

Asylkoordination Österreich. Regular procedure - asylum information database: European council on refugees and exiles, April 2022. URL https://asylumineurope.org/reports/country/austria/asylum-procedure/procedures/regular-procedure/#_ftn1.

Frontex. Risk analysis for 2019, 2019. URL https://data.europa.eu/doi/10.2819/86682.

M. Collyer. Stranded migrants and the fragmented journey. *Journal of Refugee Studies*, 23(3):273–293, 2010.

M. Collyer and H. De Haas. Developing dynamic categorisations of transit migration. *Population, Space and Place*, 18(4):468–481, 2012.

Council of the EU. Asylum applications in the EU - Consilium, n.d. URL https://www.consilium.europa.eu/en/infographics/asylum-applications-eu/.

M. Czaika. The political economy of refugee migration. *Jahrbücher für Nationalökonomie und Statistik*, 229(6):803–824, 2009.

H. De Haas. The determinants of international migration. 2011.

S. Djajić. Asylum seeking and irregular migration. *International Review of Law and Economics*, 39:83–95, 2014.

S. Djajić. Transit migration. *Review of International Economics*, 25(5):1017–1045, 2017.

S. Djajić and M. S. Michael. Controlling illegal immigration: On the scope for cooperation with a transit country. *Review of International Economics*, 22(4):808–824, 2014.

S. Djajić and A. Vinogradova. Liquidity-constrained migrants. *Journal of International Economics*, 93(1):210–224, 2014.

S. Engel and A. M. Ibáñez. Displacement due to violence in Colombia: A household-level analysis. *Economic development and cultural change*, 55(2):335–365, 2007.

P. Esaiasson, N. Lajevardi, and J. Sohlberg. Reject, limbo, and accept: the effect of migration decisions on asylum seekers. *Journal of Ethnic and Migration Studies*, pages 1–15, 2022.

European Commission. Statistics on migration to Europe, 2022. URL `https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/promoting-our-european-way-life/statistics-migration-europe_en`.

European Union Agency for Asylum. Easo asylum report 2021. 2021.

European Union Agency for Asylum. Latest asylum trends - annual overview 2021, Apr 2022. URL `https://euaa.europa.eu/latest-asylum-trends-annual-overview-2021`.

European Union Agency for Asylum. Latest asylum trends, Jan 2023. URL `https://euaa.europa.eu/latest-asylum-trends-asylum`.

Eurostat. Annual asylum statistics, Nov 2022. URL `https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Annual_asylum_statistics&oldid=584073#Age_and_sex_of_first-time_applicants`.

J. Hainmueller, D. Hangartner, and D. Lawrence. When lives are put on hold: Lengthy asylum processes decrease employment among refugees. *Science advances*, 2(8):e1600432, 2016.

J. R. Harris and M. P. Todaro. Migration, unemployment and development: a two-sector analysis. *The American economic review*, 60(1):126–142, 1970.

M. Heeren, J. Mueller, U. Ehlert, U. Schnyder, N. Copiery, and T. Maier. Mental health of asylum seekers: a cross-sectional study of psychiatric disorders. *BMC psychiatry*, 12 (1):1–8, 2012.

A. Hewett. Living in limbo: A decade of delays in the UK asylum system. 2021. URL `https://www.refugeecouncil.org.uk/wp-content/uploads/2021/07/Living-in-Limbo-A-decade-of-delays-in-the-UK-Asylum-system-July-2021`.

IOM. Mediterranean: Missing migrants project, 2023. URL `https://missingmigrants.iom.int/region/mediterranean`.

IRC. What is the EU-turkey deal?, 2022. URL `https://eu.rescue.org/article/what-eu-turkey-deal`.

J. Kennan and J. R. Walker. The effect of expected income on individual migration decisions. *Econometrica*, 79(1):211–251, 2011.

K. Koser. Why migrant smuggling pays. *International Migration*, 46(2):3–26, 2008.

K. Kuschminder, J. De Bresser, and M. Siegel. Irregular migration routes to Europe and factors influencing migrants' destination choices. *Maastricht: Maastricht Graduate School of Governance*, pages 8–20, 2015.

D. Kyle and Z. Liang. Migration merchants: human smuggling from ecuador and china. 2001.

S. W. Polachek and F. W. Horvath. A life cycle approach to migration: Analysis of the perspicacious peregrinator. *35th Anniversary Retrospective*, page 349, 2012.

P. Schaeffer. Refugees: on the economics of political migration. *International Migration*, 48(1):1–22, 2010.

L. A. Sjaastad. The costs and returns of human migration. *Journal of political Economy*, 70(5, Part 2):80–93, 1962.

Statista. EU illegal border crossings 2021, Nov 2022. URL `https://www.statista.com/statistics/454775/number-of-illegal-entries-between-bcps-to-the-eu/`.

UNHCR. Global trends report 2021, 2021. URL `https://www.unhcr.org/publications/brochures/62a9d1494/global-trends-report-2021.html`.

Vienna Forum for Democracy and Human Rights. An alternative to "fortress Europe" and temporary protection in the event of mass flight, 2022. URL `https://www.humanrights.at/en/temporary-protection/`.

World Bank. Adjusted net national income per capita (current US$), 2020. URL `https://data.worldbank.org/indicator/NY.ADJ.NNTY.PC.CD?most_recent_value_desc=false`.

A. Appendix

A.1. Analytic solution of the optimization problem if $r = r^* = \rho$

In the first case, we assume $r = r^* = \rho$ to derive consumption rates and expected discounted lifetime welfare.

A.1.1. Option A - direct migration to the EU

We begin with option A, which is direct migration to the EU. The Lagrangian function for successful entry into the EU and the granting of asylum is given by

$$L = \int_{\tau}^{T} u(c_t^*)e^{-\rho(t-\tau)}dt + \lambda \left\{ \int_{\tau}^{T} (w^* - c_t^*)e^{-r^*(t-\tau)}dt - Ke^{r\tau} \right\}. \tag{A.1}$$

The first-order condition with respect to the consumption rate c_t^* is:

$$\frac{\partial L}{\partial c_t^*} = u'(c_t^*)e^{-\rho(t-\tau)} - \lambda e^{-r^*(t-\tau)} = 0. \tag{A.2}$$

We use the CRRA utility function and obtain a constant consumption rate for this period:

$$u'(c_t^*) = \lambda \Leftrightarrow c_t^* = c^* = \lambda^{-\frac{1}{\theta}}. \tag{A.3}$$

By using this in the budget constraint (2.3), we solve for the consumption rate

$$c^* = w^* - \frac{r^*K}{e^{-r^*\tau} - e^{-r^*T}}. \tag{A.4}$$

The Lagrangian function for the successful entry into the EU and the rejected asylum application is given by

$$L = \int_{\tau}^{T} u(\tilde{c}_t)e^{-\rho(t-\tau)}dt + \lambda \left\{ \int_{\tau}^{T} (\tilde{w} - \tilde{c}_t)e^{-r(t-\tau)}dt - Ke^{r\tau} \right\}. \tag{A.5}$$

The first-order condition with respect to the consumption rate $\tilde{c}_t$,

$$\frac{\partial L}{\partial \tilde{c}_t} = u'(\tilde{c}_t)e^{-\rho(t-\tau)} - \lambda e^{-r(t-\tau)} = 0, \tag{A.6}$$

together with the assumption $r = r^* = \rho$ implies a constant consumption rate, which we use it in the budget constraint (2.7) to derive the optimal consumption rate

$$\tilde{c} = \tilde{w} - \frac{rK}{e^{-r\tau} - e^{-rT}}. \tag{A.7}$$

The Lagrangian function for the unsuccessful transition to the EU is given by

$$L = \int_0^T u(\tilde{c}_t^{nc}) e^{-\rho t} dt + \lambda \left\{ \int_0^T (\tilde{w} - \tilde{c}_t^{nc}) e^{-rt} dt - K \right\} \tag{A.8}$$

and the first order condition with respect to the consumption rate $\tilde{c}_t^{nc}$,

$$\frac{\partial L}{\partial \tilde{c}_t^{nc}} = u'(\tilde{c}_t^{nc}) e^{-\rho(t-\tau)} - \lambda e^{-r(t-\tau)} = 0, \tag{A.9}$$

again implies that $\tilde{c}_t^{nc}$ is constant. Plugging this into the budget constraint (2.11) gives an optimal consumption rate

$$\tilde{c}^{nc} = \tilde{w} - \frac{rK}{1 - e^{-rT}}. \tag{A.10}$$

A.1.2. Option B - migration to the host country

We now show the derivations for option B, i.e., migration to the host country. The Lagrangian function for the case of asylum in the EU is as follows:

$$L = \int_\tau^T u(c_t^*) e^{-\rho(t-\tau)} dt + \lambda \left\{ \int_\tau^T (w^* - c_t^*) e^{-r^*(t-\tau)} dt + A_\tau - K e^{r\tau} \right\}. \tag{A.11}$$

The first-order condition with respect to c_t^* is

$$\frac{\partial L}{\partial c_t^*} = u'(c_t^*) e^{-\rho(t-\tau)} - \lambda e^{-r^*(t-\tau)} = 0. \tag{A.12}$$

The consumption rate is constant and we use in the budget constraint (2.17) to derive the optimal consumption

$$c^* = w^* - \frac{r^*(K - A_\tau e^{-r\tau})}{e^{-r^*\tau} - e^{-r^*T}}. \tag{A.13}$$

The Lagrangian function for the case of rejected asylum in the EU is given by:

$$L = \int_\tau^T u(\tilde{c}_t) e^{-\rho(t-\tau)} dt + \lambda \left\{ \int_\tau^T (\tilde{w} - \tilde{c}_t) e^{-r(t-\tau)} dt + A_\tau - K e^{r\tau} \right\}. \tag{A.14}$$

First order condition with respect to $\tilde{c}_t$,

$$\frac{\partial L}{\partial \tilde{c}_t} = u'(\tilde{c}_t) e^{-\rho(t-\tau)} - \lambda e^{-r(t-\tau)} = 0, \tag{A.15}$$

indicates the constant consumption rate that we apply in the budget constraint (2.21) to obtain the optimal consumption

$$\tilde{c} = \tilde{w} - \frac{r(K - A_\tau e^{-r\tau})}{e^{-r\tau} - e^{-rT}}. \tag{A.16}$$

We derive the optimal consumption rate for the first period, c, given constant consumption in later periods. The consumption rates c^* and $\tilde{c}$ depend on A_τ, which is a function of c. The Lagrangian function for the first period is then given by:

$$\begin{aligned} L = & \int_0^\tau u(c)e^{-\rho t}dt + p\int_\tau^T u(c^*(c))e^{-\rho t}dt + (1-p)\int_\tau^T u(\tilde{c}(c))e^{-\rho t}dt + \\ & + \lambda\left\{\int_0^\tau (w-c)e^{-rt}dt + p\int_\tau^T (w^*-c^*(c))e^{-r^*t}dt + \right. \\ & \left. +(1-p)\int_\tau^T (\tilde{w}-\tilde{c}(c))e^{-rt}dt - K\right\}. \end{aligned} \tag{A.17}$$

The first order condition with respect to c looks as follows:

$$\begin{aligned} \frac{\partial L}{\partial c} = & u'(c)\left(\frac{1-e^{-\rho\tau}}{\rho}\right) + pu'(c^*(c))\frac{\partial c^*(c)}{\partial c}\left(\frac{e^{-\rho\tau}-e^{-\rho T}}{\rho}\right) + \\ & + (1-p)u'(\tilde{c}(c))\frac{\partial \tilde{c}(c)}{\partial c}\left(\frac{e^{-\rho\tau}-e^{-\rho T}}{\rho}\right) - \lambda\left\{\left(\frac{1-e^{-r\tau}}{r}\right) + \right. \\ & \left. + p\frac{\partial c^*(c)}{\partial c}\left(\frac{e^{-r^*\tau}-e^{-r^*T}}{r^*}\right) + (1-p)\frac{\partial \tilde{c}(c)}{\partial c}\left(\frac{e^{-r\tau}-e^{-rT}}{r}\right)\right\} = 0. \end{aligned} \tag{A.18}$$

To derive $\frac{\partial c^*(c)}{\partial c}$, we plug A_τ from the equation (2.15) into the expression c^* in the equation (2.18) and derive with respect to c:

$$\frac{\partial c^*(c)}{\partial c} = \frac{e^{-r^*\tau}-1}{e^{-r^*\tau}-e^{-r^*T}}. \tag{A.19}$$

Similarly, for $\frac{\partial \tilde{c}(c)}{\partial c}$, we plug A_τ into the consumption rate $\tilde{c}$ in the equation (2.22) and derive:

$$\frac{\partial \tilde{c}(c)}{\partial c} = \frac{e^{-r\tau}-1}{e^{-r\tau}-e^{-rT}}. \tag{A.20}$$

Assuming that $r = r^* = \rho$, then $\frac{\partial c^*(c)}{\partial c} = \frac{\partial \tilde{c}(c)}{\partial c}$ and from the FOC we express $u'(c)$:

$$u'(c) = pu'(c^*) + (1-p)u'(\tilde{c}). \tag{A.21}$$

This expression then gives us the consumption for the first period

$$c = \left[pc^{*-\theta} + (1-p)\tilde{c}^{-\theta}\right]^{-\frac{1}{\theta}}. \tag{A.22}$$

A.1.3. Option C - no migration

Finally, we derive the optimal consumption rate for option C, i.e., no migration. The Lagrangian function for the problem is given by

$$L = \int_0^T u(\tilde{c}_t)e^{-\rho t}dt + \lambda\left\{A_0 + \int_0^T (\tilde{w}-\tilde{c}_t)e^{-rt}dt\right\}. \tag{A.23}$$

The first-order condition is

$$\frac{\partial L}{\partial \tilde{c}_t} = u'(\tilde{c}_t)e^{-\rho t} - \lambda e^{-rt} = 0. \tag{A.24}$$

It follows from the FOC and the assumption $r = \rho$ that the consumption rate is constant. We apply this to the budget constrain (2.29) and solve for the consumption rate

$$\tilde{c} = \tilde{w} + \frac{A_0 r}{1 - e^{-rT}}. \tag{A.25}$$

A.2. Analytic solution of the optimization problem if $r > r^* = \rho$

In the second part, we derive the consumption rates and expected discounted lifetime welfare values while assuming $r > r^* = \rho$.

A.2.1. Option A - direct migration to the EU

The Lagrangian function for option A in the case of successful transition to the EU and granting of asylum is given by

$$L = \int_{\tau}^{T} u(c_t^*)e^{-\rho(t-\tau)}dt + \lambda \left\{ \int_{\tau}^{T} (w^* - c_t^*)e^{-r^*(t-\tau)}dt - Ke^{r\tau} \right\}. \tag{A.26}$$

The first-order condition with respect to the consumption rate c_t^* is

$$\frac{\partial L}{\partial c_t^*} = u'(c_t^*)e^{-\rho(t-\tau)} - \lambda e^{-r^*(t-\tau)} = 0. \tag{A.27}$$

The equation can be simplified by applying $\rho = r^*$ and we get a constant consumption rate that we apply to the budget constraint (3.3) to receive the optimal consumption rate

$$c^* = w^* - \frac{r^* K e^{\tau(r-r^*)}}{e^{-r^*\tau} - e^{-r^*T}}. \tag{A.28}$$

The Lagrangian function for crossing into the EU, but without obtaining asylum, has the following form:

$$L = \int_{\tau}^{T} u(\tilde{c}_t)e^{-\rho(t-\tau)}dt + \lambda \left\{ \int_{\tau}^{T} (\tilde{w} - \tilde{c}_t)e^{-r(t-\tau)}dt - Ke^{r\tau} \right\}. \tag{A.29}$$

The first-order condition with respect to the consumption rate $\tilde{c}_t$ is

$$\frac{\partial L}{\partial \tilde{c}_t} = u'(\tilde{c}_t)e^{-\rho(t-\tau)} - \lambda e^{-r(t-\tau)} = 0. \tag{A.30}$$

The FOC shows that the consumption rate $\tilde{c}_t$ is not constant because $r > \rho$:

$$u'(\tilde{c}_t) = \lambda e^{\rho(t-\tau)}e^{-r(t-\tau)} \Leftrightarrow \tilde{c}_t = \lambda^{-\frac{1}{\theta}}e^{-g\tau}e^{gt}. \tag{A.31}$$

We can express $\tilde{c}_t$ as a function of $\tilde{c}_\tau$, assuming $g = \frac{r-\rho}{\theta}$ for simplification:

$$\tilde{c}_t = \tilde{c}_\tau e^{g(t-\tau)}. \tag{A.32}$$

We plug the consumption rate in the budget constraint (3.7) and solve for $\tilde{c}_\tau$

$$\tilde{c}_\tau = e^{g\tau} \left(\frac{\tilde{w}\left(\frac{e^{-r\tau}-e^{-rT}}{r}\right) - K}{\frac{e^{(g-r)T}-e^{(g-r)\tau}}{g-r}} \right). \tag{A.33}$$

The Lagrangian function for unsuccessful crossing in the EU is given by

$$L = \int_0^T u(\tilde{c}_t^{nc}) e^{-\rho t} dt + \lambda \left\{ \int_0^T (\tilde{w} - \tilde{c}_t^{nc}) e^{-rt} dt - K \right\}. \tag{A.34}$$

The first-order condition with respect to the consumption rate $\tilde{c}_t^{nc}$ is

$$\frac{\partial L}{\partial \tilde{c}_t^{nc}} = u'(\tilde{c}_t^{nc}) e^{-\rho(t-\tau)} - \lambda e^{-r(t-\tau)} = 0. \tag{A.35}$$

We are in the same situation as shown above when the consumption rate is not constant. We again assume $g \equiv \frac{r-\rho}{\theta}$

$$u'(\tilde{c}_t^{nc}) = \lambda e^{(\rho-r)t} \Leftrightarrow \tilde{c}_t^{nc} = \tilde{c}_0^{nc} e^{gt} \tag{A.36}$$

and plug the expression in the budget constraint (3.11) to derive the optimal consumption rate

$$\tilde{c}_0^{nc} = \left(\frac{\tilde{w}\left(\frac{1-e^{-rT}}{r}\right) - K}{\frac{e^{(g-r)T}-1}{g-r}} \right). \tag{A.37}$$

A.2.2. Option B - migration to the EU

In the case of granted asylum in the EU, the Lagrangian function is given by:

$$L = \int_\tau^T u(c_t^*) e^{-\rho(t-\tau)} dt + \lambda \left\{ A_\tau - K e^{r\tau} + \int_\tau^T (w^* - c_t^*) e^{-r^*(t-\tau)} dt \right\}. \tag{A.38}$$

The first-order condition with respect to c_t^* is

$$\frac{\partial L}{\partial c_t^*} = u'(c_t^*) e^{-\rho(t-\tau)} - \lambda e^{-r^*(t-\tau)} = 0. \tag{A.39}$$

Since $\rho = r^*$, the consumption rate c^* is constant over time. By plugging it into the respective budget constraint (3.17) we obtain the optimal consumption rate

$$c^* = w^* - \frac{r^*(K e^{r\tau} - A_\tau)}{1 - e^{r^*(\tau-T)}}. \tag{A.40}$$

The Lagrange function for the case of not granting asylum in the EU is as follows:

$$L = \int_{\tau}^{T} u(\tilde{c}_t)e^{-\rho(t-\tau)}dt + \lambda \left\{ \int_{\tau}^{T} (\tilde{w} - \tilde{c}_t)e^{-r(t-\tau)}dt + A_\tau - Ke^{r\tau} \right\}. \tag{A.41}$$

The first-order condition with respect to $\tilde{c}_t$ is

$$\frac{\partial L}{\partial \tilde{c}_t} = u'(\tilde{c}_t)e^{-\rho(t-\tau)} - \lambda e^{-r(t-\tau)} = 0. \tag{A.42}$$

The FOC shows that $\tilde{c}_t$ is increasing over time, i.e., $\tilde{c}_t = \tilde{c}_\tau e^{g(t-\tau)}$ where $g \equiv \frac{r-\rho}{\theta}$. Substituting it into the corresponding budget constraint (3.21), we obtain the optimal consumption rate

$$\tilde{c}_\tau = \left[\tilde{w} \left(\frac{1 - e^{-r(T-\tau)}}{r} \right) - Ke^{r\tau} + A_\tau \right] \left(\frac{g - r}{e^{(g-r)(T-\tau)} - 1} \right). \tag{A.43}$$

We derive the optimal consumption rate in the first period c_t. The Lagrangian function for the first period is then given by:

$$L = \int_{0}^{\tau} u(c_t)e^{-\rho t}dt + p \int_{\tau}^{T} u(c_t^*(c_t))e^{-\rho t}dt + (1-p) \int_{\tau}^{T} u(\tilde{c}_t(c_t))e^{-\rho t}dt. \tag{A.44}$$

The FOC takes the following form:

$$\frac{\partial L}{\partial c_s} = \int_{0}^{\tau} \frac{\partial u(c_t)}{\partial c_s}e^{-\rho t}dt + p \int_{\tau}^{T} \frac{\partial u(c_t^*)}{\partial c_s}e^{-\rho t}dt + (1-p) \int_{\tau}^{T} \frac{\partial u(\tilde{c}_t)}{\partial c_s}e^{-\rho t}dt. \tag{A.45}$$

From the FOC it follows that $c_t = c_0 e^{gt}$. Now we derive the optimal initial consumption rate in the first period, c_0, given consumption rates in later periods. The Lagrangian function for the first period is then given by:

$$L = \int_{0}^{\tau} u(c_t(c_0))e^{-\rho t}dt + p \int_{\tau}^{T} u(c^*(c_0))e^{-\rho t}dt + (1-p) \int_{\tau}^{T} u(\tilde{c}_t(c_0))e^{-\rho t}dt \tag{A.46}$$

The first-order condition with respect to c_0 is given by

$$\frac{\partial L}{\partial c_0} = \int_{0}^{T} \frac{\partial u(c_t)}{\partial c_0}e^{-\rho t}dt + p \int_{\tau}^{T} \frac{\partial u(c^*)}{\partial c_0}e^{-\rho t}dt + (1-p) \int_{\tau}^{T} \frac{\partial u(\tilde{c}_t)}{\partial c_0}e^{-\rho t}dt. \tag{A.47}$$

We use the following derivations to solve the FOC:

$$\frac{\partial c_t}{\partial c_0} = e^{gt} \tag{A.48}$$

$$\frac{\partial c^*}{\partial c_0} = -\left(\frac{r^*}{1 - e^{r^*(\tau - T)}} \right) \left(\frac{e^{(g+r)\tau} - 1}{g + r} \right) \tag{A.49}$$

$$\frac{\partial \tilde{c}_t}{\partial c_0} = \frac{\partial \tilde{c}_t}{\partial \tilde{c}_\tau}\frac{\partial \tilde{c}_\tau}{\partial c_0} = \frac{\partial \tilde{c}_\tau}{\partial c_0}e^{g(t-\tau)} \tag{A.50}$$

$$\frac{\partial \tilde{c}_\tau}{\partial c_0} = -\left(\frac{e^{(g+r)\tau}-1}{g+r}\right)\left(\frac{g-r}{e^{(g-r)(T-\tau)}-1}\right) \tag{A.51}$$

$$\frac{\partial u(c_t)}{\partial c_0} = \frac{\partial u(c_t)}{\partial c_t}\frac{\partial c_t}{\partial c_0} = \frac{\partial u(c_0)}{\partial c_0}e^{-\theta g t}\frac{\partial c_t}{\partial c_0} = u'(c_0)e^{(1-\theta)gt} = u'(c_0)e^{(g-r+\rho)t} \tag{A.52}$$

$$\frac{\partial u(c^*)}{\partial c_0} = \frac{\partial u(c^*)}{\partial c^*}\frac{\partial c^*}{\partial c_0} = u'(c^*)\frac{\partial c^*}{\partial c_0} \tag{A.53}$$

$$\begin{aligned}\frac{\partial u(\tilde{c}_t)}{\partial c_0} =& \frac{\partial u(\tilde{c}_t)}{\partial \tilde{c}_t}\frac{\partial \tilde{c}_t}{\partial c_0} = \frac{\partial u(\tilde{c}_\tau)}{\partial \tilde{c}_\tau}e^{-\theta g(t-\tau)}\frac{\partial \tilde{c}_t}{\partial c_0} = u'(\tilde{c}_\tau)\frac{\partial \tilde{c}_\tau}{\partial c_0}e^{(1-\theta)g(t-\tau)} = \\ =& u'(\tilde{c}_\tau)\frac{\partial \tilde{c}_\tau}{\partial c_0}e^{(g-r+\rho)(t-\tau)},\end{aligned} \tag{A.54}$$

By plugging the expressions into the FOC and integrating, we obtain the optimal c_0

$$c_0 = \left[\left(pc^{*-\theta} + (1-p)\tilde{c}_\tau^{-\theta}\right)\left(\frac{e^{-\rho\tau}\left(e^{(g+r)\tau}-1\right)(g-r)}{(g+r)\left(e^{(g-r)\tau}-1\right)}\right)\right]^{-\frac{1}{\theta}}. \tag{A.55}$$

A.2.3. Option C - no migration

The Lagrangian function for the problem is given by

$$L = \int_0^T u(\tilde{c}_t)e^{-\rho t}dt + \lambda\left\{A_0 + \int_0^T (\tilde{w} - \tilde{c}_t)e^{-rt}dt\right\}. \tag{A.56}$$

In this case, the consumption rate thus grows over time at the rate $\tilde{c}_t = \tilde{c}_0 e^{gt}$. We replace the term in the budget constraint with (3.28) and obtain the optimal consumption rate

$$\tilde{c}_0 = \left(\frac{\tilde{w}\left(\frac{1-e^{-rT}}{r}\right) + A_0}{\frac{e^{(g-r)T}-1}{g-r}}\right). \tag{A.57}$$

A.3. Permanent stay in the host country

Within the framework of the project, migrants also have the possibility to stay permanently in the host country if their asylum application is rejected. This section is intended as an extension of our model. We assume that the migrant moves to the host country at time $t = 0$ and waits τ units of time for her asylum decision. If the result is positive, she obtains asylum in the EU and moves there. If rejected, the migrant decides to stay in the host country until her planning horizon T. The model corresponds to that of option B, with the exception of the last period.

We derive the migrant's optimal consumption rates for all periods and lifetime welfare for this option, assuming $r = r^* = \rho$. As in Section 2.2, we solve for the later periods first and then for the first period. The optimal consumption rate while being granted asylum in the EU, c^*, is as in equation (2.18):

$$c^* = w^* - \frac{r^*(K - A_\tau e^{-r\tau})}{e^{-r^*\tau} - e^{-r^*T}} \tag{A.58}$$

When the migrant receives a negative decision about her asylum in the EU, she decides to stay permanently in the host country. Her maximization problem for this period is then given by

$$\max_{\tilde{c}_t} \int_\tau^T u(\tilde{c}_t) e^{-\rho(t-\tau)} dt \tag{A.59}$$

subject to the budget constraint

$$A_\tau - K e^{r\tau} + \int_\tau^T (w - \tilde{c}_t) e^{-r(t-\tau)} dt = 0. \tag{A.60}$$

The optimal consumption rate $\tilde{c}$ is constant and is given by

$$\tilde{c} = w - \frac{r(K - A_\tau e^{-r\tau})}{e^{-r\tau} - e^{-rT}}. \tag{A.61}$$

The consumption rate for the first period is derived the same way as in part A.1.2 and is given by

$$c = \left[p c^{*-\theta} + (1-p)\tilde{c}^{-\theta} \right]^{-\frac{1}{\theta}}. \tag{A.62}$$

The lifetime utility of a permanent stay in the host country then takes the following form:

$$U^{PS} = u(c)\left(\frac{1 - e^{-\rho\tau}}{\rho}\right) + p u(c^*)\left(\frac{e^{-\rho\tau} - e^{-\rho T}}{\rho}\right) + (1-p) u(\tilde{c})\left(\frac{e^{-\rho\tau} - e^{-\rho T}}{\rho}\right). \tag{A.63}$$

The only difference between the permanent and temporary stay in the host country is the wage level in the last period. When she has to return to her home country, she works for a given wage $\tilde{w}$. However, she now earns wage w in the host country. Assuming that she receives a higher wage in the host country than in her home country, $w > \tilde{w}$, the migrant is better off staying in the receiving country if the asylum decision is negative, since $U^{PS} > U^B$.