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# Risk Aversion, Time Preference and Cross-border Commuting and Migration Intentions

Klaus Nowotny*

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**Abstract**

This paper analyzes the effect of individual risk aversion and time preference on cross-border commuting and migration intentions. Both the theoretical and empirical results show that the probability of being willing to migrate decreases with risk aversion, the rate of time preference, and the maximum number of periods an individual can work abroad. The probability of being willing to commute also decreases with risk aversion, but at a smaller rate compared to the willingness to migrate, while it is (largely) unaffected by intertemporal consumption preferences. The analysis helps to shed more light on the role of time preference and risk aversion as determinants of mobility decisions, which is especially important for integrating regions where both migration and commuting are possible, as in the enlarged European Union.

**JEL classification numbers:** F22, R23, D80, D91, J61

**Keywords:** willingness to migrate, willingness to commute, risk aversion, time preference, discount rate, migration and commuting intentions

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# 1 Introduction

The decision to become internationally mobile is always a decision under uncertainty about the future states of important variables, like wage levels at home and abroad. But while a variety of studies analyzed the effect of uncertainty on migration behavior—following Burda's (1993; 1995) seminal papers on the "option value of waiting", linking the investment literature of Pindyck and Dixit[1] to migration decisions (see O'Connell, 1997; Locher, 2001; Wang and Wirjanto, 2004; Anam, Chiang, and Hua, 2008, to name just a few)—this literature did not consider cross-border commuting as an alternative to migration although commuting plays an important role in border regions between many European Union (and neighboring non-EU) countries, and can be expected to rise in importance after the end of the transitional arrangements in May 2011.[2]

Likewise, although preferences about future and present consumption can be important determinants of the decision to move across borders, earlier papers—for example following the work of Galor (1986), who focuses on aggregate welfare effects of time preference using overlapping generations models (see, e. g., Crettez, Michel, and Vidal, 1996; Meier, 2000)—did not consider the possibility of cross-border commuting and the implications of time preference in border regions where both types of mobility are possible.

This paper therefore extends the previous literature by analyzing the effect of individual risk aversion and time preference on cross-border migration and commuting intentions both theoretically as well as empirically using a unique individual level data set on mobility preferences in the Austrian-Slovak border region. From the theoretical model (section 2), three hypotheses about the effect of risk aversion and individual time preference on migration and commuting decisions can be derived: first, higher risk aversion should decrease both the willingness to migrate and to commute (relative to staying in the home country), but the relative effect should be larger for migration than for cross-border commuting. Second, a higher discount rate should be associated with an increased migration propensity, but have no effect on the willingness to commute. Third, the migration propensity should be higher for younger individuals, and the young should, if willing to move abroad, rather be willing to migrate than to commute. These hypotheses are confirmed in an empirical analysis based on a multinomial probit model (see section 4).

[1] See Pindyck (1991), Dixit (1992) and Dixit and Pindyck (1994).

[2] The possibility of cross-border commuting—and thereby an increased prospect of mobile labor in the border regions—was one of the main driving forces leading Austria, together with Germany, to use the transitional period limiting the free mobility of labor for workers from the 8 CEECs which joined the EU in 2004 to its maximum possible extent of 7 years.

The paper not only helps to shed more light on the role of individual risk aversion and time preference in mobility decisions, but also highlights the importance of considering cross-border commuting as an alternative mode of international labor mobility from a theoretical point of view: as theories about international migration cannot simply be extended to cross-border commuting, explicitly allowing for the possibility to commute across the border thus helps to achieve a better understanding of the drivers of cross-border mobility and of the functioning of labor markets in border regions.

## 2 Theoretical model

To analyze the effect of risk aversion and time preference on the migration and cross-border commuting propensities, the theoretical model starts by assuming that there are only two countries, home ($h$) and foreign ($f$). An individual living and working in her home country faces a Samuelson (1937)-type intertemporal utility function of the form:

$$U_t\left(w^h\right) = \sum_{s=t}^{T} u\left(w_s^h\right) \tau^{s-t} \tag{1}$$

The lifetime utility of working in $h$ is the sum over all future utilities in the interval $s \in [t, T]$, which are increasing in income in the home country, $w_s^h$.[3] Future incomes (and, by that, future consumption) in periods $s > t$ are, however, discounted by a time-invariant discount factor $\tau^{s-t}$, with $\tau \in [0, 1]$.[4]

When considering whether to migrate abroad, the individual compares the discounted lifetime utility in (1) to the discounted lifetime utility of income in $f$:[5]

$$U_t\left(w^f\right) = \sum_{s=t}^{T} u\left(w_s^f\right) \tau^{s-t} \tag{2}$$

[3] $T$ represents the period of retirement. The model is written in discrete time to facilitate illustration, but could easily be extended to a model in continuous time.

[4] One can think of $\tau$ as representing $1/(1+\rho)$, where $\rho$ is the rate of time preference (the preference for current consumption). The higher the rate of time preference, the lower the discount rate.

[5] If migration is a one-time decision and the individual will not return to $h$, $T$ represents—as noted above—the period of retirement. Alternatively, one could also think of an individual considering where to work for, say, the next $y$ years (so that $T = t + y$) to allow for the possibility of return migration.

The individual will state a willingness to migrate if the utility differential (2)-(1) exceeds the disutility arising from the one-time costs of migration, $u(M)$.[6] Defining $I$ an index function

$$I = \begin{cases} 1 & \text{if} \quad U_t\left(w^f\right) - U_t\left(w^h\right) > U_t(M) \\ 0 & \text{if} \quad U_t\left(w^f\right) - U_t\left(w^h\right) \leq U_t(M) \end{cases} \tag{3}$$

the probability of $I = 1$ (and thus the probability of being willing to migrate vis-à-vis staying in the home country) is given by:

$$\Pr(I = 1) = \Pr\Big(U_t\left(w^f\right) - U_t\left(w^h\right) > U_t(M)\Big)$$

Assuming that migration costs are paid in the initial period $t$, this expression can be rewritten as:

$$\begin{aligned} \Pr(I = 1) &= \Pr\left(\sum_{s=t}^{T} u\left(w_s^f\right)\tau^{s-t} - \sum_{s=t}^{T} u\left(w_s^h\right)\tau^{s-t} > u(M)\right) \\ &= \Pr\left(\sum_{s=t}^{T}\left[u\left(w_s^f\right) - u\left(w_s^h\right)\right]\tau^{s-t} > u(M)\right) \end{aligned}$$

The probability of being willing to migrate therefore depends on the development of future incomes at home and abroad. Generally, it can be asserted that the individual does not have perfect foresight, so that there is uncertainty concerning the future development of the utility differential.

Without loss of generality, it can be assumed that the individual uses the current wage levels as a basis for the evaluation of future wages, so that $w_s^f = w_t^f = \overline{w}^f \wedge \ w_s^h = w_t^h = \overline{w}^h \ \forall \ s$, but perceives future wages abroad as uncertain.[7] The return to migration then depends on the expected utility of working in $f$, $E\left[u\left(\overline{w}^f\right)\right]$, which is—as is well known—less than the utility of the expected income, $u\left(E\left[\overline{w}^f\right]\right)$, for risk averse individuals. Defining $\Pi(r)$ a risk premium which depends on individual risk aversion $r$ so that

[6] Assuming separability of the utility function. Although several papers highlighted the role of amenities in mobility decisions (see, for example, Hunt and Mueller, 2004; Okamoto, 2007; Krupka, 2009, for some recent contributions), differences in amenities are not considered in the theoretical model for the sake of simplicity.

[7] This simplifying assumption is justified by the fact that the decision process is ultimately determined by the utility differential between working at home and abroad. Whether the uncertainty arises from uncertainty about $u\left(\overline{w}^f\right)$ alone or from uncertainty about the differential $u\left(\overline{w}^f\right) - u\left(\overline{w}^h\right)$ is, in the end, irrelevant for the following discussion.

$E\left[u\left(\overline{w}^f\right)\right] = u\left(E\left[\overline{w}^f\right] - \Pi(r)\right)$,[8] the expression for the probability of being willing to migrate compared to staying can be written as:[9]

$$\Pr(I=1) = \Pr\left(\left[u\left(E\left[\overline{w}^f\right] - \Pi(r)\right) - u\left(\overline{w}^h\right)\right]\frac{\tau^{T-t+1}-1}{\tau-1} > u(M)\right) \quad (4)$$

Because $\left(\tau^{T-t+1}-1\right)/(\tau-1)$ increases strictly with $\tau$, the probability of being willing to migrate versus staying in the home country rises with the discount rate (decreases with the rate of time preference): individuals who place a high value on current consumption discount the higher future income earned abroad heavily, and are thus less inclined to move abroad because migration costs have to be covered up front.[10] Expression (4) also shows that the probability of being willing to migrate ceteris paribus decreases with risk aversion: more risk averse individuals are less inclined to move abroad as risk-neutral or risk-loving individuals. Furthermore, the migration propensity increases with the potential number of periods an individual can earn income abroad, $T-t$,[11] and thus decreases with age because

$$\frac{\partial\left(\tau^{T-t+1}-1\right)/(\tau-1)}{\partial(T-t)} > 0.$$

Additionally, equation (4) shows that the propensity to migrate abroad (instead of staying in $h$) is increasing in the expected wage abroad and decreasing in the wage in the home country and the costs of migration.

But migration is not the only possible mode of cross-border labor mobility if individuals can also commute across the border. In this case, the individual would face a disutility arising from the (constant) per-period costs of commuting $c$: $U_t(c) = \sum_{s=t}^{T} u(c)\,\tau^{s-t} = u(c)\sum_{s=t}^{T}\tau^{s-t}$. Defining $J$ an index function

[8] $\partial\Pi(r)/\partial r > 0$, $\Pi(r) > 0$ for risk-averse individuals, $\Pi(r) = 0$ for risk-neutral individuals, and $\Pi(r) < 0$ for risk-loving individuals.

[9] The risk premium may also reflect alternative risks, like a less-than-one probability of finding employment abroad. In any case, it is assumed that there are no insurance markets for these risks, which is a mild assumption considering, for example, the implications of information asymmetry or moral hazard problems on an insurance against less-than-expected future wages or unemployment abroad.

[10] In principle, the same argument applies if migration costs were to be paid in the future and discounted to the current period, especially for individuals with $\tau$ close or equal to 1. This could, however, increase the probability of migration for individuals with a high degree of time preference because it lowers the present discounted value of migration costs. In the extreme case of $\tau = 0$ (i. e., if individuals are so myopic they only care about utility in the current period), this can lead to $\partial\Pr(I=1)/\partial\tau < 0$ depending on the parameters used. However, it is more natural to assume that migration costs are paid upon migration and not in later periods.

[11] If $T$ is not the period of retirement and the individual considers the possibility of return migration, equation (4) indicates that the migration propensity increases with the intended number of periods she wants to work abroad.

capturing whether the individual is willing to commute to $f$ (vis-à-vis staying in $h$) along the lines of (3), the probability that $\Pr(J = 1)$ is given by:

$$\begin{aligned}\Pr(J = 1) &= \Pr\Big(U_t\left(w^f\right) - U_t\left(w^h\right) > U_t(c)\Big) \\ &= \Pr\left(\sum_{s=t}^{T}\left[u\left(w_s^f\right) - u\left(w_s^h\right)\right]\tau^{s-t} > u(c)\sum_{s=t}^{T}\tau^{s-t}\right)\end{aligned}$$

Again, assuming that the individual uses current wage levels as a basis for her expectations about future wages but considers the future development of $\overline{w}^f$ as uncertain, this probability can be rewritten as:

$$\Pr(J = 1) = \Pr\Big(u\left(E\left[\overline{w}^f\right] - \Pi(r)\right) - u\left(\overline{w}^h\right) > u(c)\Big) \tag{5}$$

As (5) shows, the probability of being willing to commute (vs. staying in the home country) is increasing in the expected wage abroad and decreasing in risk aversion, wages in $h$, and commuting costs. The commuting propensity is, however, unaffected by time preferences or the potential number of periods the individual can work abroad: if the utility differential between wages abroad and at home exceeds the disutility from commuting costs in the current period, it does so also in all future periods. Because the costs of commuting incur every period, the individual's age also has no effect on the willingness to commute. To sum up, only risk aversion, current income and mobility costs matter when considering whether to commute across the border or staying in the home country. Commuting thus gives individuals the possibility of working abroad who would otherwise stay in their home country if migration was the only possible mode of cross-border labor mobility, especially those with high rates of time preference or older workers.

Finally, as individuals may find both cross-border commuting and migration to increase their utility, the question which mode of labor mobility an individual with $I = 1$ and $J = 1$ will choose, remains. We therefore need an expression which defines the conditions under which migration is superior to cross-border commuting if both are preferred to staying. If $K$ is an index function denoting the individual's choice of migration over cross-border commuting, the proba-

bility of an individual migrating instead of commuting can be derived from a comparison between equations (4) and (5):

$$\Pr(K=1) = \Pr\Bigg( \left[ u\left(E\left[\overline{w}^f\right] - \Pi(r)\right) - u\left(\overline{w}^h\right) \right] \frac{\tau^{T-t+1}-1}{\tau-1} - u(M) > u\Bigg( E\left[\overline{w}^f\right] - \Pi(r) \Bigg) - u\left(\overline{w}^h\right) - u(c) \Bigg)$$

$$= \Pr\Bigg( \left[ u\left(E\left[\overline{w}^f\right] - \Pi(r)\right) - u\left(\overline{w}^h\right) \right] \frac{\tau^{T-t+1}-\tau}{\tau-1} > u(M) - u(c) \Bigg) \quad (6)$$

As is obvious from equation (6), for given wages and costs of mobility the probability of an individual choosing migration over commuting is decreasing in risk aversion. Risk averse individuals are thus more likely to commute than to migrate. Furthermore, as $\left(\tau^{T-t+1}-\tau\right)/(\tau-1)$ is positive and strictly increasing in $\tau$, the probability of migration being superior to commuting increases with the discount rate, and thus decreases with the rate of time preference: individuals with values of $\tau$ close to 1 are—ceteris paribus—rather willing to migrate than to commute, while more myopic individuals with low discount rates $\tau$ will show a higher propensity to commute than to migrate. It can also be seen from (6) that $\Pr(K=1)$ increases in $T-t$, the number of periods the individual can potentially work abroad. Younger individuals—if willing to move abroad—will therefore rather choose to migrate than to commute.[12] Introducing commuting in a model of cross-border labor mobility therefore not only makes some individuals (especially those with high rates of time preference or older workers) willing to commute to $f$ which would otherwise stay in $h$, it also makes some individuals willing to commute which would otherwise choose to migrate, especially those with higher risk aversion, rate of time preference or age.

To sum up, three hypotheses arise from the theoretical discussion which can be tested in an empirical analysis. First, for given wages and costs of mobility, higher risk aversion should decrease both the probabilities of being willing to migrate and to commute (vis-à-vis staying in the home country), but ceteris paribus be associated with a higher commuting propensity compared to migration: risk aversion should thus have a more pronounced effect on the willingness to migrate, while both migrants and commuters should be selected from the lower end of the distribution of risk attitudes. Second, a higher discount rate (a lower rate of time preference) should be associated with an increased willingness to migrate (both compared to staying and cross-border commuting) while there should be no effect on the commuting propensity. Third, the migration

[12] Again, if the individual considers return migration, equation (6) shows that the migration propensity increases with the intended number of periods she wants to work abroad.

propensity should be higher for younger individuals, and the young should, if willing to move abroad, rather be willing to migrate than to commute. These empirical hypotheses can be tested using a multinomial probit model in three dimensions derived from equations (4), (5) and (6).[13]

# 3 Data and variables

The empirical analysis uses recent individual level data collected within the scope of the Austrian-Slovakian FAMO project.[14] The aim of this project was to gain information on the willingness to commute and migrate in Vienna and the western Slovakian border regions to Austria, Bratislava and Trnava. The data to be used in the empirical analysis were collected between November 2008 and February 2009 in a single wave of personal face-to-face interviews, and are thus cross-sectional in nature. Quota sampling was applied to ensure a representative sample of the working-age population 15 years and older in each region. In total, 2,986 interviews were conducted, 1,500 in the Slovak regions and 1,486 in Vienna. Focusing on the population 18 to 64 years of age who are not currently working abroad reduces the sample to 2,738 observations.

The data are especially suitable for this analysis because the regions under consideration can act as model regions for analyzing the willingness to migrate and to commute across borders, as the low distances to the border (and to densely populated areas in the neighboring country, such as the capitals of Austria and the Slovak Republic, Vienna and Bratislava) allow for both types of mobility to emerge. Due to the transitional arrangements, the institutional setting does not yet allow labor to be fully mobile between the Slovak Republic and Austria.[15] This will, however, change after the end of the transitional period in May 2011.

## 3.1 Willingness to migrate and to commute

The dependent variable is the individual's willingness to migrate, commute or stay in her home country defined from questions about preferences concerning cross-border mobility. Interviewees were asked "Would it be conceivable for

[13] Compared to the more common multinomial logit model, the multinomial probit model has the advantage that it allows for an arbitrary covariance structure between the response categories and does therefore not require the restrictive "independence of irrelevant alternatives" assumption. See Maddala (1983), or Train (2009) for a recent discussion.

[14] The project "FAMO – Fachkräftemonitoring" is financed by the European Regional Development Funds within the "Cross-border cooperation program Slovakia-Austria 2007-2013" and cofinanced by the Austrian Federal Ministry of Labor and Social Affairs and the Slovak Ministry for Construction and Regional Development.

[15] Austria and Germany chose to use the maximum possible transitional period of 7 years for citizens of the Central and Eastern European countries which joined the EU in May 2004. At the time of the interview, these transitional arrangements were therefore still in place.

you to work abroad?", with possible answers "yes" or "no". Those who affirmed the above question were then asked whether they would prefer (1) "daily commuting", (2) "weekly commuting", (3) "monthly commuting" or (4) "living and working abroad". Those who stated a preference for daily and weekly commuting were categorized as "willing to commute" ($J = 1$), those who preferred "living and working abroad" or "monthly commuting" as "willing to migrate" ($I = 1$). All persons who did not express a willingness to migrate or to commute were labeled "stayers" ($I, J = 0$).[16]

Because the data contain information on stated instead of revealed preferences only, the calculated willingness to migrate and to commute across the border may overestimate true future mobility because not all mobility intentions will be realized.[17] Nevertheless, as shown for example by van Dalen and Henkens (2008), intentions are good—albeit not perfect—predictors of real future mobility. Studying the determinants of mobility intentions therefore also helps reveal the determinants of real migration and cross-border commuting decisions, and it can be expected that the factors which determine the individual's willingness to work abroad also affect her decision to work abroad.

## 3.2 Measures of risk aversion and time preference

To test the hypotheses arising from the theoretical model, measures of individual risk aversion and time preference are needed. The methods for calculating these measures are based on Ventura (2003) and Eisenhauer and Ventura (2009). Ventura (2003) shows that a second-order Taylor expansion of an intertemporal utility function like (1) or (2) and the definition of the Arrow-Pratt coefficient of absolute risk aversion[18] can be used to calculate intertemporal preference factors from responses to survey questions about hypothetical situations without drawing assumptions about the specific form of the individual utility function. In the survey, individuals were confronted with the following hypothetical situations:

> *Question 1: Suppose you have won* {monetary amount} *in a lottery. However, the lottery will not pay out the prize to you until exactly*

[16] In contrast to the theoretical analysis, it cannot be determined whether individuals would be both willing to migrate and to commute ($I = 1 \wedge J = 1$) from the data. Thus, in the empirical analysis $I = 1$ only if $K = 1$, and $J = 1$ only if $K = 0$.

[17] Furthermore, it cannot be ruled out that there may be individuals who have stated a willingness to work abroad simply because the question whether it would be conceivable for them to work abroad reminded them of the possibility of working in another country. It is thus possible that working abroad was not on the individual's mindset before the interview (because it was, for example, clouded by a "threshold of indifference", see van der Velde and van Houtum, 2004; van Houtum and van der Velde, 2004; van der Velde, Janssen, and van Houtum, 2005), thereby adding to the overestimation of future mobility based on data about migration and commuting intentions.

[18] The Arrow-Pratt coefficient of absolute risk aversion, defined as $A(w) = -u''(w)/u'(w)$, is a measure of the curvature of the utility function and usually interpreted as a measure of local risk aversion (see Arrow, 1965; Pratt, 1964).

*one year from now. How much are you willing to pay to receive the* {monetary amount} *immediately instead of one year from now?*

*Question 2: Now, suppose the lottery will not pay out the* {monetary amount} *prize to you until exactly two years from now. How much are you willing to pay to receive these* {monetary amount} *immediately instead of two years from now?*

*Question 3: Suppose you are being offered a lottery ticked which either wins you* {monetary amount} *in cash immediately or nothing at all. Both events are equally probable. How much are you at most willing to pay for such a lottery ticket?*

The inteviewees in Bratislava and Trnava were confronted with a monetary amount of SKK 100,000.– in all three questions and were asked to give responses in SKK which were later converted to Euro values. For the interviews in Vienna, the monetary amount was € 10,000.–, and interviewees were asked to give monetary amounts in Euros.[19]

Denoting the total prize as $p$ (which is equal for all three questions), the responses to the first and second questions as $y_1$ and $y_2$, respectively, and the response to the third question as $l$, the discount factor $\tau$ and an interval measure of absolute risk aversion $IA$ can be calculated from the survey data using the following expressions (Ventura, 2003; Eisenhauer and Ventura, 2009, see the appendix for details):[20]

$$\tau = \frac{y_2 - IA\left(py_2 - 0.5y_2^2\right)}{y_1 - IA\left(py_1 - 0.5y_1^2\right)} - 1 \tag{7}$$

$$IA = \frac{p - 2l}{pl - l^2} \tag{8}$$

Concerning the discount factor, $\tau = 1$ and future values are not discounted if the individual is not willing to pay anything for the immediate receipt of the prize, i. e., if $y_1 = y_2 = 0$. Only if $y_2 > y_1 > 0$, $\tau$ will be observed in the open interval $(0, 1)$.[21] 238 observations where $y_2 > y_1 = 0$ and 398 with $y_2 = y_1 > 0$

[19] The Euro officially replaced the Slovak Crown (SKK) on January 1, 2009. Using the fixed SKK to Euro conversion rate of 30.126, the sum of SKK 100,000.– thus amounts to € 3,319.39. Considering the annual median equivalized net incomes of employees (€ 21,646.– in Austria, compared to € 5,531.– in the Slovak Republic according to EU-SILC data for 2008), the relative payoff of the hypothetical lotteries in Austria and the Slovak Republic is close to the relative median incomes and can thus be considered an equally attractive prize.

[20] In contrast to Ventura (2003), the interval measure of absolute risk aversion defined in Eisenhauer and Ventura (2009) is used to calculate (7) instead of the coefficient of absolute risk aversion $A(w)$ calculated from a second-order Taylor expansion of expected utility (see also Eisenhauer and Ventura, 2003). As shown by Eisenhauer and Ventura (2009), $IA$ has several advantages over $A(w)$, but still approaches $A(w)$ for small risks.

[21] Only cases where $y_1$, $y_2$ and $l$ are nonnegative are considered meaningful responses. In any case, negative values for these variables do not appear in the survey. There are also no

were excluded, since equation (7) would either not be defined in these cases or take on the value zero althoug the discount factor is clearly positive or 1.[22] 91 cases where $y_2 < y_1$ (resulting in $\tau < 0$) are also ruled out although there is some evidence of hyperbolic discounting in the literature which could lead to negative discount factors (for a comprehensive survey see Frederick, Loewenstein, and O'Donoghue, 2002; empirical evidence on hyperbolic discounting can be found in Eisenhauer and Ventura, 2006). As in Ventura (2003), 300 cases where $y_2$ is so much lager than $y_1$ that equation (7) would result in $\tau > 1$ are also discarded. A time preference factor exceeding unity would indicate a higher preference for future than for present consumption, contrary to the interviewees' responses. Thus, for the sake of prudence, $\tau$ is restrained to the interval $(0, 1]$.

The interval measure of absolute risk aversion $IA$ equals zero if individuals are characterized by risk neutrality, which occurs when individuals are willing to pay $p/2$ (the expected payoff of the lottery) for the lottery ticket. Values of $IA < 0$ (willingness to pay above expected payoff, $l > p/2$) indicate risk-loving individuals, while a positive value $IA > 0$ ($l < p/2$) indicates risk aversion. 501 observations where $l = 0$ are excluded, as this would indicate that individuals exhibit either infinite risk aversion (which cannot be computed from our survey data), loss aversion (which is not modeled in the theoretical section), or did not seriously consider the hyothetical offer in question 3. All in all, these restrictions reduce the sample to be used in the empirical analysis to 1,210 observations of individuals age 18–64 who are currently not working abroad.[23] According to the definitions in section 3.1, 35.87 % of these are willing to work abroad; 26.12 % are willing to commute, while 9.75 % are willing to migrate.

Before proceeding, it is also important to name the assumptions underlying equation (7), which may point to limitations of the approach: first of all, it assumes that income is the same in the next two periods. Whether this assumption holds is, however, debatable, especially for specific subgroups like students who might have very low earnings while going to school or university but expect a relatively steep increase in income when finishing education. Furthermore, the mobility choices of students may be driven by completely different motives, like the prestige or quality of educational institutions abroad (see Tremblay, 2002), which are unrelated to questions of time preference and risk aversion. Therefore, regressions including and excluding students will be presented in the empirical analysis.

cases where $y_1$, $y_2$ or $l$ exceed $p$, which would be interpreted as an indicator that the question was not fully understood by the interviewee.

[22] More specifically, this would imply that either consumption in period 1 is not discounted in the base period while consumption in period 2 is discounted in both periods or that cosumption in periods 1 and 2 is discounted in the base period, but consumption in period 2 is not discounted in period 1, respectively.

[23] 551 from Austria and 659 from Slovakia.

Second, it is based on the assumption that the discount factor $\tau$ and the measure of absolute risk aversion $IA$ are constant over the next two periods. Although there are some studies which show that discount factors vary over the life cycle (see, e. g., Trostel and Taylor, 2001), it can safely be assumed that the discount factor is either constant over the short period of time considered, or perceived as being constant by the individual based on his evaluations about future consumption at the time of the interview. Many studies, for example, use age as a proxy for the discount rate (e. g., Burda, 1993), and thus also implicitly assume a constant discount rate over the life cycle.[24] This comes, however, at the price of not being able to identify age and time preference effects separately, which is an advantage of the approach chosen here. The same argument can be applied to the measure of risk aversion used, as assumed in other studies on related topics (e. g., Kan, 2003).

Third, it may be argued that discount rates derived from hypothetical situations are not representative for the discount rates in real situations, and that individuals' real-life behavior may contradict their reported behavior when confronted with hypothetical situations. However, it can be assumed that, even if there may be quantitative differences between an individual's discount rate computed from answers to hypothetical questions and her real-life discount rate, the two will be correlated, and that qualitatively both methods will yield similar results in interpersonal comparisons, so that the discount rate calculated here is a good proxy for the real discount rate in cross-sectional regressions.

## 3.3 Other explanatory variables

Age (or the potential time span an individual can work abroad, respectively) also arises as an important variable from the theoretical discussion. As the model of chapter 2 showed, the probability of migrating versus staying—and versus commuting—is increasing in the number of years an individual can potentially work abroad. A higher migration propensity can thus be expected among younger individuals and age can be expected to have a negative effect on the probability of being willing to migrate while having no effect on the willingness to commute.

Costs of mobility also play an important role in determining the migration and commuting propensities. As the direct costs of mobility are not observable for migration and commuting intentions, we include variables intended to capture indirect costs of commuting and migration like a dummy variable for marital status ("single") and the presence of children in the household ("kids"). Previ-

[24] Other proxies used for time preference in the literature include, for example, (dis)saving behavior during a specified time period (Smith, Bogin, and Bishai, 2005).

ous research suggest that persons living in larger households will face higher costs of migration (such as job search costs or schooling for other household members) than single households (see Mincer, 1978). Furthermore, variables which measure whether the respondents have family members or friends working abroad are included to proxy for potential network effects, as networks have been shown to affect mobility decisions by reducing mobility (and job search) costs significantly (see, e. g., Bartel, 1989; McKenzie and Rapoport, 2007; Pedersen, Pytlikova, and Smith, 2008). We also control for whether the individual has already worked abroad, since previous migration experience may also reduce search costs abroad. To control for other variables aside from those in the model which might affect the individual's decision to migrate or commute abroad, a gender dummy is included in the empirical application. To control for the skill level and determinants of earnings possibilities abroad, dummies for the highest completed education (vocational, secondary or tertiary education with primary education as the base category) and dummies for knowledge of a foreign language language are also included.[25] Summary statistics for the independent variables can be found in table 1.

For some of these variables it might however be hypothesized that they are themselves correlated with time preference and/or risk aversion. E. g., education could be seen as an indicator of a larger discount factor: if education is an investment in future earnings, those with tertiary education will ceteris paribus have a discount factor closer to 1 than those with primary education only. A high correlation between independent variables can lead to multicollinearity problems in the regression. To dispel concerns about multicollinearity, OLS regressions of $\tau$ and $IA$ on all other independent variables were run.[26] The first regression shows that the measure of risk aversion and the dummy variable for previous mobility are positively correlated with $\tau$, while higher education is associated with a lower discount rate. The second regression shows that $\tau$, age and being female are positively correlated with risk aversion, while having knowledge of a foreign language is associated with a lower $IA$. Although there are thus some correlations among the independent variables, the adjusted $R^2$ in the first regression is only 0.014, and only 0.022 in the second regression. The correlations are therefore miniscule and no real cause for concern.

## 3.4 Preliminary results

As the summary statistics in table 1 show, the average discount rate is about 0.80, which is considerably lower compared to the results in Ventura (2003),

[25] Language skills might also affect the psychological costs of living and/or working abroad and by that also impact total (pecuniary and non-pecuniary) mobility costs.

[26] Results are available from the author upon request.

| Variable | Mean | S. D. | Mean $I, J = 0$ | Mean $I = 1$ | Mean $J = 1$ |
|---|---|---|---|---|---|
| $\tau$ | 0.797 | 0.263 | 0.776 | 0.846 | 0.805 |
| $IA$ | 0.214 | 0.290 | 0.238 | 0.168 | 0.179 |
| Age | 39.290 | 12.942 | 41.107 | 35.465 | 37.585 |
| Single | 0.460 | 0.499 | 0.438 | 0.506 | 0.475 |
| Kids | 0.319 | 0.466 | 0.369 | 0.234 | 0.220 |
| Network | 0.569 | 0.495 | 0.512 | 0.668 | 0.686 |
| Previous mobility | 0.147 | 0.354 | 0.108 | 0.259 | 0.102 |
| Female | 0.493 | 0.500 | 0.512 | 0.449 | 0.492 |
| Vocational educ. | 0.321 | 0.467 | 0.322 | 0.316 | 0.322 |
| Secondary educ. | 0.329 | 0.470 | 0.353 | 0.294 | 0.263 |
| Tertiary educ. | 0.212 | 0.409 | 0.195 | 0.253 | 0.220 |
| Foreign lang. | 0.889 | 0.314 | 0.841 | 0.975 | 0.975 |
| Student | 0.103 | 0.304 | 0.059 | 0.193 | 0.153 |

Table 1: Summary statistics, $N = 1,210$ observations.

who—based on a similar formula for the discount factors and data from the Bank of Italy's 2000 Survey of Income and Wealth—found an average discount rate of 0.90. It is, however, well in line with previous results in the literature (see the survey by Frederick, Loewenstein, and O'Donoghue, 2002, for an overview of empirical estimates of the discount rate). Discount rates in the sample range from 0.094 to 1, their distribution is, however, skewed to the left, with a median discount rate of about 0.89, and about 75 % of all respondents have discount rates above 0.50 (see figure 1). Table 1 also shows some preliminary evidence in favor of the theoretical hypothesis concerning the relationship between $\tau$ and the willingness to migrate: the discount rate is significantly lower for "stayers" ($\tau = 0.776$) compared to potential migrants ($\tau = 0.846$) when applying a $t$-test for equality of means ($t = 4.036$). For those with a propensity to commute, however, $\tau$ is not significantly larger than for those who are neither willing to migrate nor to commute ($t = 1.090$).

The measure of absolute risk aversion, which was derived from question 3, ranges from zero to about one (which is the approximate value for $IA$ if $l = 1$ Euro or SKK). Only 8 individuals (0.66 %) are found risk neutral in the sample and reported a willingness to pay equal to the payoff of the hypothetical lottery (SKK 50,000.– in Slovakia, € 5,000.– in Austria). Although the distribution of the interval measure of risk aversion appears skewed to the right (see figure 1),[27] the populations in both countries can be characterized as rather risk averse: the median willingness to pay for the lottery ticket was SKK 210.– (about € 7.–) in Slovakia and € 20.– in Vienna, and only 5 % of the respondents would be

[27]This is due to the calculation of $IA$ in formula (8), which increases more strongly with a decrease in the willingness to pay if $l$ is already very low.

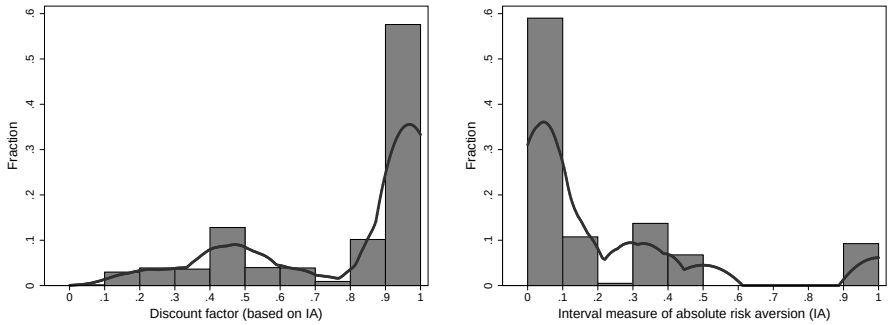


Figure 1: Empirical distributions of the discount factor ($\tau$) and the interval measure of absolute risk aversion ($IA$), histogram and kernel density estimation. $N = 1,210$ observations.

willing to pay more than SKK 5,000.– or € 1,000.–, respectively. Again, preliminary evidence shows that the theoretical predictions of section 2 concerning risk aversion and mobility preferences are supported by the data: the coefficient of risk aversion for those who are neither willing to migrate or to commute ($IA = 0.238$) is significantly larger than for potential migrants ($IA = 0.168$, $t$-test for equality of means: $t = 3.671$) and larger than for those who are willing to commute ($t = 2.066$). Furthermore, the risk aversion of those willing to commute is higher than for those willing to migrate, the difference in means is, however, not statistically significant ($t = 0.390$).

The data also show support for the hypotheses concerning age (as a proxy of the maximum amount of periods an individual can work abroad): the average potential migrant is about 5.6 years younger than the average "stayer", a difference which is also statistically significant ($t = 6.706$). Table 1 also shows that those willing to commute are younger than those neither willing to migrate or to commute (by about 3.5 years). Both potential migrants as well as potential cross-border commuters are therefore selected from among the younger population. A comparison of the average age between those willing to migrate and those willing to commute shows that the former are about 2.1 years younger than the latter, and that this difference is significantly larger than zero at the 10 % level (using a one-sided alternative, $t = 1.573$, $p$-value: 0.058). This supports the hypothesis that the migration propensity is increasing in the number of periods an individual can work abroad, and that the young are, if willing to move abroad, rather willing to migrate than to commute.

# 4 Empirical analysis

Although the preliminary evidence in section 3.4 already shows that the hypotheses derived from the theoretical model are supported by the data, only a multivariate analysis can unveil whether these are still valid if other factors are controlled for. Table 2 therefore shows the results of the multinomial probit regression of the willingness to migrate or to commute. Three models were estimated: Model 1 includes only the measures of the discount rate and risk aversion. Model 2 extends this specification, including age as a third model variable. Model 3, finally, includes all the regressors discussed in section 3.3. Because of the trivariate nature of the dependent variable and because in the multinomial probit model regression coefficients can only be identified relative to a base category, table 2 shows not only the coefficients of a regression using staying (not being willing to work abroad) as the base category (columns 1, 2, 4, 5, 7 and 8) but also the estimates of a regression using the willingness to commute as the base category (columns 3, 6 and 9).

As Model 1 in table 2 shows, the discount rate is associated with a higher migration propensity, while the coefficient of our measure of risk aversion is negative for both the willingness to migrate as well as the willingness to commute. This is consistent with the empirical hypotheses formulated in section 2 as well as with previous results in the literature. For example, Guiso and Paiella (2008) found a negative correlation between absolute risk aversion and the probability of intra-national migration in Italy, while Kan (2003), using data from the Panel Study of Income Dynamics (PSID), found that risk aversion has a significantly negative (albeit insubstantial) effect on the probabilities of (intra-U. S.) job and residence relocations. Heitmueller (2005), using a calibrated model, also found risk averse individuals to be ceteris paribus less liekly to migrate across borders. The negative coefficient of $IA$ in column (3) suggests that risk averse individuals are rather willing to commute than to migrate, the effect is, however, not statistically significant.

The results also imply that—contrary to the predictions of the theoretical model—a higher discount rate is not only associated with a higher propensity to migrate, but also with a higher willingness to commute. The coefficient of $\tau$ in column (2) is, however, significant only at a 10 % level of significance. Adding the age of the individual (Model 2) to the list of regressors does not change the qualitative results concerning the effects of $\tau$ and $IA$. As hypothesized in section 2, age decreases the willingness to migrate because it decreases the potential number of periods an individual can earn income abroad $(T - t)$. As expected, younger individuals are significantly more willing to migrate than

| | Model 1 | | | Model 2 | | | Model 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| | Migrating | Commuting | Migrating | Migrating | Commuting | Migrating | Migrating | Commuting | Migrating |
| | vs. | vs. | vs. | vs. | vs. | vs. | vs. | vs. | vs. |
| Variables | Staying | Staying | Commuting | Staying | Staying | Commuting | Staying | Staying | Commuting |
| $\tau$ | 0.959*** | 0.430* | 0.529* | 0.976*** | 0.449* | 0.528* | 0.986*** | 0.452* | 0.535* |
| | (0.219) | (0.260) | (0.282) | (0.220) | (0.260) | (0.283) | (0.230) | (0.271) | (0.293) |
| $IA$ | −0.814*** | −0.601** | −0.213 | −0.769*** | −0.558** | −0.211 | −0.592*** | −0.458* | −0.134 |
| | (0.199) | (0.247) | (0.266) | (0.202) | (0.247) | (0.268) | (0.207) | (0.254) | (0.274) |
| Age | | | | −0.029*** | −0.017*** | −0.012** | −0.024*** | −0.012** | −0.011* |
| | | | | (0.004) | (0.005) | (0.006) | (0.005) | (0.006) | (0.006) |
| Single | | | | | | | −0.069 | −0.167 | 0.098 |
| | | | | | | | (0.129) | (0.155) | (0.163) |
| Kids | | | | | | | −0.489*** | −0.564*** | 0.075 |
| | | | | | | | (0.139) | (0.172) | (0.184) |
| Network | | | | | | | 0.474*** | 0.598*** | −0.124 |
| | | | | | | | (0.122) | (0.149) | (0.159) |
| Previous mobility | | | | | | | 0.678*** | −0.122 | 0.800*** |
| | | | | | | | (0.155) | (0.217) | (0.218) |
| Female | | | | | | | −0.174 | −0.079 | −0.095 |
| | | | | | | | (0.117) | (0.142) | (0.150) |
| Vocational educ. | | | | | | | −0.108 | −0.346 | 0.237 |
| | | | | | | | (0.190) | (0.220) | (0.232) |
| Secondary educ. | | | | | | | −0.399** | −0.649*** | 0.251 |
| | | | | | | | (0.190) | (0.222) | (0.235) |
| Tertiary educ. | | | | | | | −0.026 | −0.379 | 0.353 |
| | | | | | | | (0.203) | (0.238) | (0.250) |
| Foreign lang. | | | | | | | 1.327*** | 1.397*** | −0.070 |
| | | | | | | | (0.263) | (0.355) | (0.399) |
| Constant | −1.365*** | −1.647*** | 0.281 | −0.287 | −1.003*** | 0.716** | −1.705*** | −2.161*** | 0.457 |
| | (0.187) | (0.220) | (0.241) | (0.249) | (0.296) | (0.321) | (0.425) | (0.526) | (0.576) |
| Observations | | 1,210 | | | 1,210 | | | 1,210 | |
| Log-likelihood | | -1025.874 | | | -1003.811 | | | -937.162 | |

Table 2: Multinomial probit regression of willingness to migrate, commute, or stay. Observations with $l = 0$ excluded. Standard errors in parentheses. *** significant at 1 %, ** significant at 5 %, * significant at 10 %.

willing to commute. Age, however, also has a significantly negative (albeit considerably smaller) effect on the commuting propensity.

The conclusions from the multinomial probit regression hardly change when all independent variables discussed in section 3.3 are included (Model 3). While gender and marital status do not affect the willingness to migrate or to commute, having kids is associated with lower migration and commuting propensities. The same holds true for individuals with secondary education, who appear less willing to move abroad than those with primary education (the base category). The willingness to migrate or to commute across borders however is higher for those with knowledge of at least one foreign language or individuals with family or friends already working abroad. Having worked abroad before is only associated with an increased willingness to migrate, but has no effect on the willingness to commute. These results correspond to the analysis by Huber and Nowotny (2008) and show that the indirect costs of mobility affect the migration and commuting propensities as expected.

Excluding students—whose motives for international mobility are possibly driven by other factors than time preference and risk aversion—the regression shows even more clearly that the hypotheses of the theoretical model are confirmed in the data used (table 3), especially in the full specification of Model 6: a discount rate $\tau$ closer to 1 is associated with an elevated willingness to migrate, but has no significant effect on the willingness to commute across borders, while age decreases the willingness to migrate, but has—as expected—no effect on the commuting propensity. As hypothesized in section 2, a higher level of risk aversion $IA$ is associated with a decreased willingness to migrate and to commute, and the effect is larger (albeit not significantly so) for migration than for commuting.

The coefficients in tables 2 and 3 can, however, not be directly interpreted as changes in the probabilities of being willing to migrate or to commute. Therefore, marginal effects for the model variables $\tau$, $IA$ and age on the probabilities of being willing to migrate, being willing to commute abroad as well as not being willing to migrate or commute abroad were calculated for the full specifications in Models 3 and 6 (see table 4).[28]

The probability of being willing to migrate appears about 16.5 percentage points higher for (otherwise identical) individuals who do not discount future income at all ($\tau = 1$) when compared to the most myopic individual in the sample (with a discount rate of $\tau = 0.094$, see table 1). A centered change in $\tau$ of one standard deviation (about 0.263) is associated with an increase in the willingness to migrate by about 5.5, a centered change of $\Delta\tau = 0.1$ by about

[28]The results for the other models are quantitatively and qualitatively similar and therefore not included here. They are available from the author upon request.

| | Model 4 | | | Model 5 | | | Model 6 | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| | Migrating | Commuting | Migrating | Migrating | Commuting | Migrating | Migrating | Commuting | Migrating |
| | vs. | vs. | vs. | vs. | vs. | vs. | vs. | vs. | vs. |
| Variables | Staying | Staying | Commuting | Staying | Staying | Commuting | Staying | Staying | Commuting |
| $\tau$ | 0.632*** | 0.329 | 0.303 | 0.680*** | 0.355 | 0.325 | 0.607** | 0.301 | 0.306 |
| | (0.229) | (0.276) | (0.300) | (0.231) | (0.276) | (0.301) | (0.244) | (0.291) | (0.314) |
| $IA$ | −0.784*** | −0.624** | −0.160 | −0.743*** | −0.593** | −0.150 | −0.560** | −0.500* | −0.060 |
| | (0.212) | (0.263) | (0.286) | (0.214) | (0.264) | (0.288) | (0.220) | (0.273) | (0.296) |
| Age | | | | −0.023*** | −0.011* | −0.012* | −0.019*** | −0.007 | −0.012* |
| | | | | (0.005) | (0.006) | (0.006) | (0.005) | (0.006) | (0.007) |
| Single | | | | | | | −0.188 | −0.151 | −0.038 |
| | | | | | | | (0.137) | (0.166) | (0.176) |
| Kids | | | | | | | −0.500*** | −0.493*** | −0.007 |
| | | | | | | | (0.144) | (0.177) | (0.191) |
| Network | | | | | | | 0.408*** | 0.596*** | −0.189 |
| | | | | | | | (0.130) | (0.161) | (0.173) |
| Previous mobility | | | | | | | 0.732*** | −0.080 | 0.812*** |
| | | | | | | | (0.163) | (0.228) | (0.230) |
| Female | | | | | | | −0.208* | −0.244 | 0.036 |
| | | | | | | | (0.126) | (0.153) | (0.164) |
| Vocational educ. | | | | | | | −0.062 | −0.366 | 0.304 |
| | | | | | | | (0.205) | (0.237) | (0.253) |
| Secondary educ. | | | | | | | −0.550*** | −0.793*** | 0.243 |
| | | | | | | | (0.213) | (0.248) | (0.268) |
| Tertiary educ. | | | | | | | 0.019 | −0.376 | 0.395 |
| | | | | | | | (0.216) | (0.252) | (0.267) |
| Foreign lang. | | | | | | | 1.286*** | 1.564*** | −0.278 |
| | | | | | | | (0.273) | (0.412) | (0.453) |
| Constant | −1.225*** | −1.644*** | 0.419* | −0.344 | −1.211*** | 0.868** | −1.506*** | −2.361*** | 0.855 |
| | (0.194) | (0.232) | (0.253) | (0.270) | (0.326) | (0.352) | (0.461) | (0.602) | (0.655) |
| Observations | | 1,085 | | | 1,085 | | | 1,085 | |
| Log-likelihood | | -885.927 | | | -874.865 | | | -808.970 | |

Table 3: Multinomial probit regression of willingness to migrate, commute, or stay. Students and observations with $l = 0$ excluded. Standard errors in parentheses. *** significant at 1 %, ** significant at 5 %, * significant at 10 %.

| Model 3 | | $\Delta \Pr(I=1)$ | $\Delta \Pr(J=1)$ | $\Delta \Pr(I,J=0)$ |
|---|---|---|---|---|
| $\tau$ | Min $\rightarrow$ Max | 0.165 | 0.018 | $-0.184$ |
| | $\pm\frac{1}{2}$ S. D. | 0.055 | 0.004 | $-0.059$ |
| | $\pm 0.05$ | 0.021 | 0.002 | $-0.023$ |
| $IA$ | Min $\rightarrow$ Max | $-0.109$ | $-0.032$ | 0.141 |
| | $\pm\frac{1}{2}$ S. D. | $-0.034$ | $-0.010$ | 0.044 |
| Age | Min $\rightarrow$ Max | $-0.221$ | $-0.026$ | 0.247 |
| | $\pm\frac{1}{2}$ S. D. | $-0.064$ | $-0.007$ | 0.071 |
| | $\pm 0.5$ | $-0.005$ | $-0.001$ | 0.006 |
| Model 6 | | $\Delta \Pr(I=1)$ | $\Delta \Pr(J=1)$ | $\Delta \Pr(I,J=0)$ |
| $\tau$ | Min $\rightarrow$ Max | 0.101 | 0.013 | $-0.114$ |
| | $\pm\frac{1}{2}$ S. D. | 0.032 | 0.004 | $-0.036$ |
| | $\pm 0.05$ | 0.012 | 0.001 | $-0.013$ |
| $IA$ | Min $\rightarrow$ Max | $-0.096$ | $-0.036$ | 0.132 |
| | $\pm\frac{1}{2}$ S. D. | $-0.030$ | $-0.011$ | 0.042 |
| Age | Min $\rightarrow$ Max | $-0.177$ | $-0.007$ | 0.185 |
| | $\pm\frac{1}{2}$ S. D. | $-0.048$ | $-0.002$ | 0.050 |
| | $\pm 0.5$ | $-0.004$ | 0.000 | 0.004 |

Table 4: Marginal effects on willingness to migrate, commute, or stay based on multinomial probit regressions of Models 3 and 6 (see tables 2 and 3) at mean values of all other independent variables.

2.1 percentage points. When students are excluded from the sample (Model 6), the marginal effects of $\tau$ on the migration propensity decline but are still substantial.

The (ceteris paribus) difference in the probability of being willing to migrate between the most risk averse individual in the sample and an otherwise identical risk neutral individual is -9.6 to -10.9 percentage points, depending on the model used. For the probability of being willing to commute, this difference is considerably smaller and ranges between -3.2 and -3.6 p. p. This supports the hypothesis that those with higher risk aversion have a lower probability of being willing to migrate or to commute abroad, but that the effect of risk aversion is more pronounced for the willingness to migrate. A centered one standard deviation rise in $IA$ is associated with a 3.0 to 3.4 p. p. lower probability of being willing to migrate, and a 1.0 to 1.1 p. p. lower cross-border commuting propensity.

The marginal effects of age in table 4 also illustrate that younger individuals are more willing to migrate, especially if students are excluded from the regression: as shown by the marginal effects derived from Model 6, the probability of being willing to migrate is 17.7 percentage points higher for an 18 year old individual than for a 64 year old. At the mean, a centered change of 1 year decreases the migration propensity by 0.4 to 0.5 p. p.

# 5 Summary and conclusions

The decision to become internationally mobile is always a decision under uncertainty. Individual risk attitudes can therefore be expected to affect the willingness to work abroad. Furthermore, as the gains of mobility become manifest in a stream of (higher) future incomes, the individual's preference for current vs. future consumption will also affect her willingness to become mobile. This paper analyzed the effect of time preference and risk aversion on an individual's willingness to migrate or commute across borders. The theoretical model shows that a higher rate of time preference (a lower discount rate) decreases the probability of being willing to migrate, while it has no effect on the willingness to commute. A higher risk aversion, on the other hand, should affect both the willingness to migrate as well as the willingness to commute negatively, but have a more pronounced effect on the migration propensity. Finally, as age decreases the maximum potential number of periods an individual can work abroad, older individuals should be less willing to migrate.

Using a unique data set on mobility intentions in the Austrian-Slovak border region, which also allows the calculation of the discount rate and a measure of risk aversion from hypothetical questions, the empirical analysis confirms these theoretical predictions: the probability of being willing to migrate is 9.6–10.9 percentage points higher for risk neutral individuals when compared to strongly risk averse individuals, the probability of being willing to commute is about 3.2 to 3.6 p. p. higher. An individual who does not discount future utility has an estimated willingness to migrate which is 10.1–16.5 percentage points higher than for the most myopic individuals in the sample. And a 1-year change in age is associated with a decrease in the willingness to migrate by 0.4–0.5 p. p., but has a negligible marginal effect on the commuting propensity. The empirical support for the theoretical hypotheses is enhanced if students, whose motives for international mobility are possibly driven by factors other than time preference and risk aversion (like the prestige or quality of educational institutions abroad), are excluded from the regression.

The results show that in border regions where cross-border commuting is possible, commuting will provide risk-averse or rather myopic individuals as well as older workers with an alternative to migration. These results can be extended beyond the Austrian-Slovak border region analyzed in the empirical section to other border regions where the institutional setting allows (or will allow in the future) the free movement of labor, as in the enlarged European Union. There are, however, some possibilities for future extensions. First, although the theoretical model does in principle allow for the possibility of return migration (or commuting abroad only for a limited time), the intended

time the individual plans to work abroad is still assummed to be exogenous. Second, it is also assumed that the choice of the point of time the individual moves abroad is given exogenously. These points highlight important topics for future research on the effect of individual risk aversion and time preference on cross-border migration and commuting.

Despite these limitations, the analysis helps to shed more light on the role of individual time preference and risk aversion as determinants of cross-border commuting and migration decisions, which is especially important for integrating border regions. It also shows that theories about international migration cannot simply be transferred to cross-border commuting, as the two types of mobility are driven by different factors, and common determinants affect the decisions to migrate or to commute across the border in different intensities. Explicitly considering the possibility of cross-border commuting in theoretical as well as empirical models therefore increases our understanding of the drivers of cross-border labor mobility and of the functioning of labor markets in border regions. More research on the determinants of migration and cross-border commuting, as well as the interdependencies between the two types of mobility, is therefore needed.

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# Appendix

## A Deriving the empirical measures of time preference and risk aversion from survey data

The discussion in this appendix proceeds along the lines of Ventura (2003) and Eisenhauer and Ventura (2003). Starting from an intertemporal utility function like (1) or (2) the responses to the first two hypothetical questions $y_1$ and $y_2$ (see page 9) can be interpreted as reservation prices above which the offer to receive the prize instantly would be turned down. This allows us to define:

$$\begin{aligned} u(w_t + p - y_1) + \tau u(w_{t+1}) &= u(w_t) + \tau u(w_{t+1} + p) \\ u(w_t + p - y_2) + \tau^2 u(w_{t+2}) &= u(w_t) + \tau^2 u(w_{t+2} + p) \end{aligned} \tag{A1}$$

From equations (A1) it can immediately be seen that $\tau = 1$ if $y_1 = y_2 = 0$. Assuming that income in all periods is equal ($w_{t+1} = w_{t+2} = \overline{w}$), a second order Taylor expansion of the equations in (A1) around $\overline{w}$ yields (after some rearrangements) two equations in two unknowns, $\tau$ and $u(\overline{w})$:

$$\begin{aligned} \left[u'(\overline{w})p + 0.5u''(\overline{w})p^2\right](1-\tau) &= u'(\overline{w})y_1 + u''(\overline{w})\left[py_1 - 0.5y_1^2\right] \\ \left[u'(\overline{w})p + 0.5u''(\overline{w})p^2\right](1-\tau^2) &= u'(\overline{w})y_2 + u''(\overline{w})\left[py_2 - 0.5y_2^2\right] \end{aligned} \tag{A2}$$

Computing the ratio of the expressions in (A2)

$$\frac{(1-\tau^2)}{(1-\tau)} = \frac{u'(\overline{w})y_2 + u''(\overline{w})\left[py_2 - 0.5y_2^2\right]}{u'(\overline{w})y_1 + u''(\overline{w})\left[py_1 - 0.5y_1^2\right]}$$

and solving for $\tau$ gives

$$\tau = \frac{u'(\overline{w})y_2 + u''(\overline{w})\left[py_2 - 0.5y_2^2\right]}{u'(\overline{w})y_1 + u''(\overline{w})\left[py_1 - 0.5y_1^2\right]} - 1 \tag{A3}$$

Using the definition of the Arrow-Pratt (Pratt, 1964; Arrow, 1965) coefficient of absolute risk aversion

$$A(w) = -\,u''(w)/\,u'(w)$$

we can insert $u''(\overline{w}) = -A(w)u'(\overline{w})$ in equation (A3) to obtain:

$$\tau = \frac{y_2 - A(w)\left[py_2 - 0.5y_2^2\right]}{y_1 - A(w)\left[py_1 - 0.5y_1^2\right]} - 1 \tag{A4}$$

To calculate $\tau$ we thus need an empirical value for the coefficient of absolute risk aversion. Following Eisenhauer and Ventura (2003), Ventura (2003) and Guiso and Paiella (2008), this coefficient can be calculated from the third hypothetical question (see page 9). Again, the amount stated $l$ can be interpreted as a reservation price above which the individual would not purchase the lottery ticket. This reservation price must satisfy:

$$0.5u(\overline{w} + p - l) + 0.5u(\overline{w} - l) = u(\overline{w}) \tag{A5}$$

Eisenhauer and Ventura (2003) and Ventura (2003) use a second-order Taylor expansion of this expression around $\overline{w}$ to find a measure of $A(w)$, yielding, after some rearrangements,

$$u'(p - 2l) + \left(0.5p^2 - pl + l^2\right) u'' = 0$$

Using this formula, the coefficient of absolute risk aversion could be calculated from the data as:

$$A(w) = -\frac{u''(\overline{w})}{u'(\overline{w})} = \frac{p - 2l}{0.5p^2 - pl + l^2} \tag{A6}$$

Risk-neutral individuals are characterized by $A(w) = 0$, which occurs when individuals are willing to pay $p/2$ (the expected payoff of the lottery) for the lottery ticket. Values of $A(w) < 0$ (willingness to pay above expected payoff, $l > p/2$) indicates risk-loving individuals, and a positive value $A(w) > 0$ ($l < p/2$) indicates risk aversion. While expression (A6) gives a computable measure for the coefficient of absolute risk aversion without having to specify the functional form of the individual's utility function it is, however, constrained within the interval $[-2/p, 2/p]$ as $l$ moves from $p$ to zero and may thus underestimate true risk aversion.[29]

Eisenhauer and Ventura (2009, p. 6) thus propose an alternative interval measure of absolute risk aversion which is calculated not from the derivative of the utility function, but from discrete changes in utility:

$$IA = \frac{p - 2l}{pl - l^2} \tag{A7}$$

This coefficient has the advantage that it can not only capture local risk aversion for marginal changes in wealth, but allows the analysis of risk attitudes over risks of any magnitude. As expected, $IA \to \infty$ as $l \to 0$. Furthermore, $IA = 0$ if the willingness to pay for the lottery equals the expected payoff ($l = p/2$,

[29] E. g., as pointed out by Guiso and Paiella (2008), one would expect the true risk aversion to approach infinity as $l \to 0$. In formula (A6), however, it approaches $p/2$ as the willingness to pay for the lottery goes to zero.

risk-neutral individuals), $IA > 0$ if the expected payoff exceeds the individual's willingness to pay ($l < p/2$, risk-averse individuals) and is negative if $l > p/2$ (risk-loving individuals). Indeed, as shown by Eisenhauer and Ventura (2009, p. 4), $IA$ is a generalization of the Arrow-Pratt coefficient of absolute risk aversion and approaches $A(w) = -u''(\overline{w})/u'(\overline{w})$ for small risks (as $p \to 0 \wedge l \to 0$). Using (A7) as coefficient of absolute risk aversion $A(w)$ in equation (A4), the discount factor $\tau$ is therefore calculated from the data as:

$$\tau = \frac{y_2 - \frac{p-2l}{pl-l^2}\left(py_2 - 0.5y_2^2\right)}{y_1 - \frac{p-2l}{pl-l^2}\left(py_1 - 0.5y_1^2\right)} - 1$$

which gives equation (7) on page 10.

# B Infinite risk aversion

As noted on page 11, 501 observations with $l = 0$ were excluded from the sample because the formula to calculate the measure of risk aversion from our survey data (8) is undefined for these observations. A zero willingness to pay can, however, be interpreted as infinite risk aversion since $\lim_{l\to 0} IA = \infty$. To consider these observations in the estimation of the willingness to migrate or to commute, we can therefore include a dummy variable $IA = \infty$ which takes on the value 1 for these undefined values of $IA$ and zero otherwise while setting $IA = 0$ for those observations with $l = 0$. Because $IA$ also enters the calculation of the discount rate $\tau$, formula (7) will be replaced by

$$\lim_{IA\to\infty} \tau = \frac{py_2 - 0.5y_2^2}{py_1 - 0.5y_1^2} - 1$$

for the observations with $l = 0$ (and $IA = \infty$), which can be shown by the rule of l'Hôpital. Using this new formula, 470 additional observations can now be considered in the empirical analysis, bringing the total number of observations to be used in the estimation to 1,680 observations.[30] Table B1 shows the results of multinomial probit regressions including the $IA = \infty$ dummy variable. For the results in table B2, students are again excluded, decreasing the sample to 1,526 observations. Table B3 shows the marginal effects of the full specifications in tables B1 and B2, Models 9 and 12.

As shown by the results of the multinomial probit regression, the qualitative conclusions are unaffected by the inclusion of the observations with $l = 0$, emphasizing the robustness of the results in the main section of the paper. The

[30] 792 from interviews conducted in Vienna, and 888 from interviews conducted in the Bratislava and Trnava regions. 31 of the 501 observations excluded before because of $l = 0$ had to be dropped because $\lim_{IA\to\infty} \tau$ yields $\tau > 1$.

| | Model 7 | | | Model 8 | | | Model 9 | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| | Migrating | Commuting | Migrating | Migrating | Commuting | Migrating | Migrating | Commuting | Migrating |
| | vs. | vs. | vs. | vs. | vs. | vs. | vs. | vs. | vs. |
| Variables | Staying | Staying | Commuting | Staying | Staying | Commuting | Staying | Staying | Commuting |
| $\tau$ | 0.867*** | 0.311 | 0.556** | 0.880*** | 0.323 | 0.557** | 0.888*** | 0.344 | 0.544* |
| | (0.208) | (0.246) | (0.268) | (0.209) | (0.246) | (0.269) | (0.219) | (0.255) | (0.278) |
| $IA$ | −0.805*** | −0.591** | −0.214 | −0.761*** | −0.547** | −0.213 | −0.590*** | −0.464* | −0.126 |
| | (0.199) | (0.246) | (0.266) | (0.202) | (0.247) | (0.267) | (0.206) | (0.253) | (0.273) |
| $IA = \infty$ | −0.694*** | −0.642*** | −0.052 | −0.617*** | −0.593*** | −0.024 | −0.497*** | −0.527*** | 0.030 |
| | (0.120) | (0.155) | (0.166) | (0.122) | (0.157) | (0.167) | (0.127) | (0.162) | (0.173) |
| Age | | | | −0.028*** | −0.017*** | −0.011** | −0.024*** | −0.013*** | −0.011** |
| | | | | (0.004) | (0.005) | (0.005) | (0.004) | (0.005) | (0.005) |
| Single | | | | | | | 0.002 | −0.014 | 0.015 |
| | | | | | | | (0.111) | (0.136) | (0.145) |
| Kids | | | | | | | −0.338*** | −0.285* | −0.052 |
| | | | | | | | (0.118) | (0.147) | (0.159) |
| Network | | | | | | | 0.475*** | 0.539*** | −0.065 |
| | | | | | | | (0.104) | (0.129) | (0.138) |
| Previous mobility | | | | | | | 0.745*** | −0.102 | 0.847*** |
| | | | | | | | (0.136) | (0.195) | (0.196) |
| Female | | | | | | | −0.269*** | −0.098 | −0.171 |
| | | | | | | | (0.100) | (0.124) | (0.132) |
| Vocational educ. | | | | | | | −0.151 | −0.370** | 0.219 |
| | | | | | | | (0.157) | (0.188) | (0.200) |
| Secondary educ. | | | | | | | −0.461*** | −0.588*** | 0.126 |
| | | | | | | | (0.159) | (0.189) | (0.201) |
| Tertiary educ. | | | | | | | −0.123 | −0.362* | 0.239 |
| | | | | | | | (0.172) | (0.205) | (0.218) |
| Foreign lang. | | | | | | | 1.172*** | 1.445*** | −0.274 |
| | | | | | | | (0.219) | (0.335) | (0.367) |
| Constant | −1.292*** | −1.554*** | 0.262 | −0.244 | −0.910*** | 0.666** | −1.473*** | −2.224*** | 0.751 |
| | (0.179) | (0.209) | (0.230) | (0.228) | (0.273) | (0.296) | (0.368) | (0.483) | (0.526) |
| Observations | | 1,680 | | | 1,680 | | | 1,680 | |
| Log-likelihood | | -1354.975 | | | -1326.644 | | | -1244.902 | |

Table B1: Multinomial probit regression of willingness to migrate, commute, or stay. Standard errors in parentheses. *** significant at 1 %, ** significant at 5 %, * significant at 10 %.

| | Model 10 | | | Model 11 | | | Model 12 | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| | Migrating | Commuting | Migrating | Migrating | Commuting | Migrating | Migrating | Commuting | Migrating |
| | vs. | vs. | vs. | vs. | vs. | vs. | vs. | vs. | vs. |
| Variables | Staying | Staying | Commuting | Staying | Staying | Commuting | Staying | Staying | Commuting |
| $\tau$ | 0.551** | 0.196 | 0.355 | 0.595*** | 0.217 | 0.377 | 0.540** | 0.212 | 0.327 |
| | (0.217) | (0.260) | (0.283) | (0.218) | (0.260) | (0.284) | (0.230) | (0.273) | (0.296) |
| $IA$ | −0.776*** | −0.613** | −0.163 | −0.736*** | −0.580** | −0.156 | −0.571*** | −0.515* | −0.057 |
| | (0.212) | (0.263) | (0.286) | (0.213) | (0.264) | (0.287) | (0.219) | (0.272) | (0.295) |
| $IA = \infty$ | −0.578*** | −0.593*** | 0.015 | −0.526*** | −0.564*** | 0.037 | −0.396*** | −0.497*** | 0.100 |
| | (0.127) | (0.164) | (0.176) | (0.129) | (0.165) | (0.178) | (0.134) | (0.172) | (0.184) |
| Age | | | | −0.023*** | −0.012** | −0.011** | −0.020*** | −0.008 | −0.012** |
| | | | | (0.004) | (0.005) | (0.006) | (0.005) | (0.005) | (0.006) |
| Single | | | | | | | −0.055 | 0.024 | −0.079 |
| | | | | | | | (0.117) | (0.145) | (0.155) |
| Kids | | | | | | | −0.330*** | −0.234 | −0.095 |
| | | | | | | | (0.122) | (0.152) | (0.165) |
| Network | | | | | | | 0.424*** | 0.571*** | −0.147 |
| | | | | | | | (0.111) | (0.138) | (0.149) |
| Previous mobility | | | | | | | 0.766*** | −0.066 | 0.832*** |
| | | | | | | | (0.143) | (0.204) | (0.207) |
| Female | | | | | | | −0.301*** | −0.229* | −0.072 |
| | | | | | | | (0.107) | (0.133) | (0.142) |
| Vocational educ. | | | | | | | −0.117 | −0.369* | 0.252 |
| | | | | | | | (0.166) | (0.201) | (0.215) |
| Secondary educ. | | | | | | | −0.594*** | −0.691*** | 0.097 |
| | | | | | | | (0.174) | (0.209) | (0.226) |
| Tertiary educ. | | | | | | | −0.085 | −0.341 | 0.256 |
| | | | | | | | (0.180) | (0.216) | (0.230) |
| Foreign lang. | | | | | | | 1.120*** | 1.599*** | −0.479 |
| | | | | | | | (0.224) | (0.390) | (0.418) |
| Constant | −1.162*** | −1.541*** | 0.379 | −0.281 | −1.083*** | 0.802** | −1.301*** | −2.487*** | 1.186** |
| | (0.185) | (0.220) | (0.241) | (0.245) | (0.297) | (0.322) | (0.392) | (0.551) | (0.594) |
| Observations | | 1,526 | | | 1,526 | | | 1,526 | |
| Log-likelihood | | -1184.815 | | | -1169.555 | | | -1090.055 | |

Table B2: Multinomial probit regression of willingness to migrate, commute, or stay. Students excluded. Standard errors in parentheses.
*** significant at 1 %, ** significant at 5 %, * significant at 10 %.

| Model 9 | | $\Delta \Pr(I=1)$ | $\Delta \Pr(J=1)$ | $\Delta \Pr(I,J=0)$ |
|---|---|---|---|---|
| $\tau$ | Min $\rightarrow$ Max | 0.141 | 0.011 | $-0.152$ |
| | $\pm\frac{1}{2}$ S. D. | 0.045 | 0.002 | $-0.047$ |
| | $\pm 0.05$ | 0.018 | 0.001 | $-0.019$ |
| $IA$ | Min $\rightarrow$ Max | $-0.102$ | $-0.030$ | 0.132 |
| | $\pm\frac{1}{2}$ S. D. | $-0.030$ | $-0.008$ | 0.038 |
| $IA=\infty$ | $0 \rightarrow 1$ | $-0.086$ | $-0.040$ | 0.126 |
| Age | Min $\rightarrow$ Max | $-0.213$ | $-0.028$ | 0.241 |
| | $\pm\frac{1}{2}$ S. D. | $-0.062$ | $-0.008$ | 0.070 |
| | $\pm 0.5$ | $-0.005$ | $-0.001$ | 0.005 |
| Model 12 | | $\Delta \Pr(I=1)$ | $\Delta \Pr(J=1)$ | $\Delta \Pr(I,J=0)$ |
| $\tau$ | Min $\rightarrow$ Max | 0.086 | 0.006 | $-0.093$ |
| | $\pm\frac{1}{2}$ S. D. | 0.026 | 0.001 | $-0.028$ |
| | $\pm 0.05$ | 0.011 | 0.001 | $-0.011$ |
| $IA$ | Min $\rightarrow$ Max | $-0.092$ | $-0.033$ | 0.125 |
| | $\pm\frac{1}{2}$ S. D. | $-0.027$ | $-0.010$ | 0.037 |
| $IA=\infty$ | $0 \rightarrow 1$ | $-0.065$ | $-0.037$ | 0.102 |
| Age | Min $\rightarrow$ Max | $-0.177$ | $-0.010$ | 0.186 |
| | $\pm\frac{1}{2}$ S. D. | $-0.047$ | $-0.003$ | 0.050 |
| | $\pm 0.5$ | $-0.004$ | 0.000 | 0.004 |

Table B3: Marginal effects on willingness to migrate, commute, or stay based on multinomial probit regressions of Models 9 and 12 (see tables B1 and B2) at mean values of all other independent variables.

dummy variable for infinite risk aversion is significant in the migration and commuting regressions, and the negative signs of its coefficients show that both the migration and commuting propensities are significantly lower for highly risk averse individuals. According to the marginal effects in table B3, the impact of the $IA=\infty$ dummy variable on the probability of being willing to migrate is slightly lower than the effect of a change in $IA$ from the minimum to the maximum observed values in the sample. For the probability of being willing to commute, the marginal effect of $IA=\infty$ is only slightly larger. Generally, it can therefore be asserted that the empirical results are highly robust and largely unaffected by the choice of specifications or changes in the empirical strategy.