

The environmental cost of the international job market for economists

Supplementary Appendices

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July 11, 2022

A Details of the computations

A.1 Data on participants

For each annual meeting, we know the place of departure of the candidates (inferred from their IP address), of the recruiters (from their institutional affiliation) and the place of arrival (conference venue). We complement our dataset with the official list of institutions that conducted interviews at the EEA Congress in Rotterdam, as reported by the European Economic Association. We also web-scrape job postings from the American Economic Association website and include all institutions that announced their presence at the AEA Meeting in San Diego. Although not all interviews are arranged via www.econjobmarket.com, we estimate that the database covers about 95% of candidates in Rotterdam and 80% in San Diego at each meeting (see Appendix B hereafter).

A.2 Data on distance

The figures include return trips between cities of residence and cities of meetings. We use data from Google Maps to compute the distance and travel duration between pairs of cities. For rail, we use the Distance Matrix API developed by Google Maps to precisely measure the rail distance between departure and arrival railway stations. We identify the fastest train journey to reach Rotterdam or San Diego, and collect information on the exact rail distance for these trips. For plane, we compute the geodesic distance between the closest airports from residence cities and international airports of Rotterdam and San Diego, respectively. We make the conservative assumption that candidates and recruiters chose to travel by rail if the fastest train journey was shorter than 6 hours (as in [Jäckle, 2019](#); 5 hours, or [Neugebauer et al., 2020](#); 8 hours). We believe that this assumption is conservative in the sense that

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we probably under-estimate the number of plane passengers and the emissions associated with this type of transportation. For plane, we account for the fact that the great distance circle underestimates actual distance, hence actual emissions (Jäckle, 2019) mainly for three reasons. First, direct flights are not usually available and connecting flight implies another landing and take-off cycle, and a longer distance - between 20% (Klöwer et al., 2020) and 32% (Astudillo and AzariJafari, 2018). Second, even for direct flights, the great circle distance is not followed due to (expected) detours related to air routes and (unexpected) detours due to traffic, congestion and weather-driven diversions. This represents 5% to 14% longer distance for Reynolds (2014) or 14.3% for Baumeister and Leung (2021). Third, transfers between the place of residence and the airport of departure, and between the airport of arrival and conference centers, generate extra distance (with unknown transportation modes). Overall, we choose to apply a 1.2 factor to the great circle distance (as in Jäckle 2019). Finally, we make another conservative assumption by assuming that recruitment committees only include two members.

A.3 Data on emissions (see also Table 1)

For train, we consider the fastest trip between departure and arrival railway stations. We decompose the total trip into several portions, corresponding to the distance travelled in each country, and compute the CO₂-eq emissions associated with each portion. If no detailed information on the specific journey is available, we multiply the country-specific rail distance with the country average railway emission per km. When additional information on the journey is available (Thalys, Eurostar, French high-speed train and specific trains in the Paris area), we manually check which train is used for the journey, and use the specific emission information for this itinerary.

For plane, we should account for the fact that CO₂-eq emission per passenger/km are distance-dependent, and that they should cover direct greenhouse gas emissions as well as radiative forcing due to aviation-induced cirrus or altocumulus, generation of ozone by NO_x, and destruction of methane by NO_x. We rely on the best available emission calculator to date, from the Atmosfair German carbon offsetting non-profit organization (as did Klöwer et al., 2020). It provides emission estimates based on actual planes used by actual companies operating actual routes, under plausible assumptions (load factor, cargo share, economic/business split, ...) for 92% of the world traffic (Atmosfair, 2021). We compute the emissions for 30 routes between San Diego and Rotterdam on the one hand, and various capitals from countries candidates or recruiters are originated from on the other hand. We then choose the emission averages that include radiative forcing (in gCO₂-eq/km/passenger) for three classes: 225 for short-haul (<1,500 km), 205 for medium-haul (1,500-5,000 km) and 260 for long-haul (>5,000 km).

For accommodations, we do not consider CO₂-eq emissions. Although there is some evidence that the annual average energy consumption per m² in residential buildings is on average 33% lower than in hotel both in Europe and the USA (European Commission, 2021; Goldstein et al., 2020; Ricaurte and Jagarajan, 2021), too many uncertainties surround the calculations to obtain a reasonable estimate. In particular, we do not know the remaining fraction of home energy consumption while participants are at the hotel, nor the average surface per person, the type of residence, the rate of room occupancy, the number of nights spent without

additional emissions during the travel ...

We assume that an online instead of a face-to-face interview brings together one candidate with two recruiters for 30 minutes, and generates an extra consumption of 46.3 Watt-hour per hour of connection with laptop, Wi-Fi and HD video ([Kamiya, 2020](#)), hence 46.3 Watt-hour $\times$ 0.5 hours $\times$ 3 people = 69.45 Watt-hour per online interview. This leads to an average CO₂-eq emissions associated with one hour of videoconference of 9.26 grams per person ([Kamiya, 2020](#)). We do not factor in any other extra electricity consumption with respect to working from home, considering that the average energy mix of the participants in their places of residence does not significantly differ from the one in San Diego and Rotterdam.

A.4 Data on time lost

Time lost (i.e., opportunity cost of time) corresponds to the non-productive professional time related to mobility that could have been otherwise used to work. We adopt a conservative view by assuming that candidates and recruiters lose two hours of work per train trip and three hours per plane trip.

A.5 Data on economic values (see also Table 1)

Climate-related costs correspond to the costs associated with CO₂-eq emissions. Other external costs correspond to the other sources of costs associated with electricity consumption and transports (accidents, local air pollution, noise, congestion, well-to-tank, habitat). As above, we distinguish rail and air transports. For rail, we consider an average climate-related cost of €0.026 and other external cost of €0.026 per passenger kilometer ([European Commission, 2019](#)) based on electric train travel. Regarding plane, we distinguish the costs between short haul (<1,500 km), medium haul (1,500-5,000 km) and long haul (>5,000 km) because of differences in the type of aircraft, the number of passengers and the relative duration of take-off and landing phases with respect to steady flight phases. We consider average climate-related costs of €0.0426 for short haul, €0.0281 for medium haul and €0.0322 for long haul per passenger kilometer, and the average costs for other external components of €0.0187 for short haul, €0.0096 for medium haul and €0.0098 for long haul per passenger kilometer ([European Commission, 2019](#)). With regard to electricity consumption associated with online interviews, we consider the weighted external costs for climate change and other external effects per kWh for the European Union and the United States ([European Commission, 2020](#)).

For private costs directly related to participation in the job market pre-screening interviews, we assume that candidates and recruiters spend three nights at each meeting and consider an average conservative hotel price of €80 per night ([Where and When, 2022](#)). We do not account for the cost of meals taken during the conference as we assume it does not differ from the cost of meals taken at the workplace. For transport, fares depend on many country-specific parameters. However, we consider an average conservative price per passenger kilometer of €0.13 if travelers take a train ([European Commission, 2016](#), Figure 4.12), €0.13 if they take a plane ([Rome2Rio, 2018](#)), a surprising similarity. For electricity, we use [GlobalPetrolPrices \(2021\)](#) to compute the average price per kWh for the 33 countries of the participants. It is based on seven data points calculated at the average annual household consumption of electricity, and at 25%, 50%, 75%, 150%, 200% and 300% of the average

consumption level. It amounts to €0.18 per kWh (in June 2021), hence €0.0082 per hour of online connection and per person.

Regarding the valuation of time lost, we obtain country-specific estimates of the average hourly wages of recruiters and candidates based on [European Commission \(2007\)](#). For the former, we consider average wages of researchers; for the latter, we consider average wages of researchers with less than four years of experience. Based on today’s typical academic wages in the UK (drawn from [Data Commons, 2022](#); [Indeed, 2022](#) and [Payscale, 2022](#)), we compute the growth rate since 2006 and apply this same linear trend to all countries. As for the few countries which were not reviewed in [European Commission \(2007\)](#), we assume a constant wage-to-GDP ratio across countries and compute average hourly wages from the following relationship at time t : $wage^{country_t}/wage^{UK_t} = GDP\ per\ capita^{country_t}/GDP\ per\ capita^{UK_t}$.

Table 2 compares total emissions and costs associated with the 2019-20 edition of the job market meetings with three alternative scenarios. In Scenario 1, we propose an alternative in-person system where all recruiters conduct interviews at both EEA and AEA meetings while candidates only go to the closest meeting. In Scenario 2, we propose a hybrid system where both recruiters and candidates only go to their closest meeting. In this second scenario, interviews that cannot be conducted in-person are conducted online. In Scenario 3, we propose a fully virtual system where all interviews are conducted online.

The first row compares the total distance covered by candidates and all recruiters in 2019-20. The second row compares associated CO₂-eq emissions. In the first three columns, CO₂-eq emissions result from candidates’ and recruiters’ journeys between their residence and conference venues. In the last column, CO₂-eq emissions result from the energy used to conduct online interviews. The third and fourth rows detail the climate-related and other external costs for each scenario. The fifth row presents the private costs associated with each scenario, which include transport (train/plane tickets and public transportation between the train stations/airports and the conference venues) and accommodations costs. The sixth row represents the valuation of non-productive professional time spent in transportation.

B Estimation of the numbers of missing candidates and recruiters in the database

Table 3 describes the available data from the Econ Job Market (EJM) database, broken down by annual meeting. The database does not contain all interviews organized during the meetings, because some recruiters could arrange interviews by email or by other platforms rather than on www.econjobmarket.org. Hence, the overall numbers of recruiters (r_{tot}) and candidates (c_{tot}) are missing, but the former can be obtained from other sources and the latter can be estimated.

We denote as “non-observed recruiters” (r_{no}) and “non-observed candidates” (c_{no}), individuals that took part in an annual meeting, but that we do not observe in the database. We denote as “observed recruiters” and “observed candidates”, the participants who are present in the EJM database. We obtain the number of non-observed recruiters from public informa-

tion on job offers and from personal communication with the EEA: 98 in Rotterdam, leading to $r_{tot}=155$, and 245 in San Diego, leading to $r_{tot}=288$.

For the estimation of the number of non-observed candidates, let's assume that the probability that a candidate is interviewed does not depend on the type of the employer (i.e., observed or non-observed in the database), and that the average numbers of interviews by recruiters (int_r) and by candidates (int_c) do not depend on their types either (i.e., observed or non-observed). The probability of not observing a candidate in the EJM database, denoted by π , corresponds to the probability that this candidate has only been interviewed by non-observed recruiters. For a candidate with x interviews, $\pi = [\Gamma(r_{no} + 1)/\Gamma((r_{no} + 1) - x)]/[\Gamma(r_{tot} + 1)/\Gamma((r_{tot} + 1) - x)]$, where $\Gamma(\cdot)$ is the gamma function.

The average number of interviews of observed candidates by observed recruiters ($int_{c_{no}}$) is known (3,001), as well as the average number int_r of interviews by recruiters. We are then looking for the average numbers of interviews per candidate (int_c) such that $(c_o/(1 - \pi)) \times int_c = r_{tot} \times int_r$, where π is defined as above with $x \equiv int_c$. By trial and error, we converge to $\pi=3.6\%$ in Rotterdam and $\pi=21.7\%$ in San Diego, meaning that the database contains 96.4% and 78.3% of candidates. The high estimated proportion of observed candidates is due to the fact that, typically, each candidate has several interviews at the meetings: as long as a candidate has one interview from an observed recruiter, s/he is observed in the database.

In our calculation, we assumed that π is computed on int_c , the average number of interviews by candidates. However, it should rely on the whole distribution of the numbers of interviews, which is unknown. When we relax this assumption by conducting sensitivity analyses on several bimodal distributions having int_c as mean value, we conclude that the EJM platform covers at least 95.5% of the candidates in Rotterdam, and 77.3% in San Diego.

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Table 1: Parameters used in computations.

Parameter	Value	Unit	Source
Emissions:			
Plane (short haul)	225	g CO ₂ -eq/passenger km	Atmosfair (2021) ^a
Plane (medium haul)	205	g CO ₂ -eq/passenger km	Atmosfair (2021) ^a
Plane (long haul)	260	g CO ₂ -eq/passenger km	Atmosfair (2021) ^a
Train (Belgium, average)	48.4	g CO ₂ -eq/passenger km	www.bilans-ges.ademe.fr
Train (England, average)	75	g CO ₂ -eq/passenger km	www.bilans-ges.ademe.fr
Train (Europe, Eurostar)	11.2	g CO ₂ -eq/passenger km	www.sncf.com ^b
Train (Europe, Thalys)	11.6	g CO ₂ -eq/passenger km	www.sncf.com ^b
Train (France, local)	29.2	g CO ₂ -eq/passenger km	www.sncf.com ^b
Train (France, High Speed)	3.2	g CO ₂ -eq/passenger km	www.sncf.com ^b
Train (France, Transilien)	6.4	g CO ₂ -eq/passenger km	www.sncf.com ^b
Train (Germany, average)	66.8	g CO ₂ -eq/passenger km	www.bilans-ges.ademe.fr
Train (Netherlands, average)	76.3	g CO ₂ -eq/passenger km	www.bilans-ges.ademe.fr
Train (United States, average)	70	g CO ₂ -eq/passenger km	Klöwer et al. (2020) and Miller (2021) ^c
Online	9.26	g CO ₂ -eq/hour	Kamiya (2020) ^d
CO₂-related costs:			
Plane (short haul)	0.0239	€/passenger km	European Commission (2019) ^e
Plane (medium haul)	0.0185	€/passenger km	European Commission (2019) ^e
Plane (long haul)	0.0224	€/passenger km	European Commission (2019) ^e
Train	0	€/passenger km	European Commission (2019) ^e
Online	0.00218	€/hour	European Commission (2020) ^f
Other external costs:			
Plane (short haul)	0.0187	€/passenger km	European Commission (2019) ^e
Plane (medium haul)	0.0096	€/passenger km	European Commission (2019) ^e
Plane (long haul)	0.0098	€/passenger km	European Commission (2019) ^e
Train (average Belgium)	0.028	€/passenger km	European Commission (2019) ^e
Train (average England)	0.015	€/passenger km	European Commission (2019) ^e
Train (average France)	0.014	€/passenger km	European Commission (2019) ^e
Train (average Germany)	0.036	€/passenger km	European Commission (2019) ^e
Train (average Netherlands)	0.016	€/passenger km	European Commission (2019) ^e
Train (average United States)	0.041	€/passenger km	European Commission (2019) ^e
Online	0.00225	€/hour	European Commission (2020) ^f
Private costs:			
Plane	0.13	€/passenger km	Rome2Rio (2018) ^g
Train	0.13	€/passenger km	European Commission (2016) ^h
Online	0.0082	€/hour/person	GlobalPetrolPrices (2021) ⁱ
Accommodation	80	€/night	Where and When (2022)
Value of time lost:			
Average hourly wages	See sources	€/participant	European Commission (2007) ^j

Notes: This table details the values of the parameters used in our computations. ^a Average from the values obtained in atmosfair flight emission calculator (see text). ^b <https://www.sncf-connect.com/en-ch/help/calculation-co2-emissions-your-train-journey>. ^c Average from these two sources. ^d Electricity use of streaming, scenario B, and International Energy Agency global average electricity mix. ^e Table 70 for bus and electric train, Table 72 for plane. ^f Weighted average EU and US of climate cost and other effects in Table 3.1. ^g <https://www.rome2rio.com/labs/2018-global-flight-price-ranking/> ^h Average of international fares, month in advance and week in advance, Figure 4.12. ⁱ Average for the countries of the participants (see text). ^j Complemented by Data Commons, 2022; Indeed, 2022; Payscale, 2022 and own computations (see text).

Table 2: Overall emissions and economic assessment.

	Estimations	Counterfactual scenarios		
	2019-2020	Scenario 1	Scenario 2	Scenario 3
Distance (in km)	22,026,368	30,157,262	11,911,022	0
Emissions (in kg CO ₂ -eq)	4,817,493	6,513,121	2,749,273	42
CO ₂ -eq-related costs (in €)	469,169	648,624	242,165	10
Other external costs (in €)	224,572	304,625	125,626	10
Private costs (in €)	3,409,988	4,584,368	1,980,080	37
Value of time lost in transportation (in €)	342,283	454,625	275,086	0
Overall economic assessment (in €)	4,446,012	5,992,241	2,622,957	57

Notes: This table compares the estimated costs associated with the International job market for economists for the academic year 2019/2020 with 3 counterfactual scenarios. In Scenario 1, recruiters go to both meetings while European and non European job market candidates respectively go to the European/American meeting. In Scenario 2, European (non-European) recruiters and candidates only go to the European (American) meetings. Interviews between European (non European) candidates and non European (European) recruiters are conducted online. In Scenario 3, job market meetings are conducted online. Emissions and associated costs take into account return trips. The overall economic assessment sums up private, opportunity, CO₂-eq-related and other external costs.

Sources: econjobmarket.org and authors' computations.

Table 3: Interviews, candidates and recruiters in EJM and complementary data

Job market meeting:	Rotterdam	San Diego
Number of interviews: (observed in EJM database)	1,720	1,281
Number of candidates: (observed in EJM database)	637	719
Number of recruiting institutions: (observed in EJM database)	57	43
Number of recruiting institutions (r_{no}): (not observed in EJM database)	98	245
Total number of recruiting institutions (r_{tot}):	155	288

Notes: This table presents the number of interviews, candidates and recruiting institutions observed in Econ Job Market (EJM) data. It also includes the number of recruiting institutions who conducted interviews at Rotterdam (San Diego) but that are not included in the EJM database. For Rotterdam, we obtained this information from personal communication from the European Economic Association. For San Diego, we obtained this information from vacancies advertised on the website of the American Economic Association. **Sources:** econjobmarket.org, European Economic Association, American Economic Association.