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Schelling's Conjecture on Climate and Development: A Test

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Abstract: We use the integrated assessment model *FUND* to compute the income elasticities of climate change impacts for different world regions over time. We find limited support for Schelling's Conjecture that development might be the best defense against climate change impacts, and for the idea that the impacts from climate change might be akin to a "luxury good". For very poor regions, an increase in income in the short run is an effective tool to reduce impacts from climate change by making those societies less vulnerable, in particular to infectious diseases. While net climate impacts appear to be akin to a luxury good for some countries at specific times, that effect disappears in the long run as impacts from agriculture make up a large share of total impacts.

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1. Introduction

A decade ago Thomas Schelling proposed a controversial hypothesis: the best defense for poor societies against climate change impacts might be to develop quickly. This would be a more promising strategy for poor countries than to control greenhouse gas emissions (Schelling 1992). We test this hypothesis with the integrated assessment model FUND. Out of a number of otherwise similar models FUND is unique in its rich representation of the interplay of economic development and climate change impacts. We find support for Schelling's hypothesis in very poor regions. Once regions have reached a certain level of development, further increases in development no longer reduce the impacts from climate change, though.

Most integrated assessment models assume functional forms for the impacts of climate change that mask any such effect. One example is the influential DICE model and its derivatives (Nordhaus and Boyer 2000; Nordhaus 2008). The damage function in DICE is a function of the global average temperature increase since pre-industrial times; it returns the welfare impact of climate change as a percentage of GDP. By assumption, therefore, damages from climate change always increase with GDP, and proportionally so.

Tol (1995) was the first to model vulnerability to climate change as an explicit function of development, breaking the ground for the analysis of the trade-off between development and climate policy (Tol and Dowlatabadi 2001; Tol 2005; Tol 2007; Tol *et al.* 2007). Building on the work of Horowitz (2002), Hoel and Sterner (2007) suggest that the welfare impacts of climate change might be related in a more complicated way to consumption of other goods. As an example, they show that, with a constant elasticity of substitution utility function in consumption and environmental quality, the precise assumptions about the substitutability between consumption and environmental can make a significant impact on the effective discount rate to be used for an intertemporal setting. Sterner and Persson (2008) take this work a step further and replace the standard utility function in Nordhaus' DICE model with one of the form suggested in Hoel and Sterner (2007) and compute the optimal greenhouse gas mitigation paths under various parametric assumptions. Their results indicate clearly that relative prices matter, confirming the earlier conclusions of Hasselmann et al. (1997) and Yang (2003). Their numerical results on the other hand are not based on any empirical estimate of climate damages, so their results are probably best treated as an indication that the interaction between consumption levels and environmental impacts can be an important aspect in the evaluation of climate impacts, but that further research would be required to quantify this effect.

Weitzman (2010) also investigates the functional form of the damage function from a theoretical point of view. He develops a general damage function that is isomorphic to a setup with a utility function that depends both on consumption and environmental quality. His general damage function embeds two special types of damage functions, namely an additive and a multiplicative form, both of which have been discussed previously in the literature and correspond to two damage functions discussed below.

The FUND model is the only integrated assessment model that specifies the relationship between temperature increases and income increases on human welfare in some detail. There are three features that make it uniquely suited to investigate the relationship between economic development and climate impacts. First, it has regionally disaggregated estimates of climate impacts. This allows for a differentiated view that takes into account different levels of development of different regions. Second, climate impacts in FUND are specified separately for different kinds of impacts that effect human welfare. As such, structural differences between regions in the vulnerability to climate change impacts are accounted for: FUND will not produce impacts from e.g. sea-level rise if a region doesn't have a coast line. Finally, different kinds of impacts react differently to development (income, urbanization, age structure, economic structure, technology) in the affected region.

This structure of the FUND model allows us to compute the overall income elasticity of climate impacts for each region over time. Such an estimate will mainly depend on the income elasticities that have been estimated in previous work for each individual kind of impact and the share each of these impacts has in total impacts. An estimate of the income elasticity of impacts is a first attempt to answer the original question: How do impacts in different regions change at the margin if that society was a tiny bit wealthier than in the assumed scenarios of economic growth and development? And will that increase in wealth or development reduce or increase the impacts from climate change?

We present the precise methodology used in section 2 and a description of the integrated assessment model FUND in section 3. Section 4 presents and discusses results, and section 5 concludes and hints at further research topics.

2. Concepts

2.1. Income Elasticities of Climate Change Damages

The main contribution of this paper is to compute the income elasticities of climate change impacts along a business as usual path. We will first briefly repeat the standard definition of the income elasticity of damages and how we computed it with FUND and then point out why this is an interesting exercise with the FUND model, but not with a range of other, simpler models.

Let the impacts of climate change at a particular point in time in a particular region be given as

(1) $$D_{tr} = D_{tr}(Y_{tr}, S_{tr}).$$

Here D_{tr} is the total impact in the unit of equivalent consumption, expressed in USD, in region r at time t. We assume that impacts depend on income Y_{tr} in the same region at the same time as well as on a vector of other variables S_{tr}.

Our definition of the income elasticity of the damages is just the standard one. First define

(2) $$\Delta D_{tr} \equiv D_{tr}(Y_{tr} + \Delta Y, S_{tr}) - D_{tr}(Y_{tr}, S_{tr})$$

to be the change in damages at time t in region r from the addition of a small extra amount of income ΔY. The income elasticity of impacts in region r at time t is then readily given by

(3) $$\epsilon_{tr} = \frac{\Delta D_{tr}}{\Delta Y} \frac{Y_{tr}}{D_{tr}}.$$

2.2. A classification

The interpretation of a positive vs negative income elasticity of impacts changes with the sign of the total impacts. For beneficial impacts from climate change, a positive income elasticity means that those benefits increase with income, whereas a negative income elasticity implies that the beneficial impacts from climate change decrease with income. If climate change is harmful, a negative income elasticity means that rising incomes reduce those harmful impacts, whereas a positive income elasticity implies that anincome rise increases the harmful impacts from climate change.

Above, we discuss four different regimes for the income elasticity of the impact of climate change. The effect is reversed for net positive and net negative impacts, and the policy implications are different if the marginal impacts from emission reductions are negative or positive. This is set out in Table 1.

Income elasticities larger than one have a special significance: they suggest that the valuation of climate change impacts not only increases with an increase in income, but that the increase in valuation of the climate impact is even larger in percentage term than the increase in income. Such cases are similar to "luxury goods" from standard economics, i.e. things that people care more about the wealthier they get.

2.3. Functional Forms for Damage Functions

We next discuss two specific functional damage forms that have been used or discussed in the climate change economics literature, followed by an introduction to the damage function used by FUND.

The widely used DICE integrated model of climate change uses the following specific functional form for climate change impacts:

(4) $$D_{tr}^{DICE}(Y) = Y - \frac{Y}{1+\psi T_{tr}^{2}}.$$

Here D_{tr}^{DICE} is climate change impact at time t in region r, ψ is a parameter and T_{tr} is the assumed temperature increase at time t in region r of the underlying model. In this specification, the income elasticity is 1.

Others have suggested that the appropriate damage function should not depend at all on income, i.e. that impacts from climate change are absolute and do not depend economic development. In our framework this damage function would have the form

(5) $$D_{tr}^{ADD}(Y) = F(T_{tr}).$$

Here D_{tr}^{ADD} is climate change impact at time t in region r, $F(\cdot)$ is simply some function of the temperature that is assumed in the scenario for which climate damages are to be computed.

Again, computing the income elasticity for such a damage function is trivial: it is 0.

In the FUND model the damage function has a much richer form that doesn't allow for such a trivial computation of income elasticities. FUND's damage function is the sum of individual damages functions for different types of impacts or sectors:

(6) $D_{tr}^{FUND}(Y) = \sum_s D_{trs}(Y).$

$D_{trs}(\cdot)$ is the damage function for sector s in region r at time t, assuming a given temperature trajectory. The individual damage functions in FUND range from fairly simple functional forms to complex sub-models of e.g. sea-level rise. For the purpose of this paper the main observation is that for each type of impact the income elasticity is different and calibrated to estimates from the impacts and valuation literature. As such, the income elasticity that we compute for a specific region and time will depend on the assumed income elasticities of the various damage categories that are accounted for in FUND and the shares of the various impact categories in the total impacts of a given region.

3. The Model

This paper uses version 3.6 of the *Climate Framework for Uncertainty, Negotiation and Distribution* (*FUND*). Version 3.6 of *FUND* corresponds to version 1.6 (Tol 1999; Tol 2001; Tol 2002c) except for the impact module described in (Tol 2002a; Tol 2002b; Link and Tol 2004). A full list of papers, the source code, and the technical documentation for the model can be found on line at http://www.fund-model.org.

In many ways, *FUND* is a standard integrated assessment model (Tol 1997; Tol 1999; Guo *et al.* 2006; Tol 2006). It has simple representations of the demography, economy, energy, emissions, and emission reduction policies for 16 regions. It has simple representations of the cycles of greenhouse gases, radiative forcing, climate, and sea level rise. In other ways, though, *FUND* is unique. It is alone in the detail of its representation of the impacts of climate change. Impacts on agriculture, forestry, water use, energy use, the coastal zone, hurricanes, ecosystems, and health are all modelled separately – both in "physical" units and their monetary value (Tol 2002a; Tol 2002b). Moreover, *FUND* allows vulnerability to climate change impacts to be an explicit function of the level and rate of regional development (Tol 2005; Tol *et al.* 2007).

The climate impact module (Tol 2002a; Tol 2002b) includes the following categories: agriculture, forestry, sea level rise, cardiovascular and respiratory disorders related to cold and heat stress, malaria, dengue fever, schistosomiasis, diarrhoea, energy consumption, water resources, unmanaged ecosystems and tropical and extra tropical storms. All impacts are monetised.

4. Results

Table 2 and 3 show the estimated income elasticities of climate change impacts for ten selected years and all 16 regions of the FUND model. Table 2 shows the elasticities for regions and times with estimated damages from climate change. Table 3 shows elasticities for regions and times with estimated benefits from climate change.

We removed income elasticity estimates for time periods that are adjacent to a switch from beneficial to harmful impacts. These elasticities are estimated very close to zero impacts and are distorted by limited numerical precision.

Income elasticities vary greatly between regions and change over time. They range from <-1 to >1, which suggests that depending on the circumstances of the society affected, additional income might reduce or increase impacts from climate change. This confirms earlier findings about climate change impacts: They are highly heterogeneous across time and space and aggregated net world impact estimates hide a lot of the distributional consequences of climate impacts. The observation also suggests that what we have come to call Schelling's Conjecture might be true for some regions in some time periods but not as a general feature of climate impacts.

If the income elasticity of impacts is greater than unity, impacts and impacts relative to income rise with income. In this case, the discount rate would effectively fall in a reduced-complexity model a la Sterner and Persson (2008). Only the former Soviet Union (FSU), North Africa (NAF) and Sub-Saharan Africa (SSA) never have an income elasticity larger than 1 (for the period analyzed in this paper). The reason is that the damage categories that have income elasticities larger than 1 in FUND -- namely biodiversity loss, dryland loss, wetland loss and emigration and immigration due to sea-level rise -- do not play a significant role in these regions. Sea-level rise is less of an issue in the former Soviet Union because most of its coast is uninhabited. In Africa, coastal protection rapidly expands with development. Forced migrations would rarely move to any of these three regions. Finally, all three regions value biodiversity loss less than is the case in other regions due to their relatively slow economic development.

In the regions with net damages that do have income elasticities larger than 1, the income elasticity falls over time and eventually drops below 1 (sometimes after 2100, not shown in Table 2). The main driver for this result is the shift in the composition of damages. As temperatures reach higher levels in later periods, the impacts in particular in the agricultural sector start to dominate the total damages. In FUND, it is assumed that the impacts from agriculture have an income elasticity <1 so that the growing importance of agriculture reduces the overall income elasticity of impacts.

If the income elasticity of impacts is negative, Schelling's Conjecture may hold. Development policy would reduce the impact of climate change, and may be preferred over greenhouse gas emission reduction.

Among regions and times with net damages, only the former Soviet Union and Sub-Saharan Africa ever have negative income elasticities. In the former Soviet Union this effect is only present in the first decade, and in sub-Saharan Africa it quickly disappears towards the middle of the century. In the former Soviet Union this is driven by a stark reduction in diarrhea deaths. In sub-Saharan Africa, improvements in basic health care also explain the negative income elasticity: Both diarrhea and malaria deaths constitute a large portion of total damages in poor sub-Saharan Africa and these infectious diseases rapidly fall with economic growth. Once Sub-Saharan Africa has left its extreme poverty (an assumption made in all of the commonly used socio economic scenarios employed in climate change analysis), the further reduction in deaths from these diseases from an incremental increase in income is reduced.

So far, we discussed the case of net damages of climate change. Climate change also has positive impacts, and these may dominate the negative effects in some periods and regions. In this case, the interpretation of the income elasticities changes. The income elasticities for these cases are presented in Table 3. The estimated income elasticities for these cases show a much more homogenous picture than for net damages. Most income elasticities in this case are between 0 and 1, suggesting that while absolute benefits from higher temperatures would increase with higher incomes, relative benefits fall. Income elasticities fall over time in almost all cases.

The main benefits are increased agricultural yield (CO_2 fertilization in all regions and a more beneficial climate in some) and reductions in heating costs. Heating benefits saturate over time, once a region has reached a climate that does not require any heating anymore at all, further temperature increases are not yielding any further benefits. For both sectors, the income elasticities are between 0 and 1 and that explains why the overall income elasticities for regions and times with net benefits stay in the same range.

5. Conclusion

We used the integrated assessment model FUND to compute the income elasticities of climate change impacts for different world regions over time. We find limited support for both Schelling's Conjecture that development might be the best defense against climate change impacts and the idea that the impacts from climate change might be akin to a "luxury good".

For very poor societies, we find strong confirmation of Schelling's Conjecture. Impacts are dominated by health impacts in those regions and those are the kinds of impacts that fade dramatically as societies develop and get richer. While we do not see this effect for more than a few decades, this result is most likely driven by strong, and maybe questionable, assumptions of the underlying socio economic scenario. Almost all scenarios that are used in climate change analysis make strong assumptions about economic development. Today's very poor regions are assumed to develop quickly, and for all practical purposes no single region will be "left behind" or stay at a development level as seen today. This seems an area for future research: if some regions stay poor throughout the century, it is highly likely that even small increases in wealth might be the best way to lower the harmful impacts from climate change.

For wealthier regions we see that at least until temperatures reach high levels, climate impacts show characteristics of a "luxury good", i.e. the valuation of a given temperature increase reacts more than proportional to an increase in income. But this effect wanes at later times, once agricultural impacts begin to dominate the total damage estimates.

In some cases we can clearly say that either more development (i.e. an increase in income) or emission reductions would have a beneficial effect on climate impacts, and not the other. Those cases are presented in Table 4. In later years in particular, when climate change gets more severe, emission reduction clearly dominates as a tool to reduce climate impacts (note though, that we only look at the effect of development on impacts. While impacts might increase with an increase in income, that situation might still be preferred because impacts might increase slower than income).

The conclusions we take from our results are twofold. First, we believe our results show that careful empirical analysis that takes into account regional and sectorial heterogeneities is required to answer bold questions such as whether climate change impacts are a luxury good or whether development might be the best approach to lower climate impacts. Most likely, simple answers cannot be found, in many cases the answer will depend crucially on the circumstances. Our results rest on a large number of assumptions, but we believe the finding that income elasticities vary greatly between regions and time is a robust result. Second, we also believe that the few results on very poor regions (essentially sub-Saharan Africa for the first couple of decades of this century) make for a compelling argument along Schelling's Conjecture, namely that especially for very poor regions development is key to avoid the worst impacts from climate change.

Our results carry a long list of caveats with them. They are based on a single model, on a single assumed scenario of economic development, they span time frames for which predictions of socio economic development are highly difficult and the damage functions that are used are estimated on very limited data sets from a few geographical locations and are then extrapolated to the rest of the world. Our analysis ignores all aspects of uncertainty, in particular the potential for catastrophic but unlikely outcomes. The potential for catastrophes has been suggested as the real reason for concern about climate change (Weitzman 2009). More research in this area, especially more original studies of climate change impacts, would certainly be most welcome.

Our results should be of interest for quite a large number of issues that have been discussed in the climate change economics literature in recent years. First, as Schelling has pointed out himself (Schelling 1999) there is a direct connection between discounting and distributional questions and the income elasticity of climate impacts. A marginal change in income will also change marginal utility of a region, and when a Ramsey framework is used, this will change the discount rate. It is the interaction of the effect on the discount rate and on the estimated damages that will determine how the net present value of impacts changes when income changes, they key measure that would drive today's policy decisions. Second, the income elasticities of impacts should also have an effect on risk adjustments to the computation of the net present value of expected damages, when uncertainty is introduced into a model like FUND. Future research on both questions would be most welcome.

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Results

		$\epsilon < 0$	$\epsilon > 0$
I < 0	dI < 0	D-,R-	D+,R- D>R
	dI > 0	D-,R+ R>D	D+,R+
I > 0	dI < 0	D+,R- D>R	D-,R-
	dI > 0	D+,R+	D-,R+ R>D

Table 1. The eight alternative cases for the effect of emission reduction and development on the impact of climate change; ϵ = income elasticity; I = net impact; dI = marginal impact; D-/+: development policy has a harmful/beneficial effect on the impact of climate change; R-/+: emission reduction has a harmful/beneficial effect on the impact of climate change; D>/<R: development /climate policy is preferred over climate / development policy.

	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
ANZ										
CAM										1.22
CAN									2.21	1.50
CHI										0.96
EEU						2.18	1.47	1.22	1.09	1.01
FSU	-0.23	0.13	0.43	0.61	0.70	0.75	0.78	0.80	0.81	0.81
JPK										
LAM				0.43	1.19	1.33	1.35	1.31	1.27	1.22
MDE										
NAF	0.85	0.94	0.94	0.95	0.94	0.93	0.91	0.90	0.88	0.86
SAS									1.75	1.19
SEA						1.91	1.43	1.20	1.08	1.00
SIS										
SSA	-0.60	-0.31	-0.09	0.11	0.29	0.46	0.60	0.69	0.74	0.77
USA			1.34	1.17	1.08	1.03	0.99	0.97	0.94	0.92
WEU			3.03	1.88	1.48	1.27	1.15	1.07	1.01	0.92

Table 2: Estimated income elasticicities for harmful impacts from climate change

	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
ANZ	0.62	0.62	0.62	0.61	0.61	0.60	0.59	0.58	0.56	0.53
CAM	0.97	0.82	0.72	0.64	0.56	0.45	0.20			
CAN	0.49	0.44	0.37	0.27	0.11	-0.20				
CHI	0.70	0.69	0.67	0.66	0.65	0.63	0.58			
EEU	0.50	0.34	0.02							
FSU										
JPK	0.56	0.55	0.55	0.54	0.54	0.53	0.51	0.49	0.45	0.40
LAM	9.77									
MDE	0.78	0.84	0.79	0.76	0.74	0.72	0.70	0.67	0.64	0.56
NAF										
SAS	0.64	0.35	0.23	0.14	0.06	-0.16				
SEA	-0.74	-1.10	-2.11							
SIS	0.78	0.75	0.93	0.82	0.74	0.69	0.62	0.52		
SSA										
USA										
WEU										

Table 3: Estimated income elasticities for beneficial impacts from climate change

	2010	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
ANZ		D>R	D>R	D>R	D>R	D>R				
CAM		D>R	D>R	D>R						R>D
CAN		D>R				R>D			R>D	R>D
CHI		D>R	D>R	D>R						R>D
EEU		D>R	D>R			R>D	R>D	R>D	R>D	R>D
FSU			R>D	R>D	R>D	R>D	R>D	R>D	R>D	R>D
JPK		D>R	D>R	D>R	D>R	D>R	D>R			
LAM				R>D	R>D	R>D	R>D	R>D	R>D	R>D
MDE	D>R	D>R	D>R	D>R	D>R					
NAF	R>D		R>D	R>D	R>D	R>D	R>D	R>D	R>D	R>D
SAS		D>R	D>R	D>R		R>D			R>D	R>D
SEA	R>D					R>D	R>D	R>D	R>D	R>D
SIS		D>R	D>R	D>R						
SSA				R>D	R>D	R>D	R>D	R>D	R>D	R>D
USA			R>D	R>D	R>D	R>D	R>D	R>D	R>D	R>D
WEU				R>D	R>D	R>D	R>D	R>D	R>D	R>D

Table 4: Preferred policy (R=reduction of emissions, D=development, shaded cells have beneficial impacts from climate change)

Acronym	Name	Countries
USA	USA	United States of America
CAN	Canada	Canada
WEU	Western Europe	Andorra, Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Liechtenstein, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino, Spain, Sweden, Switzerland, United Kingdom
JPK	Japan and South Korea	Japan, South Korea
ANZ	Australia and New Zealand	Australia, New Zealand
EEU	Central and Eastern Europe	Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Hungary, FYR Macedonia, Poland, Romania, Slovakia, Slovenia, Yugoslavia
FSU	Former Soviet Union	Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan
MDE	Middle East	Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, West Bank and Gaza, Yemen
CAM	Central America	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama
SAM	South America	Argentina, Bolivia, Brazil, Chile, Colombia, French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela
SAS	South Asia	Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan, Sri Lanka
SEA	Southeast Asia	Brunei, Cambodia, East Timor, Indonesia, Laos, Malaysia, Myanmar, Papua New Guinea, Philippines, Singapore, Taiwan, Thailand, Vietnam
CHI	China plus	China, Hong Kong, North Korea, Macau, Mongolia
NAF	North Africa	Algeria, Egypt, Libya, Morocco, Tunisia, Western Sahara
SSA	Sub-Saharan Africa	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Congo-Brazzaville, Congo-Kinshasa, Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea- Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mauritania, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe
SIS	Small Island States	Antigua and Barbuda, Aruba, Bahamas, Barbados, Bermuda, Comoros, Cuba, Dominica, Dominican Republic, Fiji, French Polynesia, Grenada, Guadeloupe, Haiti, Jamaica, Kiribati, Maldives, Marshall Islands, Martinique, Mauritius, Micronesia, Nauru, Netherlands Antilles, New Caledonia, Palau, Puerto Rico, Reunion, Samoa, Sao Tome and Principe, Seychelles, Solomon Islands, St Kitts and Nevis, St Lucia, St Vincent and Grenadines, Tonga, Trinidad and Tobago, Tuvalu, Vanuatu, Virgin Islands

Table 5: FUND Regions

	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
ANZ	29,966	35,848	42,027	48,368	54,663	61,164	68,438	76,477	84,517	92,188
CAM	3,835	4,896	6,223	7,892	9,994	12,693	16,260	20,942	26,474	32,692
CAN	27,239	32,453	38,118	43,966	49,760	55,712	62,328	69,591	76,860	83,818
CHI	1,344	1,774	2,364	3,151	4,193	5,571	7,391	9,759	12,525	15,550
EEU	4,015	5,701	7,893	10,385	12,919	15,590	18,843	22,724	26,571	29,951
FSU	2,431	3,452	4,779	6,289	7,823	9,440	11,410	13,760	16,090	18,136
JPK	42,326	50,635	59,361	68,318	77,211	86,393	96,667	108,021	119,377	130,213
LAM	5,007	6,394	8,126	10,306	13,050	16,574	21,232	27,346	34,570	42,689
MDE	3,098	3,956	5,027	6,376	8,073	10,254	13,135	16,918	21,387	26,410
NAF	1,572	2,007	2,551	3,235	4,096	5,203	6,665	8,584	10,851	13,400
SAS	580	740	941	1,193	1,511	1,919	2,459	3,167	4,003	4,944
SEA	2,096	2,676	3,401	4,313	5,461	6,936	8,886	11,444	14,468	17,866
SIS	1,413	1,804	2,293	2,908	3,682	4,676	5,990	7,715	9,754	12,044
SSA	606	774	984	1,248	1,580	2,007	2,571	3,312	4,187	5,170
USA	38,745	46,162	54,220	62,538	70,779	79,247	88,657	98,989	109,328	119,225
WEU	31,658	37,863	44,424	51,177	57,896	64,810	72,465	80,837	89,226	97,282

Table 6: Income per capita in the FUND scenario, in 1995 USD

Year	Number	Title/Author(s) ESRI Authors/Co-authors *Italicised*
2011		
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	381	Trade Liberalisation and Climate Change: A CGE Analysis of the Impacts on Global Agriculture Alvaro Calzadilla, Katrin Rehdanz and *Richard S.J. Tol*
	380	The Marginal Damage Costs of Different Greenhouse Gases: An Application of FUND David Anthoff, Steven Rose, *Richard S.J. Tol* and Stephanie Waldhoff
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