

Natural capital and aggregate income growth

Dale T. Manning^{1*} and Ed Barbier²

¹Baker School and Agricultural and Resource Economics, University of Tennessee, Knoxville, TN, USA and ²Department of Economics, Colorado State University, Fort Collins, CO, USA

*Corresponding author. E-mail: dtmanning@utk.edu

ONLINE APPENDIX

Appendix A. Cobb Douglas and Factor Substitutability

Following the convention of much of the growth accounting literature, we assume a Cobb-Douglas aggregate production function, which now has three factors – physical, human, and natural capital (see also Monge-Naranjo *et al.* (2019)).

However, assuming a three-factor Cobb-Douglas aggregate production function has implications for factor substitutability. As in the two-factor case, the elasticity of substitution between factors is one, provided that the third factor remains constant. This also implies that the factors are substitutes. A change in the price ratio of any two of the factors induces the economy to use larger amounts of the relatively cheaper factor.

This could be a highly restrictive representation of aggregate production in an economy using three factors, such as physical, human, and natural capital. When any price ratios change, all the amounts of each type of capital should adjust and not necessarily in the same direction. As a result, the substitution elasticities can be either positive or negative. That is, any two factors may be substitutes, when larger amounts of one of them is associated with smaller amounts of the other, or they can be complements, when larger amounts of one factor is associated with a larger amount of the other.

There are two ways of avoiding these implications. One is to use a more generalized multi-factor aggregate production function with natural capital, as employed by Brandt *et al.* (2017). However, this approach requires time series and cross-country data on the price, or returns, to all capital including natural capital, which currently limits its application in many countries. The second alternative is to adopt a flexible functional representation of production with three or more factors, such as a translog specification. Although such a specification may avoid some of the substitutability limitations of Cobb-Douglas aggregate production, a translog function should be treated, at best, as a second-order approximation to the true but unknown production process.

Appendix B. *Equivalence of output elasticities and shares in aggregate income*

$$\max_{L_{jt}, K_{jt}} \pi = A_{jt} L_{jt}^{\alpha} N_{jt}^{\delta} K_{jt}^{1-\alpha-\delta} - wL_{jt} - rK_{jt} - sN_{jt}$$

$$\frac{\partial \pi}{\partial L_{jt}} = \alpha A_{jt} L_{jt}^{\alpha-1} N_{jt}^{\delta} K_{jt}^{1-\alpha-\delta} - w = 0$$

Multiplying both sides by L_{jt} :

$$\alpha A_{jt} L_{jt}^{\alpha} N_{jt}^{\delta} K_{jt}^{1-\alpha-\delta} = wL_{jt}$$

$$\alpha Y_{jt} = wL_{jt}$$

The right-hand side is the payment to human capital in the economy, which is equal to the output elasticity times output value. Similarly for natural capital:

$$\delta Y_{jt} = sN_{jt}$$

And physical capital:

$$(1 - \alpha - \delta)Y_{jt} = rK_{jt}$$

Appendix C. Data Sources

Table A1: Data Summary

Variable	Source	Notes
Real GDP (in mil. 2011US\$)	PWT 10.0	rgdpna
Capital stocks		
Physical capital (in mil. 2011US PWT 10.0)	PWT 10.0	cn
Human capital (index)	PWT 10.0	Employees times human capital index per worker
Natural capital		
Cropland (sq. km)	FAOSTAT	
Pastureland (sq. km)	FAOSTAT, WDI	Average of FAOSTAT data and WB WDI calculation
Timberland (sq. km)	FAOSTAT	Area in plantation forest
Subsurface		
Minerals (tons)	World Bank	
Coal (tons)	World Bank	
Gas (tj)	World Bank	
Oil (barrels)	World Bank	
Share of GDP		
Physical capital	residual	1 minus sum of natural and human capital shares
Human capital	PWT 10.0	labsh
Natural capital		
Cropland	FAO, WDI, WB Methodology*	Share of land in crops times crop output value divided by GDP
Pastureland	FAO, WDI, WB Methodology*	Share of land in pasture times pasture output value divided by GDP
Timberland	WB WDI	
Subsurface		
Minerals (tons)	WB WDI	
Coal (tons)	WB WDI	
Gas (tj)	WB WDI	
Oil (barrels)	WB WDI	

*World Bank Methodology refers to World Bank (2018), and includes references to Avila and Evanson (2010), Coelli and Rao (2005), and Nin-Pratt and Yu (2008).

Appendix D. Country-specific results

Table A2: Country-specific results, 2001-2005, sorted by D

Country	Region	Income Level	TFP		D
			growth with NK	Relative NK dependence*	
Saudi Arabia	Middle East and North Africa	UM	0.081	-0.069	-0.069
Kuwait	Middle East and North Africa	H	0.243	-0.065	-0.065
Ecuador	Latin America and the Caribbean	LM	0.084	-0.041	-0.041
Rwanda	Sub-Saharan Africa	L	0.137	-0.033	-0.033
Chile	Latin America and the Caribbean	UM	0.052	-0.024	-0.024
Lao People's DR	East Asia and Pacific	L	-0.046	0.023	-0.023
Indonesia	East Asia and Pacific	L	0.084	-0.021	-0.021
Norway	Europe and Central Asia	H	0.061	-0.020	-0.020
China	East Asia and Pacific	LM	0.158	-0.020	-0.020
Mauritania	Sub-Saharan Africa	L	0.084	-0.018	-0.018
Brazil	Latin America and the Caribbean	UM	-0.036	0.017	-0.017
Argentina	Latin America and the Caribbean	UM	0.073	-0.017	-0.017
Colombia	Latin America and the Caribbean	LM	0.054	-0.014	-0.014
Australia	East Asia and Pacific	H	0.043	-0.013	-0.013
Bulgaria	Europe and Central Asia	LM	0.050	-0.012	-0.012
New Zealand	East Asia and Pacific	H	0.046	-0.012	-0.012
U.R. of Tanzania: Mainland	Sub-Saharan Africa	L	0.112	-0.011	-0.011
India	South Asia	L	0.098	-0.010	-0.010
Nicaragua	Latin America and the Caribbean	L	-0.009	0.008	-0.008
Romania	Europe and Central Asia	LM	0.273	-0.008	-0.008
Togo	Sub-Saharan Africa	L	-0.082	0.008	-0.008
South Africa	Sub-Saharan Africa	UM	0.081	-0.007	-0.007
Venezuela (Bolivarian Republic of)	Latin America and the Caribbean	UM	0.023	-0.006	-0.006
Kenya	Sub-Saharan Africa	L	0.011	-0.006	-0.006
Malaysia	East Asia and Pacific	UM	0.114	-0.005	-0.005
Canada	North America	H	0.011	-0.005	-0.005
Benin	Sub-Saharan Africa	L	0.006	-0.005	-0.005
Cameroon	Sub-Saharan Africa	L	0.049	-0.004	-0.004
Philippines	East Asia and Pacific	LM	0.080	-0.004	-0.004
Lithuania	Europe and Central Asia	LM	0.211	-0.003	-0.003
Lesotho	Sub-Saharan Africa	L	0.041	-0.003	-0.003
Thailand	East Asia and Pacific	LM	0.118	-0.003	-0.003
Croatia	Europe and Central Asia	UM	0.102	-0.003	-0.003
Fiji	East Asia and Pacific	LM	0.039	-0.003	-0.003
Zimbabwe	Sub-Saharan Africa	L	-0.269	0.003	-0.003
Peru	Latin America and the Caribbean	LM	0.082	-0.003	-0.003
Hungary	Europe and Central Asia	UM	0.108	-0.003	-0.003
United Kingdom	Europe and Central Asia	H	0.041	-0.003	-0.003
Sri Lanka	South Asia	LM	0.004	-0.002	-0.002
Poland	Europe and Central Asia	UM	0.090	-0.002	-0.002
Tunisia	Middle East and North Africa	LM	0.037	-0.002	-0.002
Denmark	Europe and Central Asia	H	0.027	-0.002	-0.002
Costa Rica	Latin America and the Caribbean	LM	0.004	-0.002	-0.002
Netherlands	Europe and Central Asia	H	0.011	-0.002	-0.002

Slovakia	Europe and Central Asia	UM	0.146	-0.002	-0.002
Eswatini	Sub-Saharan Africa	LM	0.219	-0.002	-0.002
Turkey	Europe and Central Asia	LM	0.148	-0.002	-0.002
Russian Federation	Europe and Central Asia	LM	0.229	-0.001	-0.001
Ireland	Europe and Central Asia	H	0.012	-0.001	-0.001
Burkina Faso	Sub-Saharan Africa	L	0.135	-0.001	-0.001
Jordan	Middle East and North Africa	LM	0.110	-0.001	-0.001
Estonia	Europe and Central Asia	UM	0.198	-0.001	-0.001
Mauritius	Sub-Saharan Africa	UM	0.015	-0.001	-0.001
United States	North America	H	0.056	-0.001	-0.001
Greece	Europe and Central Asia	H	0.057	-0.001	-0.001
Israel	Middle East and North Africa	H	0.016	-0.001	-0.001
Panama	Latin America and the Caribbean	UM	0.049	-0.001	-0.001
Uruguay	Latin America and the Caribbean	UM	0.022	-0.001	-0.001
Barbados	Latin America and the Caribbean	UM	0.032	-0.001	-0.001
Slovenia	Europe and Central Asia	H	0.099	-0.001	-0.001
Cyprus	Europe and Central Asia	H	0.031	-0.001	-0.001
Honduras	Latin America and the Caribbean	LM	0.069	0.000	0.000
Czech Republic	Europe and Central Asia	UM	0.137	0.000	0.000
Namibia	Sub-Saharan Africa	LM	0.096	0.000	0.000
Belgium	Europe and Central Asia	H	0.030	0.000	0.000
Portugal	Europe and Central Asia	H	0.004	0.000	0.000
China, Hong Kong SAR	East Asia and Pacific	H	0.088	0.000	0.000
Luxembourg	Europe and Central Asia	H	0.013	0.000	0.000
Germany	Europe and Central Asia	H	-0.001	0.000	0.000
Latvia	Europe and Central Asia	LM	0.266	0.000	0.000
Sweden	Europe and Central Asia	H	0.097	0.000	0.000
Finland	Europe and Central Asia	H	0.031	0.001	0.001
Italy	Europe and Central Asia	H	-0.051	-0.001	0.001
Spain	Europe and Central Asia	H	-0.027	-0.001	0.001
Bolivia (Plurinational State of)	Latin America and the Caribbean	LM	0.042	0.001	0.001
Armenia	Europe and Central Asia	L	0.544	0.001	0.001
Republic of Moldova	Europe and Central Asia	L	0.342	0.001	0.001
Gabon	Sub-Saharan Africa	UM	-0.028	-0.001	0.001
Jamaica	Latin America and the Caribbean	LM	-0.025	-0.002	0.002
Ukraine	Europe and Central Asia	L	0.267	0.002	0.002
Paraguay	Latin America and the Caribbean	LM	0.094	0.002	0.002
Central African Republic	Sub-Saharan Africa	L	-0.043	-0.002	0.002
Guatemala	Latin America and the Caribbean	LM	0.012	0.003	0.003
Botswana	Sub-Saharan Africa	UM	0.001	-0.006	0.004
Kyrgyzstan	Europe and Central Asia	L	0.031	0.004	0.004
Tajikistan	Europe and Central Asia	L	0.353	0.005	0.005
Dominican Republic	Latin America and the Caribbean	LM	0.038	0.005	0.005
Bahrain	Middle East and North Africa	UM	0.006	-0.019	0.008
Trinidad and Tobago	Latin America and the Caribbean	UM	0.190	0.010	0.010
Nigeria	Sub-Saharan Africa	L	0.205	0.015	0.015
Mexico	Latin America and the Caribbean	UM	-0.003	-0.015	0.015
Iran (Islamic Republic of)	Middle East and North Africa	LM	-0.008	0.039	0.023
Sierra Leone	Sub-Saharan Africa	L	0.268	0.033	0.033

Burundi	Sub-Saharan Africa	L	-0.039	-0.037	0.037
Mongolia	East Asia and Pacific	L	0.113	0.075	0.075
Angola	Sub-Saharan Africa	L	0.235	0.090	0.090
Kazakhstan	Europe and Central Asia	LM	0.192	0.100	0.100
Iraq	Middle East and North Africa	LM	-0.086	-0.111	0.111
Qatar	Middle East and North Africa	H	-0.012	-0.140	0.140

L = lower income; LM = lower middle income; UM = upper middle income; H = high income

* natural capital dependence defined as $\delta(n_{j,t} - k_{j,t})$

Table A3: Country-specific results, 2006-2010, sorted by D

Country	Region	Income Level	TFP growth with NK	Relative NK dependence*	D
Mongolia	East Asia and Pacific	L	-0.346	0.437	-0.255
Venezuela (Bolivarian Republic of)	Latin America and the Caribbean	UM	-0.191	0.140	-0.140
Gabon	Sub-Saharan Africa	UM	0.109	-0.092	-0.092
Iraq	Middle East and North Africa	LM	0.106	-0.092	-0.092
Angola	Sub-Saharan Africa	L	0.222	-0.073	-0.073
Mauritania	Sub-Saharan Africa	L	-0.213	0.072	-0.072
Burundi	Sub-Saharan Africa	L	0.066	-0.052	-0.052
Rwanda	Sub-Saharan Africa	L	0.096	-0.049	-0.049
China	East Asia and Pacific	LM	0.143	-0.036	-0.036
Australia	East Asia and Pacific	H	-0.031	0.033	-0.028
Tunisia	Middle East and North Africa	LM	0.068	-0.026	-0.026
India	South Asia	L	0.091	-0.019	-0.019
Burkina Faso	Sub-Saharan Africa	L	0.067	-0.018	-0.018
Iran (Islamic Republic of)	Middle East and North Africa	LM	0.030	-0.017	-0.017
Malaysia	East Asia and Pacific	UM	0.026	-0.015	-0.015
Indonesia	East Asia and Pacific	L	0.048	-0.012	-0.012
Bolivia (Plurinational State of)	Latin America and the Caribbean	LM	0.072	-0.012	-0.012
Estonia	Europe and Central Asia	UM	-0.081	0.010	-0.010
Namibia	Sub-Saharan Africa	LM	-0.085	0.010	-0.010
Peru	Latin America and the Caribbean	LM	0.088	-0.010	-0.010
Kyrgyzstan	Europe and Central Asia	L	0.069	-0.009	-0.009
Argentina	Latin America and the Caribbean	UM	0.051	-0.009	-0.009
Lesotho	Sub-Saharan Africa	L	0.254	-0.007	-0.007
Canada	North America	H	-0.053	0.006	-0.006
Central African Republic	Sub-Saharan Africa	L	0.103	-0.005	-0.005
Trinidad and Tobago	Latin America and the Caribbean	UM	0.031	-0.056	-0.005
Jordan	Middle East and North Africa	LM	-0.047	0.005	-0.005
Colombia	Latin America and the Caribbean	LM	0.013	-0.005	-0.005
Poland	Europe and Central Asia	UM	0.055	-0.005	-0.005
Philippines	East Asia and Pacific	LM	0.061	-0.005	-0.005
Zimbabwe	Sub-Saharan Africa	L	0.522	-0.004	-0.004
Kenya	Sub-Saharan Africa	L	0.045	-0.004	-0.004
Uruguay	Latin America and the Caribbean	UM	0.131	-0.004	-0.004
Paraguay	Latin America and the Caribbean	LM	0.100	-0.004	-0.004
Nicaragua	Latin America and the Caribbean	L	-0.024	0.003	-0.003
Costa Rica	Latin America and the Caribbean	LM	0.033	-0.003	-0.003

Nigeria	Sub-Saharan Africa	L	0.153	-0.003	-0.003
Armenia	Europe and Central Asia	L	-0.050	0.003	-0.003
Dominican Republic	Latin America and the Caribbean	LM	0.005	-0.007	-0.003
Greece	Europe and Central Asia	H	-0.100	0.003	-0.003
Sri Lanka	South Asia	LM	0.037	-0.002	-0.002
Russian Federation	Europe and Central Asia	LM	0.069	-0.002	-0.002
Eswatini	Sub-Saharan Africa	LM	0.005	-0.002	-0.002
Sierra Leone	Sub-Saharan Africa	L	0.085	-0.002	-0.002
Ecuador	Latin America and the Caribbean	LM	0.020	-0.038	-0.001
Cyprus	Europe and Central Asia	H	-0.039	0.001	-0.001
Slovenia	Europe and Central Asia	H	-0.021	0.001	-0.001
Mauritius	Sub-Saharan Africa	UM	0.026	-0.001	-0.001
Czech Republic	Europe and Central Asia	UM	0.032	-0.001	-0.001
Slovakia	Europe and Central Asia	UM	0.100	-0.001	-0.001
New Zealand	East Asia and Pacific	H	0.013	-0.001	-0.001
Sweden	Europe and Central Asia	H	0.007	0.000	0.000
China, Hong Kong SAR	East Asia and Pacific	H	0.064	0.000	0.000
Italy	Europe and Central Asia	H	-0.064	0.000	0.000
Luxembourg	Europe and Central Asia	H	-0.073	0.000	0.000
Belgium	Europe and Central Asia	H	-0.001	0.000	0.000
Croatia	Europe and Central Asia	UM	-0.088	0.000	0.000
Portugal	Europe and Central Asia	H	-0.013	0.000	0.000
United States	North America	H	0.001	0.000	0.000
Lithuania	Europe and Central Asia	LM	0.001	-0.003	0.001
Finland	Europe and Central Asia	H	-0.048	-0.001	0.001
Thailand	East Asia and Pacific	LM	0.036	0.001	0.001
Germany	Europe and Central Asia	H	-0.020	-0.001	0.001
Republic of Moldova	Europe and Central Asia	L	0.117	0.001	0.001
Spain	Europe and Central Asia	H	-0.019	-0.001	0.001
Israel	Middle East and North Africa	H	0.006	0.001	0.001
Benin	Sub-Saharan Africa	L	0.005	0.001	0.001
Ireland	Europe and Central Asia	H	-0.071	-0.001	0.001
Latvia	Europe and Central Asia	LM	-0.065	-0.001	0.001
Fiji	East Asia and Pacific	LM	-0.024	-0.001	0.001
Jamaica	Latin America and the Caribbean	LM	-0.046	-0.001	0.001
Barbados	Latin America and the Caribbean	UM	-0.036	-0.001	0.001
Netherlands	Europe and Central Asia	H	-0.017	-0.002	0.002
Turkey	Europe and Central Asia	LM	-0.098	-0.002	0.002
Panama	Latin America and the Caribbean	UM	-0.008	-0.002	0.002
Honduras	Latin America and the Caribbean	LM	-0.076	-0.002	0.002
Chile	Latin America and the Caribbean	UM	-0.040	-0.003	0.003
United Kingdom	Europe and Central Asia	H	-0.042	-0.004	0.004
Romania	Europe and Central Asia	LM	-0.034	-0.005	0.005
South Africa	Sub-Saharan Africa	UM	0.005	-0.015	0.005
Hungary	Europe and Central Asia	UM	-0.062	-0.007	0.007
Bulgaria	Europe and Central Asia	LM	-0.066	-0.010	0.010
Guatemala	Latin America and the Caribbean	LM	-0.006	-0.010	0.010
Denmark	Europe and Central Asia	H	-0.032	-0.011	0.011
Mexico	Latin America and the Caribbean	UM	-0.052	-0.011	0.011

Brazil	Latin America and the Caribbean	UM	0.041	0.012	0.012
U.R. of Tanzania: Mainland	Sub-Saharan Africa	L	0.010	0.012	0.012
Tajikistan	Europe and Central Asia	L	0.261	0.014	0.014
Ukraine	Europe and Central Asia	L	0.025	-0.071	0.022
Bahrain	Middle East and North Africa	UM	-0.080	-0.023	0.023
Botswana	Sub-Saharan Africa	UM	-0.110	-0.024	0.024
Norway	Europe and Central Asia	H	-0.043	-0.030	0.030
Lao People's DR	East Asia and Pacific	L	0.028	0.037	0.037
Togo	Sub-Saharan Africa	L	-0.005	0.055	0.045
Cameroon	Sub-Saharan Africa	L	-0.027	-0.047	0.047
Kazakhstan	Europe and Central Asia	LM	-0.025	0.137	0.086
Qatar	Middle East and North Africa	H	-0.043	-0.104	0.104
Saudi Arabia	Middle East and North Africa	UM	-0.043	-0.136	0.136
Kuwait	Middle East and North Africa	H	-0.185	-0.177	0.177

L = lower income; LM = lower middle income; UM = upper middle income; H = high income

* natural capital dependence defined as $\delta(n_{jt} - k_{jt})$

Table A4: Country-specific Results, 2011-2015, sorted by D

Country		Income Level	TFP growth with NK	Relative NK dependence*	D
Lao People's DR	East Asia and Pacific	L	-0.243	0.248	-0.238
Burkina Faso	Sub-Saharan Africa	L	-0.284	0.235	-0.235
Togo	Sub-Saharan Africa	L	0.506	-0.161	-0.161
Ukraine	Europe and Central Asia	L	-0.121	0.082	-0.082
Kyrgyzstan	Europe and Central Asia	L	-0.109	0.147	-0.071
Bolivia (Plurinational State of)	Latin America and the Caribbean	LM	0.099	-0.058	-0.058
Mauritania	Sub-Saharan Africa	L	0.094	-0.056	-0.056
Rwanda	Sub-Saharan Africa	L	0.108	-0.046	-0.046
Sierra Leone	Sub-Saharan Africa	L	0.048	-0.054	-0.042
Ecuador	Latin America and the Caribbean	LM	0.053	-0.038	-0.038
Angola	Sub-Saharan Africa	L	0.063	-0.024	-0.024
Kazakhstan	Europe and Central Asia	LM	0.104	-0.021	-0.021
Malaysia	East Asia and Pacific	UM	0.046	-0.021	-0.021
Mexico	Latin America and the Caribbean	UM	0.035	-0.018	-0.018
Indonesia	East Asia and Pacific	L	0.075	-0.018	-0.018
U.R. of Tanzania: Mainland	Sub-Saharan Africa	L	0.020	-0.022	-0.018
Gabon	Sub-Saharan Africa	UM	0.033	-0.049	-0.017
India	South Asia	L	0.115	-0.013	-0.013
Lesotho	Sub-Saharan Africa	L	0.131	-0.012	-0.012
Cameroon	Sub-Saharan Africa	L	0.096	-0.011	-0.011
Zimbabwe	Sub-Saharan Africa	L	0.090	-0.010	-0.010
Benin	Sub-Saharan Africa	L	0.250	-0.009	-0.009
Estonia	Europe and Central Asia	UM	0.010	-0.008	-0.008
Thailand	East Asia and Pacific	LM	0.092	-0.006	-0.006
Russian Federation	Europe and Central Asia	LM	0.022	-0.006	-0.006

New Zealand	East Asia and Pacific	H	0.039	-0.006	-0.006
Nigeria	Sub-Saharan Africa	L	0.100	-0.005	-0.005
Denmark	Europe and Central Asia	H	0.023	-0.005	-0.005
Netherlands	Europe and Central Asia	H	0.009	-0.005	-0.005
Guatemala	Latin America and the Caribbean	LM	-0.021	0.038	-0.005
Eswatini	Sub-Saharan Africa	LM	-0.009	0.016	-0.003
Canada	North America	H	0.007	-0.003	-0.003
Costa Rica	Latin America and the Caribbean	LM	0.019	-0.003	-0.003
Turkey	Europe and Central Asia	LM	0.019	-0.002	-0.002
Poland	Europe and Central Asia	UM	0.006	-0.002	-0.002
Colombia	Latin America and the Caribbean	LM	0.022	-0.002	-0.002
Sri Lanka	South Asia	LM	0.025	-0.002	-0.002
Philippines	East Asia and Pacific	LM	0.121	-0.002	-0.002
Romania	Europe and Central Asia	LM	0.056	-0.002	-0.002
United Kingdom	Europe and Central Asia	H	0.027	-0.002	-0.002
Hungary	Europe and Central Asia	UM	0.001	-0.001	-0.001
Czech Republic	Europe and Central Asia	UM	0.048	-0.001	-0.001
United States	North America	H	0.039	-0.001	-0.001
China	East Asia and Pacific	LM	0.009	-0.017	-0.001
Portugal	Europe and Central Asia	H	-0.014	0.001	-0.001
Republic of Moldova	Europe and Central Asia	L	0.048	-0.001	-0.001
Mauritius	Sub-Saharan Africa	UM	0.017	0.000	0.000
Germany	Europe and Central Asia	H	0.010	0.000	0.000
Barbados	Latin America and the Caribbean	UM	-0.015	0.000	0.000
Slovakia	Europe and Central Asia	UM	0.042	0.000	0.000
Belgium	Europe and Central Asia	H	0.011	0.000	0.000
Sweden	Europe and Central Asia	H	0.031	0.000	0.000
Croatia	Europe and Central Asia	UM	-0.029	0.000	0.000
Ireland	Europe and Central Asia	H	0.219	0.000	0.000
China, Hong Kong SAR	East Asia and Pacific	H	0.029	0.000	0.000
Spain	Europe and Central Asia	H	-0.003	0.000	0.000
Latvia	Europe and Central Asia	LM	0.079	0.000	0.000
Luxembourg	Europe and Central Asia	H	-0.007	0.000	0.000
Italy	Europe and Central Asia	H	-0.045	0.000	0.000
Central African Republic	Sub-Saharan Africa	L	-0.364	0.000	0.000
Jamaica	Latin America and the Caribbean	LM	-0.023	0.000	0.000
Finland	Europe and Central Asia	H	-0.053	-0.001	0.001
Slovenia	Europe and Central Asia	H	-0.004	-0.001	0.001
Israel	Middle East and North Africa	H	-0.013	-0.001	0.001
Cyprus	Europe and Central Asia	H	-0.051	-0.001	0.001
Lithuania	Europe and Central Asia	LM	0.058	0.001	0.001
Paraguay	Latin America and the Caribbean	LM	0.005	0.001	0.001
Norway	Europe and Central Asia	H	0.001	-0.003	0.002
Greece	Europe and Central Asia	H	-0.058	-0.002	0.002
Panama	Latin America and the Caribbean	UM	-0.108	-0.003	0.003
Nicaragua	Latin America and the Caribbean	L	0.050	0.004	0.004
Namibia	Sub-Saharan Africa	LM	0.005	-0.013	0.004
Bulgaria	Europe and Central Asia	LM	-0.015	-0.004	0.004
Honduras	Latin America and the Caribbean	LM	-0.019	-0.004	0.004

Uruguay	Latin America and the Caribbean	UM	0.016	0.005	0.005
Australia	East Asia and Pacific	H	0.011	0.005	0.005
Mongolia	East Asia and Pacific	L	0.173	0.005	0.005
Tunisia	Middle East and North Africa	LM	-0.005	-0.006	0.006
Argentina	Latin America and the Caribbean	UM	-0.083	-0.006	0.006
Jordan	Middle East and North Africa	LM	-0.078	-0.007	0.007
South Africa	Sub-Saharan Africa	UM	-0.043	-0.008	0.008
Dominican Republic	Latin America and the Caribbean	LM	0.019	0.009	0.009
Kenya	Sub-Saharan Africa	L	-0.006	-0.009	0.009
Botswana	Sub-Saharan Africa	UM	-0.047	-0.010	0.010
Brazil	Latin America and the Caribbean	UM	-0.096	-0.012	0.012
Fiji	East Asia and Pacific	LM	0.016	0.012	0.012
Iran (Islamic Republic of)	Middle East and North Africa	LM	-0.128	-0.012	0.012
Chile	Latin America and the Caribbean	UM	-0.016	-0.016	0.016
Iraq	Middle East and North Africa	LM	0.081	-0.179	0.018
Venezuela (Bolivarian Republic of)	Latin America and the Caribbean	UM	-0.106	-0.018	0.018
Armenia	Europe and Central Asia	L	0.145	0.020	0.020
Burundi	Sub-Saharan Africa	L	0.007	-0.035	0.020
Peru	Latin America and the Caribbean	LM	-0.004	-0.023	0.023
Bahrain	Middle East and North Africa	UM	-0.019	-0.024	0.024
Tajikistan	Europe and Central Asia	L	0.239	0.029	0.029
Trinidad and Tobago	Latin America and the Caribbean	UM	-0.143	-0.059	0.059
Saudi Arabia	Middle East and North Africa	UM	0.015	-0.110	0.080
Qatar	Middle East and North Africa	H	-0.130	-0.127	0.127
Kuwait	Middle East and North Africa	H	-0.028	-0.142	0.142

L = lower income; LM = lower middle income; UM = upper middle income; H = high income

* natural capital dependence defined as $\delta(n_{jt} - k_{jt})$

Appendix E. Online Figures

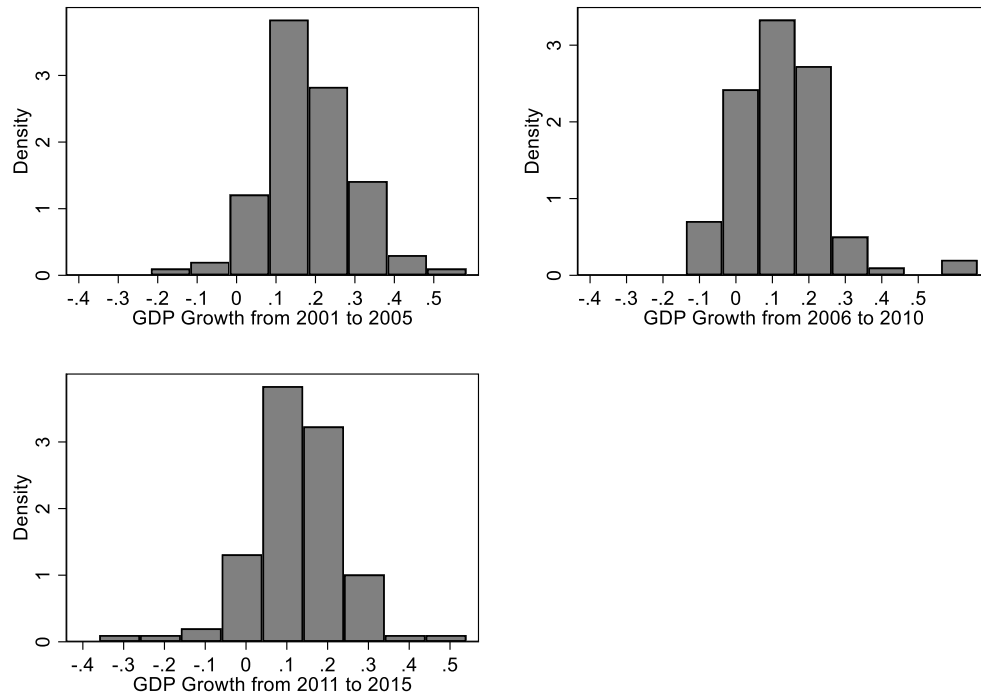
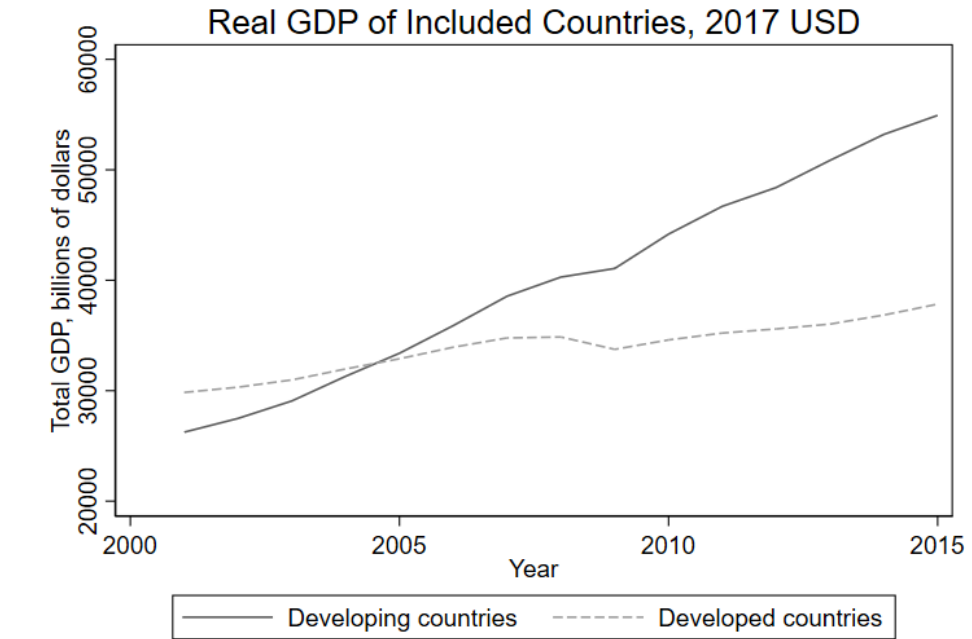


Figure A1: Real GDP and distribution of GDP growth for countries included in the analysis.

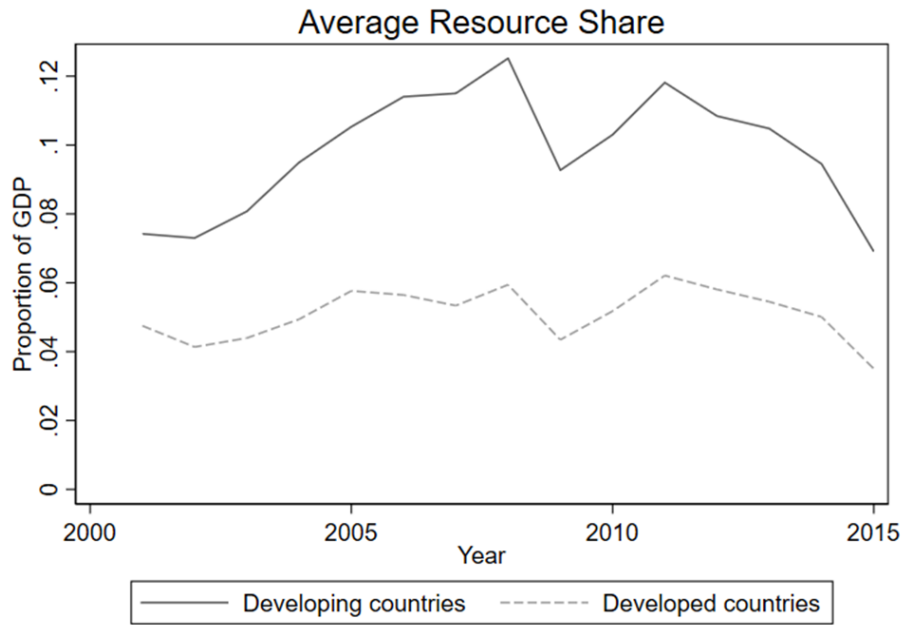


Figure A2: Calculated natural capital share over time.

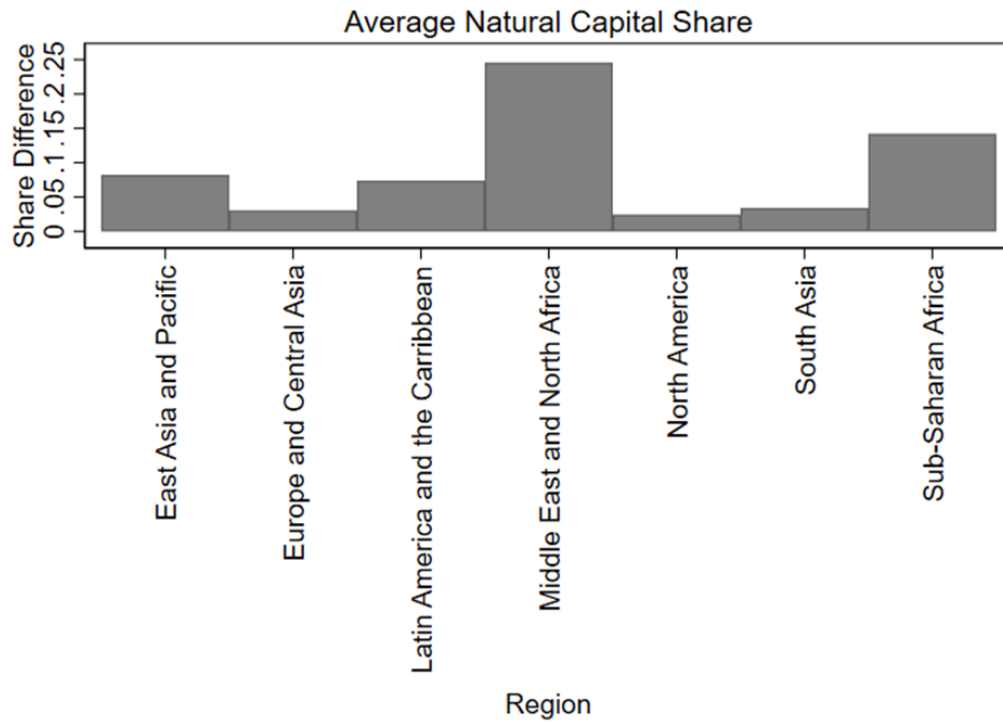


Figure A3: Average natural capital share by region.

Note: Figure reports average across countries of the average resource share over time.

References

- Avila AFD and Evenson RE** (2010) Total factor productivity growth in agriculture: the role of technological capital. In Pingali PL and Evenson RE (eds). *Handbook of Agricultural Economics*, vol 4. Burlington, The Netherlands: Academic Press, pp. 3769–3822.
- Brandt N, Schreyer P and Zipperer V** (2017) Productivity measurement with natural capital. *Review of Income and Wealth* **63**, S7–S21
- Coelli TJ and Rao DSP** (2005) Total factor productivity growth in agriculture: a Malmquist index analysis of 93 countries, 1980–2000. *Agricultural Economics* **32**, 115–134.
- Monge-Naranjo A, Sánchez JM and Santaaulalia-Llopis R** (2019) Natural resources and global misallocation. *American Economic Journal: Macroeconomics* **11**, 79–126.
- Nin-Pratt A and Yu B** (2008) Developing countries and total factor productivity growth in agriculture: new evidence using a Malmquist Index with constrained implicit shadow prices. Conference papers 331744, Purdue University, Center for Global Trade Analysis, Global Trade Analysis Project.
- World Bank** (2018) Building the World Bank’s wealth accounts: methods and data. Environment and Natural Resources Global Practice. World Bank.