DGE–CRED Practical Session 3: Implementation of damages on the agriculture sector

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On behalf of:
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
of the Federal Republic of Germany

Task 1: Calibration workbook and the Baseline scenario.

- Use the CreateRawExcelInputFileRobust.m in the miscellaneous folder.
- 3 Sectors are: Rice, Agriculture, forestry and fishing; Industry; Services
- 4 Subsectors are: Rice; Agriculture, forestry and fishing excluding rice; Industry; Services
- Region: Vietnam without MRD; MRD
- Climate variables regional: surface temperature (Celsius) (tas)
- Climate variables national: sea level (SL)
- Use the Calibration.xlsx file and copy the Sheet Data and the Baseline sheet into the ModelSimulationandCalibration4Sectorsand2Region.xlsx.
- Run the Baseline scenario, the sector structure is the following: sSubsecstart = [1, 3, 4], sSubsecend = [2, 3, 4].

Task 1: Calibration workbook and the Baseline scenario.

- First modify line 12 to 15 in the CreateRawExcelInputFileRobust.m

```
% CreateRawExcelInputFileRobust is a Matlab script to create the
% ModelSimulationandCalibration<Number of Subsectors>Sectorsand<Number of
% Regions>Regions.xlsx  workbook for parameter and scenario definitions of the
% model.

%% Prologue
clearvars;
% define working directory path
sPathWD = pwd();

%% Define sectors
casSectors = {'Rice, Agriculture, forestry, fishery excluding rice'; 'Industry'; 'Services'};
inbsectors_p = length(casSectors);
%% Define subsectors
casSubSectors = {'Rice'; 'Agriculture, forestry, fishery excluding rice'; 'Industry'; 'Services'};
inbsubsectors_p = length(casSubSectors);
%% Define regions
casRegions = {'Vietnam without MRD'; 'MRD'};
inbregions_p = length(casRegions);

%% Define regional climate variables
casClimateVarsRegionalName = {'surface temperature (Celsius)'};
casClimateVarsRegional = {'tas'};

%% Define national climate variables
casClimateVarsNationalName = {'Sea level'};
casClimateVarsNational = {'SL'};
casClimateVars = [casClimateVarsRegional casClimateVarsNational];

%% Create the workbook
sWorkBookName = ['ModelSimulationandCalibration' num2str(inbsubsectors_p) 'Sectorsand' num2str(inbregions_p) 'Regions.xlsx'];
```

Task 1: Calibration workbook and the Baseline scenario I.

- Copy from Calibration.xlsx file the data into the ModelSimulationandCalibration3Sectorsand1Region.xlsx Sheet Data.

Sector	Region	Initial Value Added Shares (phiY0)	Initial Employment Shares (phiN0)	Labour Cost Shares (phiW)
Rice	Vietnam without MRD	0.015307	0.044244	0.494986
Rice	MRD	0.019587	0.056615	0.494986
Agriculture, forestry, fishery excluding rice	Vietnam without MRD	0.09012	0.260483	0.499491
Agriculture, forestry, fishery excluding rice	MRD	0.035092	0.10143	0.499491
Industry	Vietnam without MRD	0.339898	0.121816	0.499491
Industry	MRD	0.079301	0.028258	0.499491
Services	Vietnam without MRD	0.34907	0.315529	0.602307253
Services	MRD	0.071625	0.071625	0.602307253

Task 1: Calibration workbook and the Baseline scenario II.

- Copy from Calibration.xlsx file the data into the ModelSimulationandCalibration3Sectorsand1Region.xlsx Sheet Data.

Sector	export share (phiX)	import share (phiM)	intermediate products (phiQI)
Rice	0.35	0.001771	0.559228
Agriculture, forestry, fishery excluding rice	0.166895	0.088229	0.624664
Industry	0.3	0.85	0.75
Services	0.16	0.06	0.66

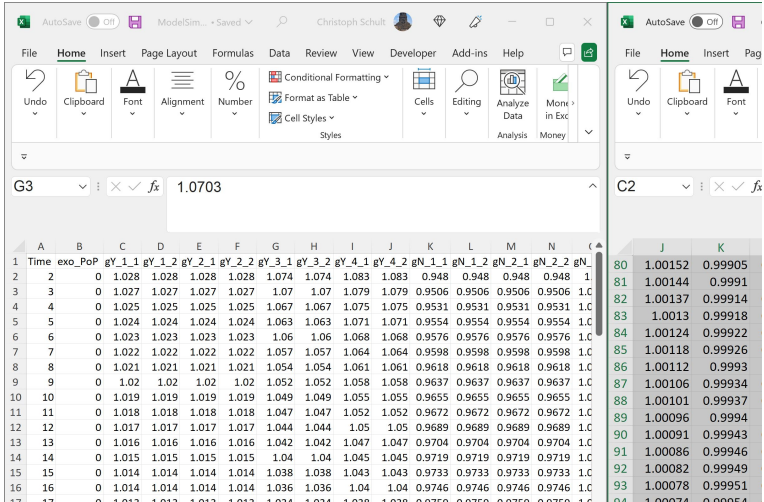
Task 1: Calibration workbook and the Baseline scenario III.

- Copy from Calibration.xlsx file the data into the ModelSimulationandCalibration3Sectorsand1Region.xlsx Sheet Data.

Name	Value
initial population (PoP0)	0.9171385
initial value added (Y0)	1
import share (phiM)	0.223201935
housing to population ratio (H0)	23.2
investmetns in residential building relative to GDP (sH)	0.005
subsector for adaptation measures in the housing sector (iGAH)	enter value here
subsector for private adaptation measures in the housing sector	enter value here
initial employment (N0_p)	0.150525996

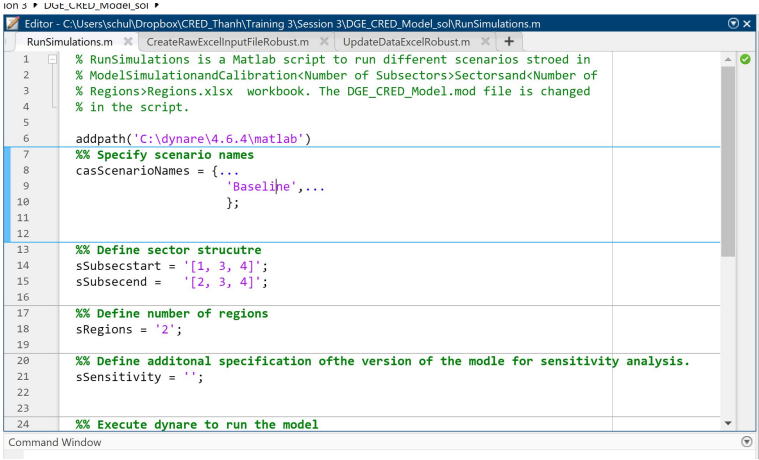
Task 1: Create the Baseline scenario.

- Copy from Calibration.xlsx file the Baseline sheet into the ModelSimulationandCalibration4Sectorsand2Region.xlsx Sheet Data.



Task 1: Execute RunSimulation.m.

- Modify the RunSimulation.m such that the number of regions is 2 and the sector structure is the following: sSubsecstart = '[1, 3, 4]', sSubsecend = '[2, 3, 4]'

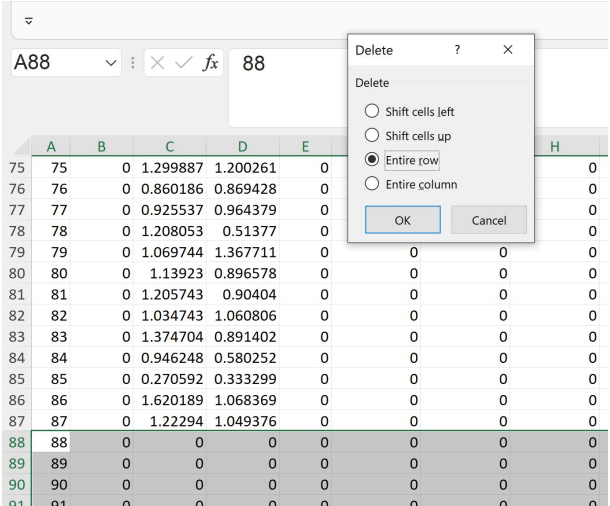


Task 2: Create SSP 119, 245 and 585 scenarios.

- Use the ClimateScenariosSSPRegions2MRI.xlsx in the data folder.
- Create a sheet for SSP119, SSP245 and SSP585.
- Copy the climate data for temperature and sea level into the sheet and paste them in Column C D E.
- Delete empty rows.
- Define damages for rice in the Mekong River Delta and in Vietnam without MRD.
  - In Vietnam, without the Mekong River Delta, the effect of a 1℃ increase in temperature reduces crop yields (exo_D_1_1) by 3 percent.
  - For the Mekong River Delta (exo_D_1_2), please use the paths provided in the ClimateScenariosSSPRegions2MRI.xlsx file.
- Run simulations.

Task 2: Copy the climate variables and delete rows not used.

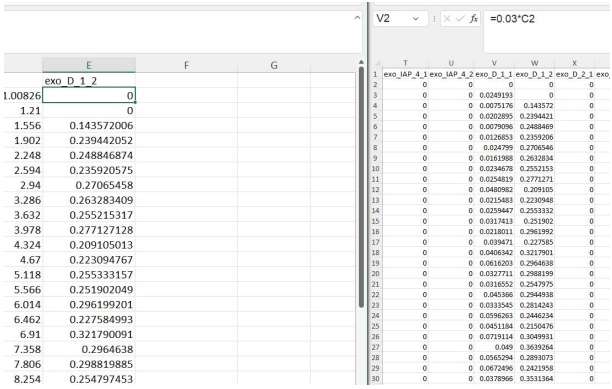
- Make sure that the last values are not zero. Otherwise, they are zero in a steady state.



	A	B	C	D	E			H
75	75	0	1.299887	1.200261	0			0
76	76	0	0.860186	0.869428	0			0
77	77	0	0.925537	0.964379	0			0
78	78	0	1.208053	0.51377	0			0
79	79	0	1.069744	1.367711	0	0	0	0
80	80	0	1.13923	0.896578	0	0	0	0
81	81	0	1.205743	0.90404	0	0	0	0
82	82	0	1.034743	1.060806	0	0	0	0
83	83	0	1.374704	0.891402	0	0	0	0
84	84	0	0.946248	0.580252	0	0	0	0
85	85	0	0.270592	0.333299	0	0	0	0
86	86	0	1.620189	1.068369	0	0	0	0
87	87	0	1.22294	1.049376	0	0	0	0
88	88	0	0	0	0	0	0	0
89	89	0	0	0	0	0	0	0
90	90	0	0	0	0	0	0	0
91	91	0	0	0	0	0	0	0

Task 2: Copy damages to rice located in MRD.

- Use the crop yield simulation results to define damages for different SSP scenarios.



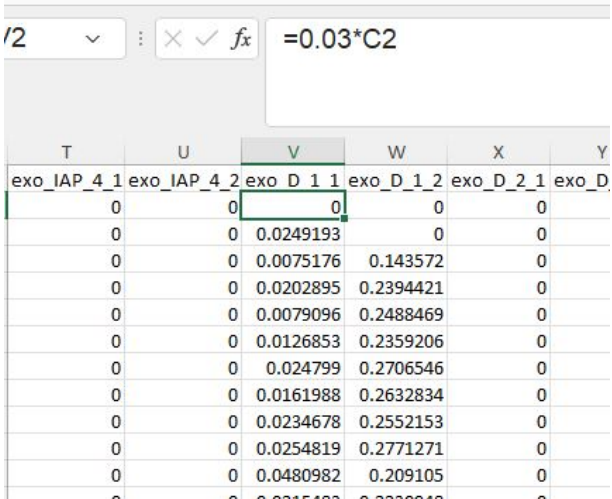
V2 =0.03*C2

	E	F	G
	exo_D_1_2		
1.00826	0		
1.21	0		
1.556	0.143572006		
1.902	0.239442052		
2.248	0.248846874		
2.594	0.235920575		
2.94	0.27065458		
3.286	0.263283409		
3.632	0.255215317		
3.978	0.277127128		
4.324	0.209105013		
4.67	0.223094767		
5.118	0.255333157		
5.566	0.251902049		
6.014	0.296199201		
6.462	0.227584993		
6.91	0.321790091		
7.358	0.2964638		
7.806	0.298819885		
8.254	0.254797453		

1	T exo_IAP_4_1	U exo_IAP_4_2	V exo_D_1_1	W exo_D_1_2	X exo_D_2_1	exo
2	0	0	0	0	0	
3	0	0	0.0249193	0	0	
4	0	0	0.0075176	0.143572	0	
5	0	0	0.0202895	0.2394421	0	
6	0	0	0.0079096	0.2488469	0	
7	0	0	0.0126853	0.2359206	0	
8	0	0	0.024799	0.2706546	0	
9	0	0	0.0161988	0.2632834	0	
10	0	0	0.0234678	0.2552153	0	
11	0	0	0.0254819	0.2771271	0	
12	0	0	0.0480982	0.209105	0	
13	0	0	0.0215483	0.2230948	0	
14	0	0	0.0259447	0.2553332	0	
15	0	0	0.0317413	0.251902	0	
16	0	0	0.0218011	0.2961992	0	
17	0	0	0.039471	0.227585	0	
18	0	0	0.0406342	0.3217901	0	
19	0	0	0.0616203	0.2964638	0	
20	0	0	0.0327711	0.2988199	0	
21	0	0	0.0316552	0.2547975	0	
22	0	0	0.045366	0.2944938	0	
23	0	0	0.0333545	0.2814243	0	
24	0	0	0.0596263	0.2446234	0	
25	0	0	0.0451184	0.2150476	0	
26	0	0	0.0719114	0.3049931	0	
27	0	0	0.049	0.3639264	0	
28	0	0	0.0565294	0.2893073	0	
29	0	0	0.0672496	0.2421958	0	
30	0	0	0.0378966	0.3531364	0	

Task 2: Define damages to rice not located in MRD.

- The effect of a 1℃ increase in temperature reduces crop yields (exo_D_1_1) by 3 percent outside of the Mekong River Delta.



T	U	V	W	X	Y
exo_IAP_4_1	exo_IAP_4_2	exo_D_1_1	exo_D_1_2	exo_D_2_1	exo_D
0	0	0	0	0	
0	0	0.0249193	0	0	
0	0	0.0075176	0.143572	0	
0	0	0.0202895	0.2394421	0	
0	0	0.0079096	0.2488469	0	
0	0	0.0126853	0.2359206	0	
0	0	0.024799	0.2706546	0	
0	0	0.0161988	0.2632834	0	
0	0	0.0234678	0.2552153	0	
0	0	0.0254819	0.2771271	0	
0	0	0.0480982	0.209105	0	

Task 2: Execute RunSimulation.m file.

- Change the scenario names to SSP119, SSP245 and SSP585.

Editor - C:\Users\schuh\Dropbox\CRED_Thanh\Training 3\Session 3\DGE_CRED_Model_sol\RunSimulations.m

RunSimulations.m | CreateRawExcelInputFileRobust.m | UpdateDataExcelRobust.m

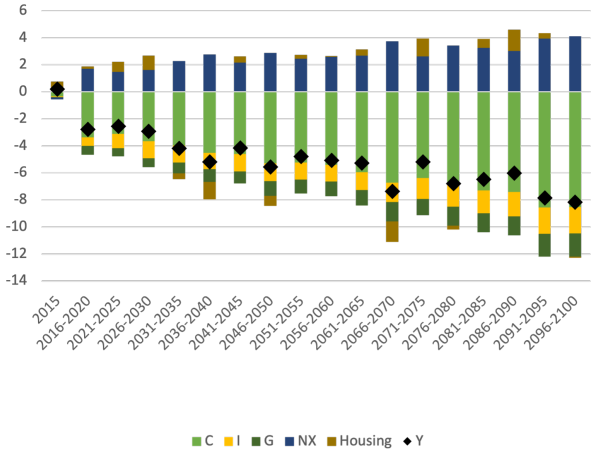
```
% RunSimulations is a Matlab script to run different scenarios stroed in
% Model$imulationandCalibration<Number of Subsectors>Sectorsand<Number of
% Regions>Regions.xlsx  workbook. The DGE_CRED_Model.mod file is changed
% in the script.

addpath('C:\dynare\5.2\matlab')
%% Specify scenario names
casScenarioNames = {...
                    'SSP119', 'SSP245', 'SSP585',...
                    };


%% Define sector strucutre
sSubsecstart = '[1, 3, 4]';
sSubsecend =   '[2, 3, 4]';

%% Define number of regions
sRegions = '2';

%% Define additonal specification ofthe version of the modle for sensitivity analysis.
sSensitivity = '';


%% Execute dynare to run the model
addpath([pwd() '/Functions'])
addpath([pwd() '/Functions/Miscellaneous'])
addpath([pwd() '/Functions/Auxiliary'])
if isoctave()
    error('Octave is currently not supported please use Matlab 2019 or above')
end

timestart = tic;
for icoScenario = 1:size(casScenarioNames,2)
    sScenario = char(casScenarioNames(icoScenario));
    % This function allows to switch between endogenous production or
```

Task 3: Create a graph to illustrate the impact of damages to the rice sector on GDP and its components.

- Use the Figures.xlsx file in the Data folder.
- Open the ResultsScenarios4Sectorsand2Regions.xlsx file.
- Change the value in Cell A4 to ResultsScenarios4Sectorsand2Regions.

Task 3: GDP components.

- Damages to the rice sector alone reduce GDP in Vietnam by almost one percent until the end of the century.

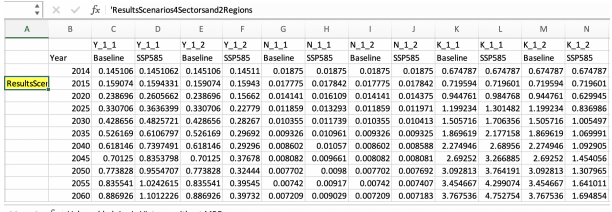


Task 4: Create a graph to illustrate the impact of damages to the rice sector on regional value-added, employment, and capital stock.

- Use the Figures.xlsx file in the Data folder.
- Create a graph depicting the deviation between the SSP 585 and Baseline path for value added Y_1_1, Y_1_2.
- Create a graph depicting the deviation between the SSP 585 and Baseline path for employment N_1_1, N_1_2.
- Create a graph depicting the deviation between the SSP 585 and Baseline path for capital K_1_1, K_1_2.
- Change the variables listed in line 2 and compute deviations between the Baseline and SSP scenarios.
- What do you observe?

Task 4: Change the links.

- Create a new sheet in Figures.xlsx.
- Change the variables listed in line 2 and compute deviations between the Baseline and SSP scenario.



'ResultsScenarios4Sectorsand2Regions

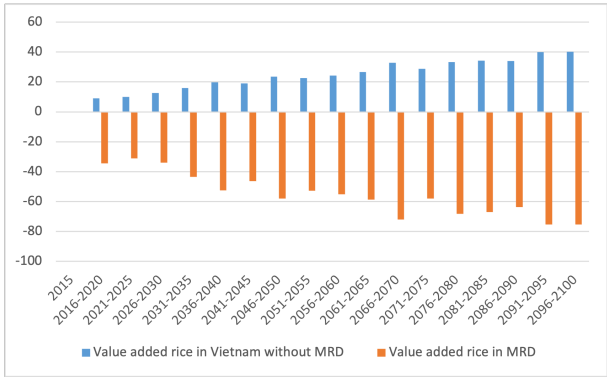
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
			Y_1_1	Y_1_1	Y_1_2	Y_1_2	N_1_1	N_1_1	N_1_2	N_1_2	K_1_1	K_1_1	K_1_2	K_1_2
		Year	Baseline	SSP585	Baseline	SSP585	Baseline	SSP585	Baseline	SSP585	Baseline	SSP585	Baseline	SSP585
		2014	0.145106	0.1451062	0.145106	0.14511	0.01875	0.01875	0.01875	0.01875	0.674787	0.674787	0.674787	0.674787
ResultsScen		2015	0.159074	0.1594331	0.159074	0.15943	0.017775	0.017842	0.017775	0.017842	0.719594	0.719601	0.719594	0.719601
		2020	0.238696	0.2605662	0.238696	0.15662	0.014141	0.016109	0.014141	0.014375	0.944761	0.984768	0.944761	0.629945
		2025	0.330706	0.3636399	0.330706	0.22779	0.011859	0.013293	0.011859	0.011971	1.199234	1.301482	1.199234	0.836986
		2030	0.428656	0.4825721	0.428656	0.28267	0.010355	0.011739	0.010355	0.010413	1.505716	1.706356	1.505716	1.005497
		2035	0.526169	0.6106797	0.526169	0.29692	0.009326	0.010961	0.009326	0.009325	1.869619	2.177158	1.869619	1.069991
		2040	0.618146	0.7397491	0.618146	0.29296	0.008602	0.01057	0.008602	0.008588	2.274946	2.68956	2.274946	1.092905
		2045	0.70125	0.8353798	0.70125	0.37678	0.008082	0.009661	0.008082	0.008081	2.69252	3.266885	2.69252	1.454056
		2050	0.773828	0.9554707	0.773828	0.32444	0.007702	0.0098	0.007702	0.007692	3.092813	3.764191	3.092813	1.307965
		2055	0.835541	1.0242615	0.835541	0.39545	0.00742	0.00917	0.00742	0.007407	3.454667	4.299074	3.454667	1.641011
		2060	0.886926	1.1012226	0.886926	0.39732	0.007209	0.009029	0.007209	0.007183	3.767536	4.752754	3.767536	1.694854

Value added rice in Vietnam without MRD

	B	C	D	E	F	G	H	I
			Y_1_1	Y_1_2	N_1_1	N_1_2	K_1_1	K_1_2
			Value added rice in Vietna	Value added rice in MRD	Employment rice in Vi	Employment rice in MRD	Capital stock rice in Vie	Capital stock ri
	2015		0.2254939	0.2254939	0.041960196	0.041960196	0.003987795	0.003988
	2016-2020		9.162284137	-34.38540147	0.824491809	0.097879045	16.76058308	-131.8901
	2021-2025		9.958789483	-31.11970729	0.433685169	0.033880119	30.91804369	-109.5377
	2026-2030		12.57796498	-34.05685044	0.322957965	0.013608039	46.80680897	-116.6946
	2031-2035		16.06155615	-43.56878735	0.310690808	-0.000219737	58.44878298	-151.9717
	2036-2040		19.67228361	-52.60617241	0.318325314	-0.002295298	67.07378361	-191.2237
	2041-2045		19.12722262	-46.27059262	0.225219669	-0.000114105	81.90589003	-176.6079
	2046-2050		23.47324889	-58.07393444	0.271206548	-0.001224249	86.76065352	-230.6517
	2051-2055		22.58669315	-52.67116243	0.20951665	-0.001493797	101.0611547	-217.0638
	2056-2060		24.1616809	-55.20216017	0.205128691	-0.002988303	111.082239	-233.6928
	2061-2065		26.59150586	-58.61179569	0.213295467	-0.002375032	122.6203434	-253.4382

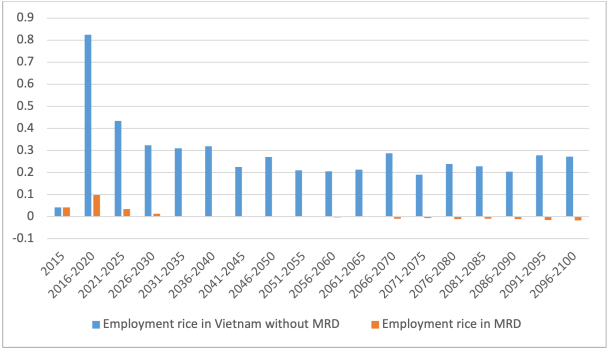
Task 4: Impact of climate change on the rice sector in Vietnam I.

- Value-added declines in the Mekong River Delta and increases outside of the Mekong River Delta.



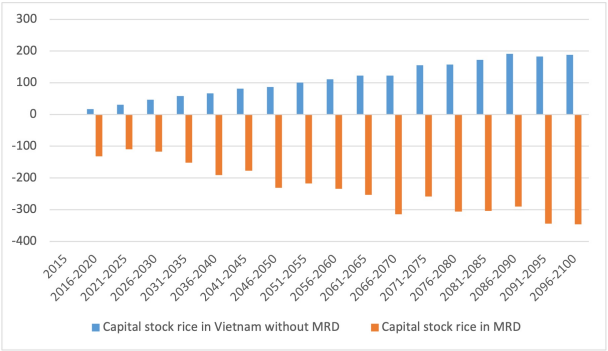
Task 4: Impact of climate change on the rice sector in Vietnam II.

- Employment in the rice sector increases in region without MRD to compensate for the loss in productivity.
- Employment in the rice sector increases in region with MRD at the beginning then decreases later.



Task 4: Impact of climate change on the rice sector in Vietnam III.

- Capital stock declines in MRD and increases in the rest of Vietnam.



Task 5: Adaptation to climate change in the rice sector (labour tax).

- Assume that the government wants to compensate rice farms in the Mekong River Delta for the loss in crop yields by lowering taxes on labour expenses paid by firms (exo_tauNF_1_2) by 10 percent.
- Create a scenario SSP585_AdaptTaxLab and add a column with the name exo_tauNF_1_2.
- Reduce the tax rate paid by farmers in the Mekong River Delta by 10 percent.
- Run simulation and plot graph in Figure.xlsx.
- Is this adaptation measure effective?

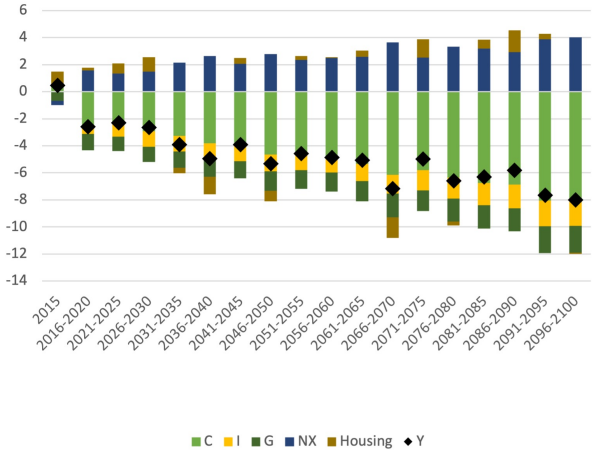
Task 5: Create SSP585_AdaptTaxLab.

- Add a column in the scenario sheet with exo_tauNF_1_2.
- Run the scenario by executing the RunSimulation.m file.

	E	F	G	H	I
2	exo_SL	exo_tauNF_1_2	exo_GA_1_1	exo_GA_1_2	exo_GA_2_1
0	1.0083	-0.1	0	0	0
1	1.21	-0.1	0	0	0
1	1.556	-0.1	0	0	0
7	1.902	-0.1	0	0	0
4	2.248	-0.1	0	0	0
6	2.594	-0.1	0	0	0
7	2.94	-0.1	0	0	0
5	3.286	-0.1	0	0	0
8	3.632	-0.1	0	0	0
5	3.978	-0.1	0	0	0
6	4.324	-0.1	0	0	0
2	4.67	-0.1	0	0	0
2	5.118	-0.1	0	0	0
9	5.566	-0.1	0	0	0
6	6.014	-0.1	0	0	0

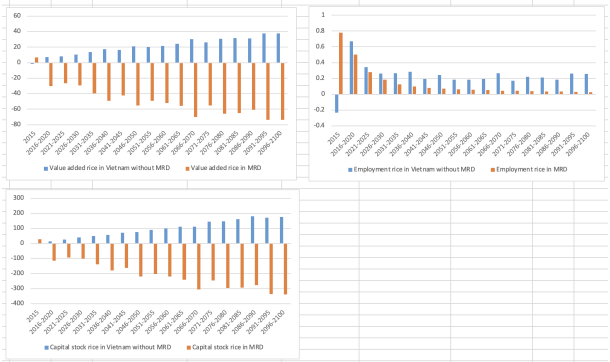
Task 5: Create GDP component figure for SSP585_AdaptTaxLab.

- Copy the GDP sheet in Figures and change the reference from SSP 585 to SSP585_AdaptTaxLab.



Task 5: Create GDP component figure for SSP585_AdaptTaxLab.

- Copy the Impact on Rice sheet in Figures and change the reference from SSP 585 to SSP585_AdaptTaxLab.



Task 6: Adaptation to climate change in the rice sector (capital tax).

- Assume that the government wants to compensate rice farms in the Mekong River Delta for the loss in crop yields by lowering taxes on capital expenses paid by firms (exo_tauKF_1_2) by 10 percent.
- Create a scenario SSP585_AdaptTaxCap and add a column with the name exo_tauKF_1_2.
- Reduce the tax rate paid by farmers in the Mekong River Delta by 10 percent.
- Run simulation and plot graph in Figure.xlsx.
- Is this adaptation measure effective?

Task 6: Create SSP585_AdaptTaxCap.

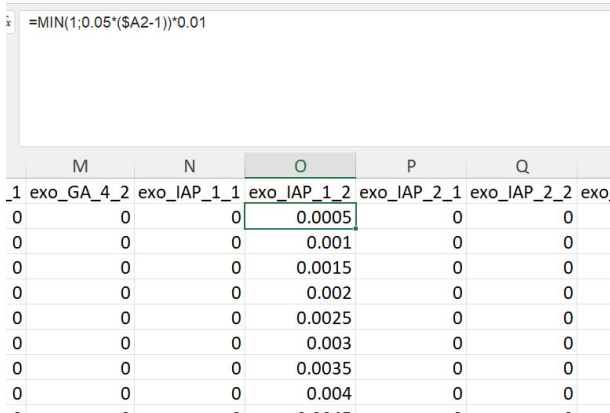
- See solution for Task 5 and change where necessary to
- Change the column name from exo_tauNF_1_2 to exo_tauKF_1_2 in the scenario sheet.

Task 7: Private adaptation to climate change in the rice sector (new crop variant).

- Assume that a new rice variant is more heat resistant and is less exposed to the salinity of the soil.
- Only 5 percent of farmers can switch to the new variant per year.
- Growing the new variant increases running costs by 1 percent of GDP today annually after all farmers switch to the new variant.
- The crop yield of the new variant is 50 percent less affected by climate change compared to the old variant.
- Assume that all farmers eventually switch to the new variant and that the adaptation costs are directly proportional to the share of farmers who have already switched to the new variant.
- Implement the measure in a new scenario called SSP585_AdaptPrivate. Use the variable exo_IAP_1_2 to account for the additional expenditures $= 0.05 \times timeperiod \times 0.01$.
- The impact of climate change depends on the time farmers have to switch to the new crop is $= (0.05 \times timeperiod \times 0.5) + (1 - (0.05 \times timeperiod)) \times D_{MRD}^{SSP585}$.
- Run simulation and plot graph in Figure.xlsx. Is this adaptation measure effective?

Task 7: Create SSP585_AdaptPrivate.

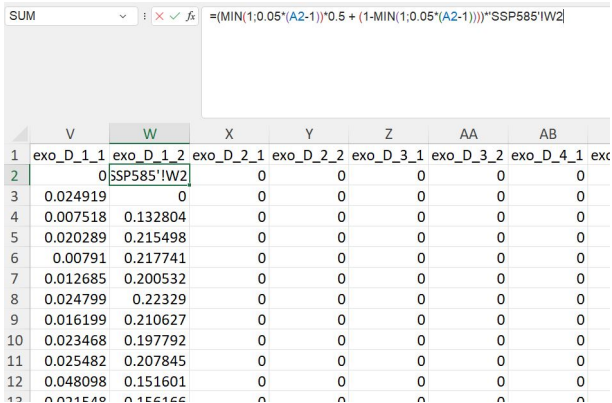
- Change the values for exo_IAP_1_2 to reflect the necessary time to change from one crop to another.
- The MIN function makes sure that private adaptation expenditures do not exceed 1 percent of current GDP.



	M	N	O	P	Q	
_1	exo_GA_4_2	exo_IAP_1_1	exo_IAP_1_2	exo_IAP_2_1	exo_IAP_2_2	exo_
0	0	0	0.0005	0	0	
0	0	0	0.001	0	0	
0	0	0	0.0015	0	0	
0	0	0	0.002	0	0	
0	0	0	0.0025	0	0	
0	0	0	0.003	0	0	
0	0	0	0.0035	0	0	
0	0	0	0.004	0	0	

Task 7: Create SSP585_AdaptPrivate.

- The impact of climate change depends on the time farmers have to switch to the new crop.
- Therefore the



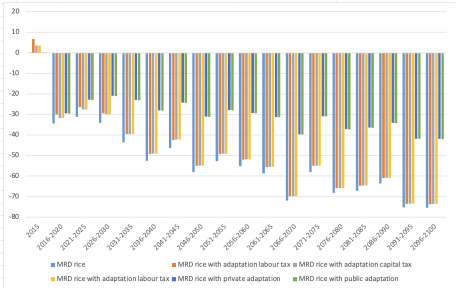
	V	W	X	Y	Z	AA	AB	
1	exo_D_1_1	exo_D_1_2	exo_D_2_1	exo_D_2_2	exo_D_3_1	exo_D_3_2	exo_D_4_1	exc
2	0	SSP585'!W2	0	0	0	0	0	
3	0.024919	0	0	0	0	0	0	
4	0.007518	0.132804	0	0	0	0	0	
5	0.020289	0.215498	0	0	0	0	0	
6	0.00791	0.217741	0	0	0	0	0	
7	0.012685	0.200532	0	0	0	0	0	
8	0.024799	0.22329	0	0	0	0	0	
9	0.016199	0.210627	0	0	0	0	0	
10	0.023468	0.197792	0	0	0	0	0	
11	0.025482	0.207845	0	0	0	0	0	
12	0.048098	0.151601	0	0	0	0	0	
13	0.021548	0.156166	0	0	0	0	0	

Task 8: Public adaptation to climate change in the rice sector (new crop variant).

- Create new sheet SSP585_AdaptPublic.
- Assume the same adaptation measure as in Task 7.
- This time adaptation measures are financed by public government expenditures exo_GA_1_2 (column G).
- Run simulation and plot graph in Figure.xlsx.
- What differences do you observe compared to Task 7?

Task 8: Public adaptation to climate change in the rice sector (new crop variant).

- Follow the solution for Task 7. instead of changing exo_IAP_1_2, change exo_GA_1_2.
- We can see the same adaptation measure financed by government or private funds can have slightly different impacts on GDP effects.



Task 9: What adaptation measure is the best to reduce the loss in consumption?

- What adaptation measure can reduce the consumption loss the most?
- Is it ok to compare only the differential in consumption levels?

Task 9: What adaptation measure is the best to reduce the loss in consumption at the end of the century?

- Computing multipliers show that even though private and public adaptation measures have the highest benefit reducing capital or labour tax gets more return relative to the necessary costs.

	Capital Tax		
	Consumption benefit	Cost	
2091-2095	0.076608202	0.000353	217.2726
2096-2100	0.076725467	0.000353	217.5668
	Labour Tax		
	Consumption benefit	Cost	
2091-2095	0.057267725	0.000346	165.7106
2096-2100	0.057699927	0.000346	166.9317
	Private		
	Consumption benefit	Cost	
2091-2095	0.556382731	0.01	55.63827
2096-2100	0.551351544	0.01	55.13515
	Public		
	Consumption benefit	Cost	
2091-2095	0.610459639	0.01	61.04596
2096-2100	0.604972381	0.01	60.49724