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Economic Growth and Employment Effects as a Result of the Upper Austrian Flood Protection Building Program

Sebastian Goers, Friedrich Schneider,
Horst Steinmüller and Andreas Zauner

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Abstract

Starting in 2002, a continuous building of flood protection infrastructure aiming at preventing high monetary damages has been taking place in Upper Austria. As a result of investments in these flood protection measures between 2002 and 2015, significant positive effects on the gross regional product as well as on the employment level have been generated. However, the macroeconomic effects are found to depend substantially on the import quota for required materials.

Keywords: flood protection infrastructure, investment, macroeconometric simulation, economic effects, Upper Austria

1. Introduction

Austria has always been confronted with flood situations, which pose a threat to the inhabitants of the particular areas and cause enormous monetary damages. Since the turn of the century, there have been 200-year floods just 11 years apart, one in August 2002 and the other one in June 2013. As a consequence, the state and federal Governments of Austria and Upper Austria, respectively, have been continuously investing into flood protection measures. The present study aims to quantify the value added and the effects on employment as a consequence of implementing the flood protection program and the measures therein. The main focus is on an ex-post analysis of the Upper Austrian economy between 2002 and 2015.

An assessment of the flood damages which were avoided due to making these investments is not the focus of this study. The damages caused by floods occurring in recent years are only rudimentarily documented. It is also noted that there is scarce or insufficient information on the economic costs of flood damage corresponding to social opportunity costs as these are not directly apparent from existing statistics [1].

Section 2 provides an overview of flood damages in Upper Austria between 2002 and 2013. In Section 3, the effects of the investments on the regional value added and the rate of employment are quantified on the basis of ex-post analyses. These are based on a comparative static assessment and a macroeconometric simulation by means of a dynamic time-series model. The conclusions of this study are drawn in Section 4.

2. Flood damages in Upper Austria

2.1. Flood of 2002

The flood of August 2002 exceeded all floods in Austria since 1965/1966 [2]. It claimed nine lives and resulted in monetary damages of € 3 bn [3]. € 420 m of those monetary damages were covered by insurances, another € 414 m were covered by the disaster fund, resulting in a deficit of approximately € 2.2 bn [4, 5]. Waterways Authority conducted a damage survey in their jurisdiction (e.g., damages to towpaths, the riverside and approach piers, silting up of harbor basins, aggradations, and suspended loads) along the Danube, March, and Thaya, estimating the damages caused by the flooding to amount to approximately € 3 m [6].

There have been different statements about the amount of damages in Upper Austria. According to Ref. [7], the flood in August 2002 caused total monetary damages of approximately € 464 m. 23.9% of the damages are apportioned to households, 49.6% to companies, 7.8% to agriculture and forestry, and 18.7% to the public sector. More than twice as much, approximately € 1.1 bn of monetary damages were reported by a territorial council at a press conference on March 9, 2013. € 500 m thereof are apportioned to the Upper Austrian Machland, a region and a cultural landscape along the Danube. The Upper Austrian agriculture faced monetary damages of € 11.6 m. A total of approximately 10,500 ha of agricultural land were affected [8].

2.2. Flood of 2002

The flood in June 2013, the second 100-year flood within 11 years, led to overall monetary damages of approximately € 870 m. The EU's disaster fund covered just under € 22 m [9]. Insurances paid out € 250 m. In Upper Austria, the total damages of the flood of 2013 amount to approximately € 220 m. The EU granted € 2.9 m from their solidarity fund as flood aid for Upper Austria [10]. The Upper Austrian agriculture was faced with estimated damages of € 15 m as a result of the flood. 247 farms were damaged throughout the state, as well as approximately 10,500 ha (as in 2002) of agricultural land. Of this, 7400 ha are forage crops,

2400 are grasslands, and 700 are vegetables and strawberries. However, the damages of the flood in June 2013 exceeded those of the flood in 2002. The reasons for this are the flooding of higher quality goods on the one hand and on the other hand, the fact that in August 2002, many fields had already been harvested. Additionally, approximately 4000 hectares of forest areas were flooded in 2013 [8].

2.3. Flood protection

In general, an increase in severe flood disasters can be observed [7]. Due to those flood events, efforts in the area of flood protection have been intensified. In 2005, the largest flood protection program to date was launched in Upper Austria. Thus, the damages of the flood in 2013 could be reduced from € 1.1 bn to one-fifth to a quarter, despite being more severe than the flood in 2002 [11]. Data about the amount of investment into the flood protection program vary between € 690 and 700 m over the period from 2002 to 2015 [12, 13]. The average infrastructure investment costs per year of approximately € 50 m are similar to those in the assessment of alternative flood control policies in the Netherlands [14]. For another flood protection project in the Eferdinger basin, a budget of € 250 m is available for the implementation period from 2014 to 2022 [15].

3. Economic ex-post analysis of the Upper Austrian flood protection program

This section investigates the effects of the investments into flood protection in Upper Austria in the period from 2002 to 2015. As shown in Ref. [16], the effects on the regional economy (e.g., employment) play an important role within the decision-making of environmental adaption measures. In the present study, the economic effects are calculated by two methods, applying comparative static analysis on one hand (see Section 3.1) and a dynamic simulation (see Section 3.2) based on the macroeconomic simulation model MOVE2 [17] on the other hand. Since this is an ex-post analysis, the primary research question is defined as follows: what economic contribution with regard to employment and value added has been created in the past (2005–2015) by the Upper Austrian flood protection construction program?

3.1. Comparative static analysis

The data of investments made between 2002 and 2015 within the context of flood protection are used as an input for the dynamic simulation of the economic effects in Upper Austria (see Section 3.2). For the period of time between 2002 and 2015, overall investments of approximately € 690 m were made (see **Figure 1** and **Tables 1** and **2** for a temporal aggregation and arrangement according to specific measures). All data were provided by the Upper Austrian Government, Environment and Water Management and are identical to the data in Ref. [1] for the time period 2002–2012.

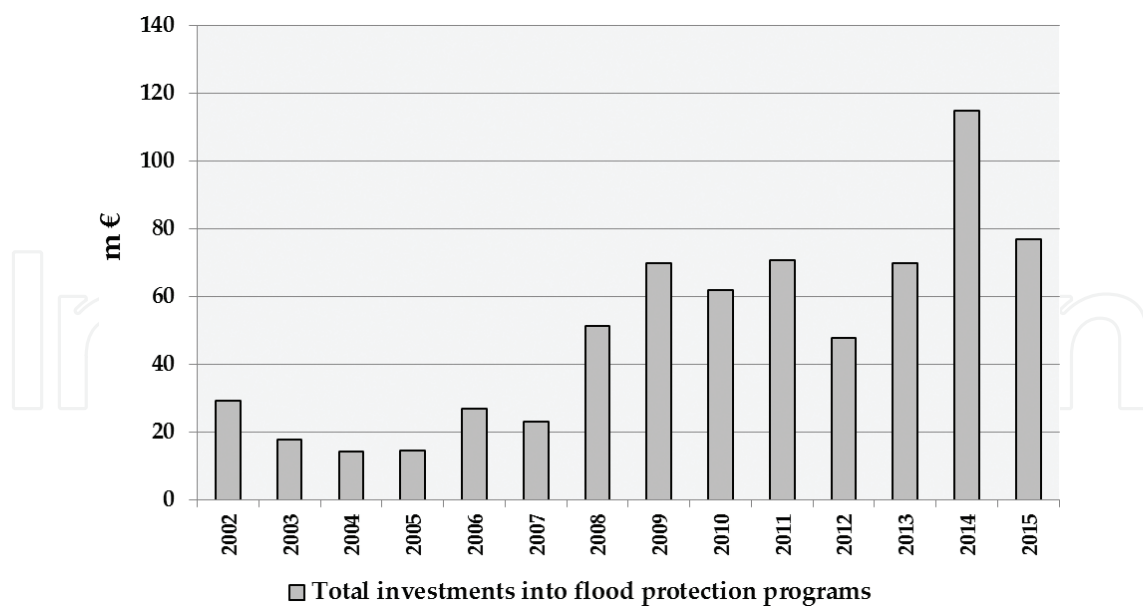


Figure 1. Total investments into flood protection programs in Upper Austria, 2002–2015.

In general, investments into the flood protection are grouped as follows:

- a. Immediate measures (€ 27 m/approximately 4% of overall investments).
- b. Flood protection measures (€ 137 m/approximately 20% of overall investments).
- c. Maintenance (€ 44 m/approximately 6% of overall investments).
- d. Costs of planning (€ 5 m/approximately 1% of overall investments).
- e. Torrent control and immediate measures (€ 140 m/approximately 20% of overall investments).
- f. Flood protection projects along the Danube¹ (€ 337 m/approximately 49% of overall investments).

The types of financing also are considered (see Table 3). Analogous to Ref. [1], there are three different types of financing: (1) federal funds, (2) state funds, and (3) funds from interested parties. As shown in Table 3, approximately 39% (€ 265 m) are accounted for by federal funds, approximately 52% (€ 361 m) by state funds, and approximately 9% (€ 64 m) by interested parties.

As imports may lead to outflows of added value, parts of the investments do not take effect in Upper Austria. Analogous to Ref. [1], three scenarios with different import quotas (0, 10, and 20%) are defined for construction services within the scope of immediate measures, flood

¹Measures of the Austrian Ministry for Transport, Innovation and Technology along the Danube in Upper Austria.

	2002	2003	2004	2005	2006	2007	2008
	(m €)	(m €)	(m €)	(m €)	(m €)	(m €)	(m €)
Immediate measures	16.6	0.0	0.0	1.0	0.1	0.0	0.0
Flood protection measures	2.3	5.1	3.7	0.1	12.7	11.0	11.7
Maintenance	2.1	2.0	2.8	3.4	1.9	1.5	5.5
Planning	0.4	0.0	0.0	0.7	0.4	0.2	0.7
Torrent control and immediate measures	7.5	10.2	5.1	6.5	6.2	7.4	16.8
Danube projects	0.4	0.4	2.9	2.9	5.6	3.1	16.7
SUM	29.2	17.7	14.4	14.5	26.8	23.1	51.3

Table 1. Investments by the type of flood protection measures, 2002–2008.

	2009	2010	2011	2012	2013	2014	2015
	(m €)	(m €)	(m €)	(m €)	(m €)	(m €)	(m €)
Immediate measures	0.1	0.1	0.2	0.1	3.9	3.1	2.3
Flood protection measures	27.3	9.2	3.0	4.3	19.4	15.5	11.6
Maintenance	4.4	3.6	1.7	0.4	6.3	5.0	3.8
Planning	0.3	0.2	0.2	0.0	0.6	0.5	0.4
Torrent control and immediate measures	10.0	9.0	8.5	5.1	19.8	15.8	11.9
Danube projects	27.8	39.9	57.3	38.2	20.0	75.0	47.0
SUM	70.0	62.0	70.9	48.0	70.0	115.0	77.0

Table 2. Investments by type of flood protection measures, 2009–2015.

protection measures, torrent control and immediate measures, and maintenance as well as projects related to the Danube (see **Table 4**).

3.2. Dynamic simulation analysis

The input for the dynamic analysis of economic effects in Upper Austria with the simulation model MOVE2 [17] is provided by the comparative statistic preparation of the data (see Section 3.1) of the investments which were made between 2002 and 2015 within the scope of the flood protection program. The focus is on macroeconomic effects due to the investments, whereas economic optimality, as for example examined in Refs. [18, 19], is not assessed. The dynamic economic impacts of the investments into the flood protection program are described

	Total investment	Federal funds	State funds	Interest parties' funds
	(m €)	(m €)	(m €)	(m €)
Immediate measures	27	15	9	3
Thereof public waters	2	2	0	0
Thereof interest parties' waters	26	14	9	3
Flood protection measures	137	72	48	17
Thereof public waters	28	24	1	3
Thereof interest parties' waters	109	48	47	14
Maintenance	44	19	12	13
Thereof public waters	7	6	0	1
Thereof interest parties' waters	37	13	12	12
Planning	5	3	2	0
Thereof public waters	1	1	0	0
Thereof interest parties' waters	4	2	2	0
Torrent control and immediate measures	140	83	26	31
Danube projects	337	74	264	0
SUM	690	265	361	64

Table 3. Investments by the type of flood protection measures and the method of funding, 2009–2015.

	Import quota: 0%	Import quota: 10%	Import quota: 20%
Year	(m €)	(m €)	(m €)
2002	29.2	26.3	23.4
2003	17.7	15.9	14.1
2004	14.4	12.9	11.5
2005	14.5	13.1	11.8
2006	26.8	24.2	21.5
2007	23.1	20.8	18.6
2008	51.3	46.2	41.2
2009	70.0	63.0	56.0
2010	62.0	55.8	49.6
2011	70.9	63.8	56.7
2012	48.0	43.2	38.4
2013	70.0	63.1	56.1

	Import quota: 0%	Import quota: 10%	Import quota: 20%
Year	(m €)	(m €)	(m €)
2014	115.0	103.6	92.1
2015	77.0	69.3	61.7
SUM	690	621	553
Ø	49.3	44.4	39.5

Note: Rounded values. Outflows of value added are taken into account for construction services within the scope of immediate measures, flood protection measures, torrent control and immediate measures, and maintenance as well as projects related to the Danube. Planning costs are not affected by outflows of added values

Table 4. Investments affecting the value added.

below. In particular, the progression and interactions of the macroeconomic parameters such as gross regional product (GRP), investments, employment, and private consumption are observed and elucidated. For the general interpretation of the results, there has to be emphasized that the simulation result shows the difference of the two development paths of the model—the difference between the business-as-usual and the simulation scenario of each endogenous variable of the model—and not the absolute values of both scenarios as in the case of a prognosis model [17].

Over the period of 2002 until 2015, positive effects of the investments in flood protection on the Upper Austrian GRP can be observed at large (see **Table 5** and **Figure 2**). For the time period from 2002 to 2015, the annual average increase of the GRP is approximately € 83, 78, or 73 m higher at import rates of 0, 10, or 20%, respectively.

Gross regional product			
	Import quota: 0%	Import quota: 10%	Import quota: 20%
Year	(m €)	(m €)	(m €)
2002	+31	+29	+27
2003	+29	+27	+25
2004	+28	+26	+24
2005	+28	+26	+24
2006	+41	+39	+36
2007	+42	+39	+37
2008	+73	+68	+64
2009	+104	+97	+90
2010	+108	+101	+94
2011	+121	+114	+106
2012	+104	+97	+91

Gross regional product			
	Import quota: 0%	Import quota: 10%	Import quota: 20%
2013	+123	+116	+108
2014	+176	+165	+154
2015	+155	+145	+136
Ø	+83	+78	+73

Note: Displaying of direct, indirect, and induced effects. Own calculations with the simulation model MOVE2 [17].

Table 5. Impacts on Upper Austria's gross regional product as a result of investments in flood protection measures, taking into account different import quotas, 2002–2015.

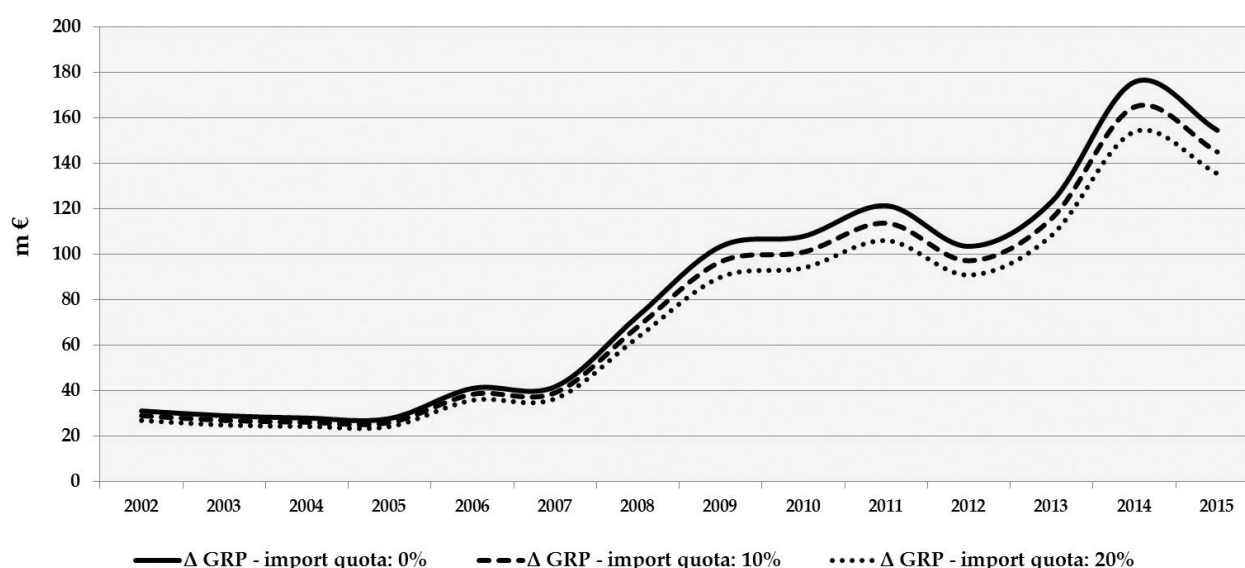


Figure 2. Impacts on Upper Austria's gross regional product as a result of investments in flood protection measures, taking into account different import quotas, 2002–2015. Note: Displaying of direct, indirect, and induced effects. Own calculations with the simulation model MOVE2 [17].

Investments into flood protection as well as the increase of private consumption of households between € 25 and 26 m per year (depending on the import quota) as a result of the induced effects of the investment impulses are the cause for this development (see **Tables 6** and **7**). The outflow of value added caused by imports of foreign materials or technologies is superimposed and thus weakened by the increase in exports as a result of the positive development of the economy. This results in net exports (difference between exports and imports) of approximately € 15, 10, or 6 m at import rates of 0, 10, or 20%, respectively (see **Table 8**).

As for the rate of employment (see **Figure 3** and **Table 9**), as a result of the increase in GRP over the time period 2002–2015, an increase of 590, 520, or 460 persons can be observed at import rates of 0, 10, or 20, respectively. 60% of the additional employees originate from the construction sector.

Investments			
	Import quota: 0%	Import quota: 10%	Import quota: 20%
Year	(m €)	(m €)	(m €)
2002	+20	+20	+20
2003	+15	+15	+15
2004	+13	+13	+13
2005	+13	+13	+13
2006	+22	+22	+21
2007	+20	+20	+20
2008	+40	+40	+40
2009	+56	+56	+55
2010	+54	+53	+53
2011	+61	+61	+60
2012	+47	+46	+46
2013	+61	+61	+60
2014	+95	+94	+93
2015	+72	+71	+70
Ø	+42	+42	+41

Note: Displaying of direct, indirect, and induced effects. Own calculations with the simulation model MOVE2 [17].

Table 6. Impacts on Upper Austria's investments as a result of investments in flood protection measures, taking into account different import quotas, 2002–2015.

Private consumption			
	Import quota: 0%	Import quota: 10%	Import quota: 20%
Year	(m €)	(m €)	(m €)
2002	+10	+10	+10
2003	+7	+7	+7
2004	+9	+9	+8
2005	+9	+8	+8
2006	+13	+13	+13
2007	+13	+12	+12
2008	+24	+23	+23
2009	+31	+31	+31
2010	+32	+32	+31

Private consumption			
	Import quota: 0%	Import quota: 10%	Import quota: 20%
Year	(m €)	(m €)	(m €)
2011	+39	+38	+37
2012	+33	+32	+31
2013	+42	+41	+41
2014	+58	+57	+56
2015	+48	+47	+46
Ø	+26	+26	+25

Note: Displaying of direct, indirect, and induced effects. Own calculations with the simulation model MOVE2 [17].

Table 7. Impacts on Upper Austria's private consumption as a result of investments in flood protection measures, taking into account different import quotas, 2002–2015.

Net exports			
	Import quota: 0%	Import quota: 10%	Import quota: 20%
Year	(m €)	(m €)	(m €)
2002	+1	–1	–3
2003	+7	+5	+3
2004	+6	+5	+3
2005	+6	+5	+3
2006	+6	+4	+2
2007	+9	+7	+4
2008	+9	+5	+1
2009	+16	+10	+4
2010	+22	+16	+10
2011	+21	+15	+9
2012	+24	+19	+14
2013	+20	+14	+7
2014	+24	+14	+4
2015	+34	+27	+19
Ø	+15	+10	+6

Note: Displaying of direct, indirect, and induced effects. Own calculations with the simulation model MOVE2 [17].

Table 8. Impacts on Upper Austria's net exports as a result of investments in flood protection measures, taking into account different import quotas, 2002–2015.

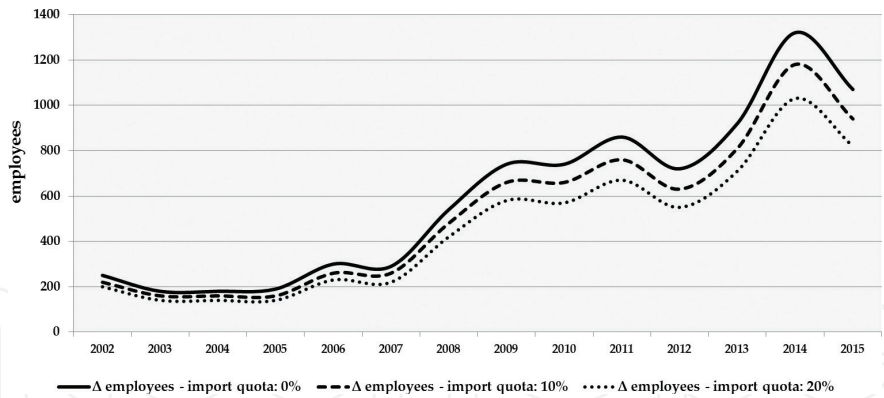


Figure 3. Impacts on Upper Austria's employment as a result of investments in flood protection measures, taking into account different import quotas, 2002–2015. Note: Displaying of direct, indirect, and induced effects. Own calculations with the simulation model MOVE2 [17].

Employment			
	Import quota: 0%	Import quota: 10%	Import quota: 20%
Year	(employees)	(employees)	(employees)
2002	+250	+220	+200
2003	+180	+160	+140
2004	+180	+160	+140
2005	+190	+160	+140
2006	+300	+260	+230
2007	+290	+260	+220
2008	+540	+480	+420
2009	+740	+660	+580
2010	+740	+660	+570
2011	+860	+760	+670
2012	+720	+630	+550
2013	+920	+810	+710
2014	+1.320	+1.180	+1.030
2015	+1.070	+940	+820
Ø	+590	+520	+460

Note: Displaying of direct, indirect, and induced effects. Own calculations with the simulation model MOVE2 [17].

Table 9. Impacts on Upper Austria's employment as a result of investments in flood protection measures, taking into account different import quotas, 2002–2015.

4. Conclusion

The study shows that the flood protection program has significant positive effects on Upper Austria's economy within the time frame from 2002 to 2015. Despite not quantifying the flood damages, which were avoided due to making the investments into flood protection, in this study, the extent of the economic effects suggest that the investments within the framework of the flood protection program are of great benefit from an economic perspective. The following points have to be emphasized.

- Positive effects of the investments into flood protection on the GRP can be obtained. Overall, the annual average increase of the GRP is approximately € 83, 78, or 73 m higher at import rates of 0, 10, or 20%, respectively.
- As a result of the increase in GRP over the time period, from 2002 to 2015, an increase in employment of 590, 520, or 460 persons can be observed at import rates of 0, 10, or 20%, respectively. 60% of the additional employees originate from the construction sector.
- As a result of the increase in employment, there is an increase of the gross income and thus private consumption, which generate positive effects on the economy. Investments into flood protection, as well as the increase of private consumption of households between € 25 and 26 m a year (depending on the import quota) as a result of the induced effects of the investment impulses, are the cause for this development.
- The outflow of value added caused by imports of foreign materials or technologies is superimposed and thus weakened by the increase in exports as a result of the positive development of the economy.
- Higher import quotas cause a smaller amount of the investments being effective on the value added and the rate of employment in Upper Austria.

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Author details

Sebastian Goers^{1*}, Friedrich Schneider^{1,2}, Horst Steinmüller¹ and Andreas Zauner¹

*Address all correspondence to: goers@energieinstitut-linz.at

1 Energieinstitut at the Johannes Kepler University, Linz, Austria

2 Department of Economics, Johannes Kepler University, Linz, Austria

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