

SUPPLEMENTAL MATERIAL

Linear programs to compute distance functions:

$$\begin{aligned}
 & [D_o^t(x^t, y^t)]^{-1} = \text{Max} \phi_k \\
 & \text{s. t.} \\
 & \phi_k y_{rk}^t - \sum_{j=1}^n \lambda_j y_{rj}^t \leq 0 \quad r = 1, \dots, s \\
 & x_{ik}^t - \sum_{j=1}^n \lambda_j x_{ij}^t \geq 0 \quad i = 1, \dots, m \\
 & \lambda_j \geq 0 \quad \forall j = 1, \dots, n
 \end{aligned} \tag{S1}$$

$$\begin{aligned}
 & [D_o^t(x^{t+1}, y^{t+1})]^{-1} = \text{Max} \phi_k \\
 & \text{s. t.} \\
 & \phi_k y_{rk}^{t+1} - \sum_{j=1}^n \lambda_j y_{rj}^t \leq 0 \quad r = 1, \dots, s \\
 & x_{ik}^{t+1} - \sum_{j=1}^n \lambda_j x_{ij}^t \geq 0 \quad i = 1, \dots, m \\
 & \lambda_j \geq 0 \quad \forall j = 1, \dots, n
 \end{aligned} \tag{S2}$$

$$\begin{aligned}
 & [D_o^{t+1}(x^{t+1}, y^{t+1})]^{-1} = \text{Max} \phi_k \\
 & \text{s. t.} \\
 & \phi_k y_{rk}^{t+1} - \sum_{j=1}^n \lambda_j y_{rj}^{t+1} \leq 0 \quad r = 1, \dots, s \\
 & x_{ik}^{t+1} - \sum_{j=1}^n \lambda_j x_{ij}^{t+1} \geq 0 \quad i = 1, \dots, m \\
 & \lambda_j \geq 0 \quad \forall j = 1, \dots, n
 \end{aligned} \tag{S3}$$

$$\begin{aligned}
 & [D_o^{t+1}(x^t, y^t)]^{-1} = \text{Max} \phi_k \\
 & \text{s. t.} \\
 & \phi_k y_{rk}^t - \sum_{j=1}^n \lambda_j y_{rj}^{t+1} \leq 0 \quad r = 1, \dots, s \\
 & x_{ik}^t - \sum_{j=1}^n \lambda_j x_{ij}^{t+1} \geq 0 \quad i = 1, \dots, m \\
 & \lambda_j \geq 0 \quad \forall j = 1, \dots, n
 \end{aligned} \tag{S4}$$

$$\begin{aligned}
 & [D_o^t(x^t, y^t)]^{-1} = \text{Max} \phi_k \\
 & \text{s. t.} \\
 & \phi_k y_{rk}^t - \sum_{j=1}^n \lambda_j y_{rj}^t \leq 0 \quad r = 1, \dots, s \\
 & x_{ik}^t - \sum_{j=1}^n \lambda_j x_{ij}^t \geq 0 \quad i = 1, \dots, m \\
 & \sum_{j=1}^n \lambda_j = 1 \\
 & \lambda_j \geq 0 \quad \forall j = 1, \dots, n
 \end{aligned} \tag{S5}$$

$$\begin{aligned}
 & [D_o^t(x^{t+1}, y^{t+1})]^{-1} = \text{Max} \phi_k \\
 & \text{s. t.} \\
 & \phi_k y_{rk}^{t+1} - \sum_{j=1}^n \lambda_j y_{rj}^t \leq 0 \quad r = 1, \dots, s \\
 & x_{ik}^{t+1} - \sum_{j=1}^n \lambda_j x_{ij}^t \geq 0 \quad i = 1, \dots, m \\
 & \sum_{j=1}^n \lambda_j = 1 \\
 & \lambda_j \geq 0 \quad \forall j = 1, \dots, n
 \end{aligned} \tag{S6}$$

$$\begin{aligned}
& [D_o^{t+1}(x^{t+1}, y^{t+1})]^{-1} = \text{Max} \phi_k \\
& \text{s. t.} \\
& \phi_k y_{rk}^{t+1} - \sum_{j=1}^n \lambda_j y_{rj}^{t+1} \leq 0 \quad r = 1, \dots, s \\
& x_{ik}^{t+1} - \sum_{j=1}^n \lambda_j x_{ij}^{t+1} \geq 0 \quad i = 1, \dots, m \\
& \sum_{j=1}^n \lambda_j = 1 \\
& \lambda_j \geq 0 \quad \forall j = 1, \dots, n
\end{aligned} \tag{S7}$$

$$\begin{aligned}
& [D_o^{t+1}(x^t, y^t)]^{-1} = \text{Max} \phi_k \\
& \text{s. t.} \\
& \phi_k y_{rk}^t - \sum_{j=1}^n \lambda_j y_{rj}^{t+1} \leq 0 \quad r = 1, \dots, s \\
& x_{ik}^t - \sum_{j=1}^n \lambda_j x_{ij}^{t+1} \geq 0 \quad i = 1, \dots, m \\
& \sum_{j=1}^n \lambda_j = 1 \\
& \lambda_j \geq 0 \quad \forall j = 1, \dots, n
\end{aligned} \tag{S8}$$

Malmquist productivity index and its components at water company level

Water company	2007/08		2008/09		2009/10		2010/11		2011/12		2012/13		2013/14		2014/15		Acummulative 2007/15	
	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA
1	1.086	1.055	1.117	0.895	1.084	1.000	1.080	1.006	1.071	1.025	1.067	0.943	1.061	1.000	1.052	1.204	1.619	1.127
2	1.038	1.030	1.086	0.878	1.055	1.120	1.046	0.912	1.016	0.901	1.048	0.960	1.032	0.992	1.030	1.042	1.353	0.836
3	1.057	1.003	1.065	0.978	1.061	1.097	1.046	0.990	1.026	0.933	1.039	1.007	1.030	0.990	1.026	1.010	1.349	1.007
4	1.015	1.000	1.037	0.862	1.030	1.046	1.007	0.948	0.957	0.903	1.007	1.131	1.007	0.885	0.999	1.044	1.058	0.819
5	1.040	1.021	1.018	0.939	1.022	1.063	1.037	1.046	0.986	0.937	1.009	1.052	0.997	0.980	0.989	0.949	1.099	1.019
6	1.043	0.991	1.047	0.783	1.039	1.030	1.020	0.937	1.005	0.954	1.011	0.916	1.003	1.019	0.997	0.988	1.165	0.619
7	1.042	1.045	1.035	0.928	1.033	1.052	1.016	1.025	0.971	0.839	1.005	0.995	1.010	1.002	0.979	0.954	1.091	0.841
8	1.046	1.002	1.042	0.979	1.028	1.015	1.029	0.999	1.022	0.997	1.008	0.961	1.019	1.036	1.005	0.982	1.199	0.970
9	1.040	1.027	1.030	0.926	1.039	0.996	1.034	0.994	1.030	1.017	1.009	0.923	1.032	1.060	0.998	0.953	1.212	0.897
10	1.036	1.003	1.052	0.994	1.024	1.032	1.021	1.022	1.014	0.929	1.012	0.996	0.987	0.904	1.017	1.070	1.163	0.950
11	1.107	1.009	1.124	1.013	1.097	0.917	1.048	1.043	1.064	1.007	1.034	0.976	1.038	0.990	1.034	0.966	1.545	0.921
12	1.021	0.976	1.030	0.926	1.019	1.038	0.919	0.894	0.999	0.949	1.030	1.029	0.940	0.948	0.895	0.881	0.853	0.641
13	0.998	1.164	1.006	0.834	0.997	0.949	0.989	0.904	0.978	0.882	0.970	0.954	0.972	0.987	0.969	0.981	0.879	0.655
14	0.999	1.013	1.021	0.653	1.013	1.158	0.983	1.058	0.949	0.923	0.971	1.061	0.965	0.930	0.956	0.959	0.857	0.755
15	0.984	1.067	0.989	0.821	1.002	1.085	0.971	1.006	0.965	0.950	0.976	1.012	0.953	0.985	0.958	1.006	0.796	0.932
16	0.985	0.984	0.574	0.651	1.449	1.337	0.979	1.005	0.948	0.936	0.954	0.929	0.985	1.027	0.954	0.973	0.829	0.842
17	0.956	1.068	0.951	1.091	0.913	0.843	1.160	1.037	0.957	0.920	0.981	1.056	0.992	1.003	0.979	1.000	0.889	1.328
18	0.936	1.023	0.925	1.055	0.951	0.909	0.909	1.086	0.882	0.914	1.076	1.081	0.999	0.860	0.965	1.025	0.642	1.110
19	1.077	0.997	1.112	1.029	1.043	0.904	1.074	1.061	1.003	1.022	1.079	1.050	1.126	0.985	1.014	0.983	1.528	1.032
20	0.976	0.998	1.020	0.905	1.033	1.296	1.002	1.033	0.924	0.828	0.710	0.809	1.204	1.043	0.904	1.616	0.772	1.530
21	1.227	1.105	0.675	0.655	0.847	0.966	0.859	1.034	0.979	1.009	0.898	1.096	0.964	1.034	0.939	0.997	0.695	0.895
22	0.988	1.050	0.981	1.042	0.970	0.998	0.876	1.017	1.009	1.101	0.838	0.670	0.830	1.003	0.846	0.986	0.412	0.866
23	0.963	1.021	0.958	1.018	1.028	1.086	0.951	1.252	0.984	1.022	0.979	1.058	0.913	1.005	1.034	1.490	0.726	1.237

Table S1. Evolution of productivity change (MPI) for the 23 water companies evaluated using SFA and DEA approach

Water company	2007/08		2008/09		2009/10		2010/11		2011/12		2012/13		2013/14		2014/15		Acummulative 2007/15	
	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA
1	0.989	1.000	1.044	1.000	1.000	1.000	0.997	1.000	0.996	1.000	1.005	1.000	1.003	1.000	0.980	1.000	1.014	1.000
2	0.975	0.933	1.038	1.001	1.018	1.126	0.995	0.916	0.959	0.872	1.019	1.011	1.004	0.991	1.003	0.994	1.010	0.843
3	0.993	0.992	1.010	0.997	1.015	1.080	1.000	0.994	0.976	0.925	1.004	1.005	1.002	0.990	1.003	0.996	1.002	0.978
4	0.981	0.939	1.008	0.962	1.005	1.030	0.990	0.938	0.948	0.896	1.001	1.228	1.009	0.904	1.006	0.852	0.948	0.747
5	1.005	0.995	0.989	0.989	0.998	1.048	1.023	1.033	0.980	0.927	1.008	1.143	1.003	0.997	1.001	0.849	1.006	0.980
6	1.014	0.912	1.021	0.926	1.017	1.026	1.005	0.945	0.996	0.934	1.005	0.971	1.003	1.021	1.003	0.930	1.063	0.664
7	1.007	1.004	1.006	1.029	1.008	1.026	1.001	1.034	0.966	0.817	0.999	1.002	1.009	0.984	0.983	0.950	0.979	0.845
8	0.999	1.000	1.000	1.000	0.991	1.000	1.000	0.997	0.998	0.984	0.992	0.981	1.008	0.994	1.002	0.986	0.990	0.941
9	0.998	1.002	0.987	1.018	1.003	1.012	1.002	1.008	1.004	1.006	0.986	1.005	1.016	1.021	0.987	0.994	0.984	1.066
10	0.997	1.000	1.012	1.046	0.995	1.019	1.000	1.007	0.996	0.981	0.999	0.999	0.977	0.995	1.015	0.980	0.992	1.027
11	1.025	1.000	1.053	1.000	1.028	1.000	0.995	1.000	1.010	1.000	0.996	1.000	1.003	1.000	1.003	1.000	1.114	1.000
12	0.998	0.959	1.001	0.956	0.997	1.043	0.915	0.871	1.001	0.958	1.033	1.047	0.953	0.941	0.912	0.966	0.811	0.739
13	0.999	1.134	1.001	1.043	1.005	0.920	1.004	0.925	1.000	0.876	1.000	1.068	1.005	0.986	1.002	0.777	1.016	0.730
14	1.006	1.000	1.005	0.823	1.016	1.110	1.006	1.085	0.995	0.952	1.009	1.061	1.006	1.000	1.003	0.678	1.045	0.708
15	0.995	1.132	0.974	0.907	1.010	0.999	1.007	0.992	1.007	0.993	1.011	1.137	1.001	0.929	1.008	0.807	1.013	0.896
16	0.997	1.000	0.866	0.774	1.136	1.278	0.999	0.987	0.993	0.928	0.967	0.929	1.007	1.002	0.988	0.954	0.953	0.852
17	1.022	1.162	1.024	1.337	0.970	0.749	1.051	1.065	1.012	1.049	1.001	1.192	1.007	1.002	0.991	0.635	1.078	1.191
18	1.008	1.116	1.005	1.271	1.000	0.769	0.936	1.158	0.979	0.958	0.954	1.172	1.012	0.853	0.975	0.554	0.869	0.851
19	0.982	0.993	1.017	1.008	0.977	0.978	1.022	1.023	0.988	1.000	1.021	1.000	1.013	1.000	0.991	1.000	1.011	1.001
20	0.997	1.000	0.991	1.000	0.936	1.000	1.010	1.000	1.049	1.000	0.694	1.000	1.189	0.837	1.135	1.195	1.002	1.032
21	0.976	1.138	1.021	0.785	0.996	1.017	0.997	1.013	0.976	1.021	0.976	1.283	1.014	1.000	1.015	0.656	0.971	0.913
22	0.994	1.000	0.995	1.000	1.001	1.000	0.974	1.000	1.055	1.000	0.975	1.000	0.999	1.000	0.965	1.000	0.958	1.000
23	1.014	1.057	1.016	1.105	1.039	1.052	0.983	0.957	0.999	0.950	0.992	1.232	1.023	1.000	0.980	0.646	1.046	0.998

Table S2. Evolution of pure efficiency change (PEC) for the 23 water companies evaluated using SFA and DEA approach

Water company	2007/08		2008/09		2009/10		2010/11		2011/12		2012/13		2013/14		2014/15		Acummulative 2007/15	
	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA
1	1.000	1.000	0.982	1.000	0.999	1.000	1.003	1.000	1.003	1.000	0.997	1.000	0.999	1.000	1.023	1.000	1.006	1.000
2	0.999	1.023	0.989	0.999	0.983	1.002	1.005	0.999	1.016	1.001	0.993	0.999	0.998	0.986	1.004	0.966	0.988	0.974
3	1.000	1.006	0.996	0.995	0.993	0.999	1.000	0.983	1.010	0.982	1.001	1.017	1.000	0.980	1.001	0.952	0.999	0.914
4	1.001	1.011	1.001	1.000	1.001	1.003	1.000	1.006	0.997	0.989	1.002	1.005	1.001	0.986	1.002	1.015	1.006	1.015
5	1.002	1.032	1.001	0.999	1.003	0.995	1.001	1.007	0.999	0.991	1.002	0.999	1.001	0.989	1.001	0.980	1.010	0.993
6	1.002	1.007	1.003	0.993	1.004	1.011	1.002	0.995	1.000	0.986	1.002	0.996	1.001	0.997	1.002	0.976	1.015	0.961
7	1.002	1.024	1.001	0.982	1.003	1.016	1.001	0.988	0.995	0.999	1.000	1.005	1.001	1.001	1.002	0.932	1.005	0.948
8	1.000	1.000	1.000	1.000	1.001	0.998	1.001	0.990	1.001	0.990	1.000	0.993	1.001	1.024	1.000	0.938	1.005	0.933
9	1.001	1.016	1.004	0.923	1.001	0.969	1.001	0.961	1.001	0.957	1.002	0.947	1.000	1.001	1.001	0.911	1.010	0.685
10	1.001	0.996	1.005	0.968	0.999	0.997	1.001	0.998	1.001	0.910	1.001	1.020	1.002	0.880	0.999	1.030	1.011	0.798
11	1.009	1.000	1.005	1.000	1.009	1.000	0.998	1.000	1.007	1.000	0.998	1.000	1.002	1.000	1.005	1.000	1.033	1.000
12	1.006	1.016	1.014	0.999	1.010	0.980	0.999	1.011	0.999	0.961	1.002	0.999	0.999	0.985	1.001	0.854	1.030	0.807
13	0.996	0.948	1.010	0.973	1.002	1.039	1.002	0.980	1.000	0.980	0.996	0.927	0.999	1.001	1.004	1.171	1.010	1.019
14	1.001	0.935	1.027	0.966	1.013	1.051	1.001	0.978	0.985	0.936	1.000	1.102	1.004	0.936	1.003	1.030	1.033	0.933
15	1.004	0.893	1.032	1.009	1.013	1.068	0.993	1.002	0.993	0.934	1.006	0.902	0.999	1.040	1.003	1.157	1.043	1.004
16	0.998	0.990	0.716	0.885	1.323	1.100	1.002	1.003	0.983	0.981	1.020	1.020	1.015	1.010	1.008	0.982	1.065	0.971
17	0.982	0.887	0.982	0.993	1.005	1.133	1.171	0.977	1.007	0.846	1.046	0.976	1.055	1.007	1.063	1.320	1.311	1.139
18	0.977	0.919	0.977	0.910	1.015	1.189	1.045	0.941	0.979	0.719	1.197	1.016	1.063	1.014	1.067	1.704	1.322	1.413
19	1.064	1.004	1.070	1.000	1.045	1.018	1.037	0.994	1.005	1.018	1.055	1.052	1.114	1.000	1.030	1.000	1.420	1.085
20	1.016	0.971	1.070	0.949	1.146	1.342	1.048	1.020	0.932	0.808	1.074	0.844	1.074	1.249	0.841	1.194	1.202	1.377
21	1.269	0.943	0.972	0.911	0.925	1.083	0.902	0.986	1.049	0.971	0.975	0.907	1.012	1.050	0.994	1.293	1.098	1.144
22	0.970	1.000	0.970	1.000	0.961	1.000	0.905	1.000	0.967	1.000	0.891	1.000	0.876	1.000	0.935	1.000	0.475	1.000
23	0.980	0.947	0.980	0.914	1.033	1.033	1.017	0.971	1.039	1.052	1.045	0.875	0.955	1.013	1.122	1.373	1.172	1.178

Table S3. Evolution of scale efficiency change (SEC) for the 23 water companies evaluated using SFA and DEA approach

Water company	2007/08		2008/09		2009/10		2010/11		2011/12		2012/13		2013/14		2014/15		Acummulative 2007/15	
	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA	SFA	DEA
1	1.097	1.055	1.091	0.895	1.086	1.000	1.079	1.006	1.072	1.025	1.066	0.943	1.059	1.000	1.050	1.204	1.600	1.127
2	1.064	1.079	1.060	0.879	1.053	0.993	1.046	0.997	1.041	1.033	1.036	0.950	1.031	1.016	1.024	1.085	1.355	1.033
3	1.064	1.005	1.059	0.985	1.053	1.018	1.046	1.013	1.041	1.029	1.035	0.986	1.028	1.020	1.022	1.065	1.348	1.120
4	1.033	1.054	1.028	0.896	1.023	1.013	1.017	1.004	1.011	1.019	1.004	0.916	0.997	0.994	0.991	1.208	1.104	1.104
5	1.034	0.995	1.028	0.951	1.021	1.020	1.013	1.005	1.008	1.020	1.000	0.921	0.993	0.994	0.987	1.140	1.083	1.047
6	1.027	1.079	1.023	0.853	1.019	0.993	1.013	0.997	1.009	1.036	1.004	0.947	0.998	1.001	0.992	1.089	1.087	0.995
7	1.033	1.017	1.028	0.919	1.022	1.009	1.014	1.004	1.010	1.028	1.006	0.988	0.999	1.017	0.994	1.078	1.107	1.060
8	1.047	1.002	1.042	0.979	1.036	1.018	1.028	1.012	1.022	1.024	1.016	0.987	1.009	1.018	1.003	1.062	1.204	1.100
9	1.042	1.009	1.038	0.986	1.036	1.015	1.031	1.026	1.026	1.057	1.021	0.970	1.016	1.037	1.010	1.053	1.219	1.153
10	1.037	1.007	1.035	0.983	1.029	1.016	1.020	1.017	1.016	1.041	1.012	0.978	1.008	1.032	1.003	1.060	1.161	1.133
11	1.073	1.009	1.066	1.013	1.060	0.917	1.055	1.043	1.047	1.007	1.039	0.976	1.033	0.990	1.026	0.966	1.398	0.921
12	1.017	1.002	1.015	0.969	1.012	1.016	1.004	1.015	0.999	1.031	0.995	0.983	0.988	1.023	0.982	1.067	1.012	1.107
13	1.002	1.082	0.995	0.822	0.990	0.993	0.983	0.997	0.979	1.028	0.974	0.964	0.968	1.001	0.963	1.078	0.853	0.964
14	0.992	1.084	0.990	0.822	0.984	0.993	0.976	0.997	0.969	1.036	0.962	0.908	0.955	0.994	0.950	1.374	0.779	1.207
15	0.985	1.057	0.982	0.897	0.978	1.017	0.970	1.012	0.965	1.025	0.959	0.987	0.953	1.018	0.947	1.077	0.740	1.091
16	0.990	0.994	0.992	0.950	0.989	0.951	0.978	1.015	0.972	1.029	0.968	0.981	0.963	1.015	0.958	1.038	0.810	0.972
17	0.953	1.037	0.944	0.822	0.938	0.993	0.937	0.997	0.938	1.036	0.934	0.908	0.929	0.994	0.926	1.193	0.500	0.979
18	0.950	0.998	0.942	0.912	0.935	0.993	0.928	0.997	0.924	1.036	0.924	0.908	0.924	0.994	0.923	1.086	0.452	0.923
19	1.031	1.000	1.025	1.022	1.020	0.908	1.016	1.044	1.010	1.005	1.002	0.998	0.999	0.985	0.992	0.983	1.096	0.945
20	0.963	1.028	0.959	0.954	0.951	0.966	0.943	1.014	0.942	1.026	0.942	0.958	0.940	0.999	0.927	1.132	0.568	1.076
21	0.981	1.030	0.975	0.917	0.969	0.877	0.960	1.035	0.954	1.018	0.946	0.942	0.937	0.985	0.930	1.175	0.652	0.977
22	1.024	1.050	1.016	1.042	1.008	0.998	0.998	1.017	0.987	1.101	0.972	0.670	0.956	1.003	0.946	0.986	0.906	0.866
23	0.970	1.021	0.962	1.008	0.955	0.999	0.951	1.025	0.946	1.023	0.941	0.981	0.935	0.992	0.932	1.003	0.592	1.052

Table S4. Evolution of technical change (TC) for the 23 water companies evaluated using SFA and DEA approach