Does green taxation drive countries toward the carbon efficiency frontier?

TOBIAS BÖHMELT
Center for Comparative and International Studies, ETH Zürich
Department of Government, University of Essex
E-mail: tobias.boehmelt@ir.gess.ethz.ch or tbohmelt@essex.ac.uk

FARZAD VAZIRI
Department of Government, University of Essex
E-mail: fvazir@essex.ac.uk

HUGH WARD
Department of Government, University of Essex
E-mail: hugh@essex.ac.uk

Appendix – Supplementary materials

This appendix summarizes additional analyses and robustness checks that further support our argument and findings of the main article. These include:

- A descriptive overview of the development of *Environmental Input Efficiency* by country and over time.
- Using CO_2 emissions per capita as an alternative (absolute-level) environmental performance indicator for the dependent variable.
- The calculation of spatial long-term equilibrium effects and temporal asymptotic effects.
- Alternative models based on Prais-Winsten regression with panel-corrected standard errors (PCSE), ordinary least squares (OLS) with year fixed effects, and when dropping potentially influential countries (US and China).
- Separate examination of taxes and fees/charges.
- In-sample prediction.
- Inclusion of variables on environmental non-governmental organizations (ENGOs) and veto players.
- Examining the role of institutions and electoral systems.
- Controlling for state capacity using different operationalizations.
- A closer examination of the "double-dividend" argument.
- A simultaneous equation model.
- Employing bootstrapped standard errors and an examination of non-stationarity and cointegration.
- We control for inflation, government debt, and education, and we employ an alternative operationalization for the green-party item.

- We incorporated the information on different income groups into our dependent variable and re-estimated the core models.
- We "simplified" the outcome variable by removing the population measure from the emissions and GDP components, and introduce population merely as another "input."
- An overview of each country's reference state.

(1) Development of *Environmental Input Efficiency* per country and over time

Figure A1. Overview of *Environmental Input Efficiency*

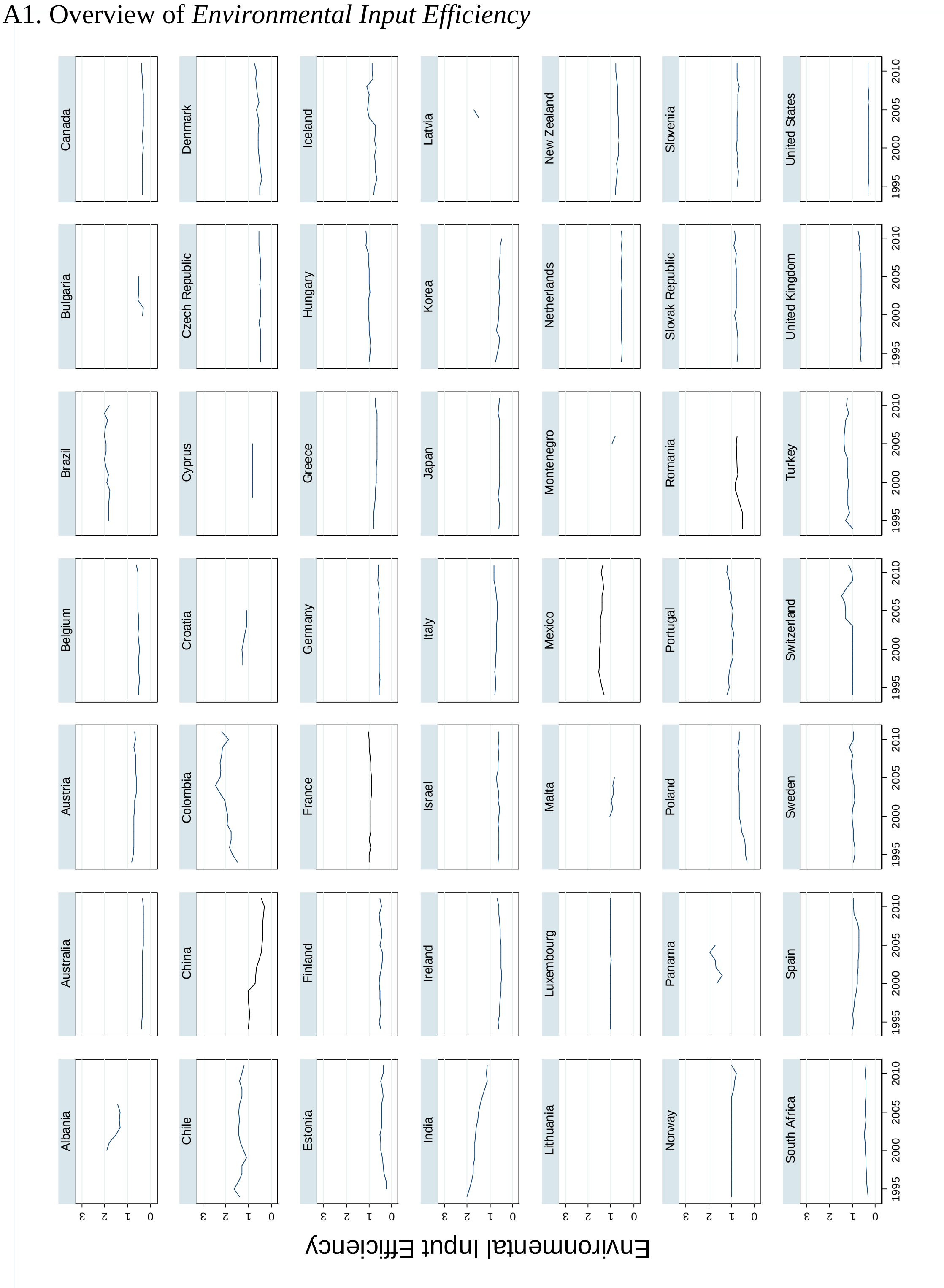


Table A1. CO_2 emissions per capita as an alternative for *Environmental Input Efficiency*

	Model 1	Model 2	Model 3
Lagged Dependent Variable	0.794	0.726	0.736
	(0.028)***	(0.031)***	(0.031)***
Green Tax Revenue per capita	-0.001		-0.001
	(0.000)**		(0.001)
Manufacturing (% of GDP)		0.001	0.001
		(0.000)***	(0.000)***
GDP per capita		-0.001	-0.001
		(0.001)	(0.001)
GDP per capita^2		0.001	0.001
		(0.000)*	(0.000)*
Unemployment		-0.001	-0.001
		(0.000)**	(0.000)*
Democracy		0.001	0.001
		(0.000)**	(0.000)**
Economic Globalization		-0.000	-0.000
		(0.000)	(0.000)
Green Party Dummy		0.000	0.000
		(0.000)	(0.000)
$\mathbf{W}y^{Geography}$		0.140	0.136
		(0.069)**	(0.069)**
Observations	671	616	616
Fixed Effects	Yes	Yes	Yes
Overall R^2	0.987	0.975	0.976

Standard errors in parentheses; constant included in estimation, but omitted from presentation.

* p<0.10, ** p<0.05, *** p<0.01

(2) Alternative dependent variable: CO_2 emissions per capita

As a first robustness check, we considered replacing our dependent variable by CO_2 emissions per capita, an absolute environmental performance measure at the outcome level commonly used in in the previous literature. Note that we do not conduct this additional analysis with the intention to show that the green-taxation variable has to be negatively signed and statistically significant. Instead, our aim is to demonstrate that the impact of our core variable may differ depending on the outcome, and the absolute level of carbon emissions per capita is, in fact, a different dependent variable. To this end, we seek to highlight that no single measure is ideal for all purposes. While carbon emissions may help in developing ideas about a fair distribution of access to the global commons in the long term, to judge whether a state is currently taking advantage of technological possibilities, given the structural constraints it faces, its performance needs to be compared to that of a reasonable benchmark so as to avoid the “comparing-apples-and-oranges” problem.

We used information on CO_2 emissions in kilotons and population from the World Bank Development Indicators to construct this alternative outcome. We also replaced the temporally lagged dependent variable and the spatial lag by measures that correspond to the new dependent variable. Finally, we added GDP per capita and its square term to those models considering the control variables, as the dependent variable no longer contains this component. Table A1 summarizes our findings with this change in the research design. We derive out of these results that the impact of *Green Tax Revenue per capita* is not robust to this alternative outcome variable. Our core explanatory variable is only significant at conventional levels in Model 1 of Table A1, where we do not include controls.

(3) Spatial long-term equilibrium effects

Coefficients in spatial-lag models indicate only the short-run impact of a shock to a variable. Therefore, we also calculated long-term equilibrium impacts, i.e. the indirect impact of x_i on y_i, from the influence y_i exerts on its neighbors y_j, which in turn feeds back into y_i. To this end, we assumed the spatial weights and all other variables remain at 2003 values, i.e. we focus on the year 2003, and hypothetically increased *Environmental Input Efficiency* in some countries by 0.1. In turn, we calculated the long-term effects on all countries, as the shock echoes through the system of spatial and temporal lags using the following equation:

$$(I_N - \Sigma \rho i \mathbf{W}_{it} - \phi\, I_N)^{-1}\, \Delta x_t\, B,$$

where I_N is the identity matrix, $\mathbf{W}_{it}$ the sub-matrix of the *i*-th weighting matrix for period *t*, and Δx_t B is the shock at time *t*. Since each unit will have a different set of connectivities to its neighbors, the impact of a hypothetical change in x_i will depend on *which unit* is being changed (Ward and Cao 2012).

Table A2. Spatial long-term equilibrium effects

	Increase in US	Increase in China	Increase in 2003 EU
USA	0.409	0.008	0.178
Canada	0.013	0.008	0.179
Mexico	0.013	0.008	0.172
Panama	0.013	0.007	0.173
Colombia	0.013	0.007	0.173
Brazil	0.012	0.006	0.176
Chile	0.013	0.005	0.168
United Kingdom	0.010	0.008	0.579
Ireland	0.010	0.008	0.579
Netherlands	0.009	0.008	0.579
Belgium	0.009	0.008	0.579
Luxembourg	0.009	0.008	0.579
France	0.010	0.008	0.580
Switzerland	0.009	0.008	0.188
Spain	0.010	0.008	0.579
Portugal	0.010	0.008	0.579
Germany	0.009	0.009	0.579
Poland	0.009	0.009	0.187
Austria	0.009	0.009	0.578
Hungary	0.009	0.009	0.187
Czech Republic	0.009	0.009	0.188
Slovak Republic	0.009	0.009	0.187
Italy	0.009	0.008	0.578
Albania	0.009	0.009	0.187
Croatia	0.009	0.009	0.187
Slovenia	0.009	0.008	0.187
Greece	0.009	0.009	0.577
Bulgaria	0.009	0.009	0.186
Estonia	0.009	0.009	0.187
Finland	0.009	0.009	0.577
Sweden	0.009	0.009	0.578
Norway	0.010	0.009	0.187
Denmark	0.009	0.009	0.579
Iceland	0.010	0.009	0.186
South Africa	0.008	0.009	0.178
Turkey	0.009	0.009	0.185
Israel	0.009	0.009	0.185
China	0.009	0.409	0.176
Korea	0.009	0.014	0.174
Japan	0.010	0.014	0.172
India	0.008	0.011	0.180
Australia	0.009	0.016	0.142
New Zealand	0.013	0.017	0.120

Based on Model 3 in the main text, Table A2 reports three such experiments for the impact of a 0.1 point increase in *Environmental Input Efficiency* in 2003, first for the US, second for

China, and third for all EU members in that year simultaneously. The table reports the median equilibrium impact, based on 1,000 random draws from the multivariate normal distribution of the spatial and temporal lags. The simulations suggest that an input efficiency shock in the US would have relatively strong and positive effects on Canada, New Zealand, and several Latin American countries, but would have comparatively small effects on many European countries. In contrast, except for states in the country's proximity, most nations would almost "free-ride" on Chinese efforts that led to an increase of 0.1 in *Environmental Input Efficiency* as other countries' increases in environmental efficiency due to a Chinese efficiency shock would be small. Finally, we simulate the effect of a simultaneous 0.1 shock in all 2003 EU countries (this excludes, obviously, those states acceding in the 2004 or 2007 rounds). Here, efficiency increases in European countries positively feed-back off each other.

Table A3. Asymptotic long-term Effects

	Model 1	Model 2	Model 2
Green Tax Revenue per capita	0.062		0.044
Manufacturing (% of GDP)		-0.014	-0.012
Unemployment		0.014	0.013
Democracy		-0.025	-0.022
Economic Globalization		0.001	-0.001
Green Party Dummy		-0.049	-0.044
$\mathbf{W}y^{Geography}$		0.729	0.745

(4) Temporal asymptotic long-term effects

Due to the temporally lagged dependent variable we include in all models of the main article, the coefficient estimates only reflect the short-term impact, i.e. the influence in a current year. In order to calculate the asymptotic, long-term effect of our variables, we modified our results according to Plümper et al. (2005, 336),

$$y_t(\alpha,\nu) = \alpha\sum_{n=0}^{T}\beta_0{}^n + \sum_{n=0}^{T}\theta_t\beta_0{}^{(t-n)}, n = [0,T]$$

where β_0 is the estimated coefficient of the lagged dependent variable, and T is the number of periods with t denoting a single period (see also Keele and Kelly 2006). Table A3 lists the long-term effects for all coefficients and all main models of our article.

(5) Prais-Winsten regression with panel-corrected standard errors, OLS with year fixed effects, and outliers

Time-series cross-section data may induce a number of estimation problems. First, errors might display panel heteroscedasticity and contemporaneous as well as serial correlation. We thus followed Beck and Katz (1995; 1996; see also Beck 2001) by including a temporally lagged dependent variable. This addresses serial correlation and allows us to estimate the degree of year-to-year inertia. In order to correct for contemporaneous correlation and panel heteroscedasticity, one might also consider empirical models that employ panel-corrected standard errors (PCSEs). We estimated such a model with PCSEs where the parameters are estimated via Prais-Winsten regression. We use a panel-specific AR (1) autocorrelation structure and assume panel-level heteroscedastic errors. Table A4, Model 4 summarizes our findings.

Moreover, we also relaxed the imposition of an AR (1) structure and, instead, use ordinary least squares (OLS) regression models, while controlling for year and country fixed effects and including a temporally lagged dependent variable. As we drop the AR (1) assumption, we opted for year fixed effects that control for temporal shocks that are common for all states in a given year (e.g. economic crises).

Finally, although we include unit, i.e. country fixed effects, it may be worth omitting potentially influential observations altogether. In our context of environmental performance and green taxation, the US and China may be particularly influential. Models 6-7 in this appendix exclude one of these countries at a time. As demonstrated in Table A4, however, none of these additional changes affects the substance of our findings.

Table A4. Prais-Winsten Regression, OLS, and outliers

	Model 4 Prais-Winsten	Model 5 OLS	Model 6 W/Out US	Model 7 W/Out China
Lagged Dependent Variable	0.680	0.718	0.756	0.710
	(0.039)***	(0.024)***	(0.023)***	(0.025)***
Green Tax Revenue per capita	0.018	0.013	0.011	0.011
	(0.008)**	(0.005)**	(0.005)**	(0.005)**
Manufacturing (% of GDP)	-0.005	-0.005	-0.003	-0.003
	(0.002)**	(0.002)***	(0.001)**	(0.001)**
Unemployment	0.003	0.003	0.003	0.003
	(0.001)**	(0.001)**	(0.001)***	(0.001)***
Democracy	-0.006	-0.005	-0.005	-0.006
	(0.003)*	(0.005)	(0.005)	(0.005)
Economic Globalization	0.001	0.001	-0.000	0.000
	(0.001)**	(0.001)*	(0.000)	(0.000)
Green Party Dummy	-0.007	-0.007	-0.011	-0.013
	(0.012)	(0.013)	(0.012)	(0.012)
$\mathbf{W}y^{Geography}$	-0.351	-0.517	0.187	0.221
	(0.223)	(0.298)*	(0.083)**	(0.079)***
Observations	657	657	599	597
Country Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	No	No
Overall R^2	0.991	0.980	0.971	0.972

Panel-corrected standard errors in parentheses (Model 4); standard errors in parentheses (Models 5-7); constant included in estimation (Models 5-7), but omitted from presentation. Models are based on Model 3 in the main text.

* p<0.10, ** p<0.05, *** p<0.01

(6) Separate examination of taxes and fees/charges

Our core explanatory variable, *Green Tax Revenue per capita*, comprises both taxes and fees/charges as we treat the latter as equivalent to the former. According to the OECD, charges are defined as payments that cover the proven expenses for handling waste or providing a resource such as water, and they therefore differ slightly from how the OECD defines taxes as such. Examples of fees/charges in our data pertain to “water abstraction charges" in several German *Länder*, while motor fuel taxes are a prominent example for taxes. In light of this discussion, we disaggregated *Green Tax Revenue per capita* into taxes and fees/charges only. Table A5 summarizes our findings for Model 3 of the main text. As demonstrated in Table A5, our results remain unaltered when taking out the fee/charges component in Model 8. In turn, however, Model 9 shows that fees/charges do not have the same effect as taxes: in fact, there is little evidence for any substantive impact on *Environmental Input Efficiency* due to green fees/charges. Arguably, environmental fees and charges are not shown here to be effective because governments make of them, so there is little variation and levels are low. Specifically, while the average country-year in our data has a green tax burden of $462.28, fees/charges only sum up to about $19.

Table A5. Disaggregation of *Green Tax Revenue per capita*

	Model 8 Taxes	Model 9 Fees/Charges
Lagged Dependent Variable	0.756	0.752
	(0.023)***	(0.023)***
Revenue per capita	0.011	0.020
	(0.005)**	(0.087)
Manufacturing (% of GDP)	-0.003	-0.004
	(0.001)**	(0.001)***
Unemployment	0.003	0.003
	(0.001)***	(0.001)***
Democracy	-0.005	-0.006
	(0.005)	(0.005)
Economic Globalization	-0.000	0.000
	(0.000)	(0.000)
Green Party Dummy	-0.011	-0.012
	(0.012)	(0.012)
$\mathbf{W}y^{Geography}$	0.181	0.182
	(0.081)**	(0.082)**
Observations	613	613
Fixed Effects	Yes	Yes
Overall R^2	0.972	0.971

Standard errors in parentheses; constant included in estimation, but omitted from presentation.

* p<0.10, ** p<0.05, *** p<0.01

(7) Assessing the predictive power of *Green Tax Revenue per capita*

Hypothesis testing that ignores prediction heuristics risks failing to identify stable structural relationships between, in our case, the environmental outcome measure and its determinants – first and foremost: green taxation (see Ward et al. 2010). Therefore, how effective is the green-taxation item in *predicting* input efficiency in-sample? That is, how accurate are the "conditional statements about a phenomenon for which the researcher actually has data, i.e. the outcome variable has been observed" (Bechtel and Leuffen 2010, 311)? To assess the predictive power of *Green Tax Revenue per-capita*, we use the mean squared prediction error (MSPE). In general, the closer the MPSE is to 0, the more accurate is the model in making predictions.

Table A6. In-sample prediction power of *Green Tax Revenue per capita*

Excluded Variable	Mean MSPE	ΔMSPE
None (Model 3 of main text)	0.01259	-
Green Tax Revenue per capita	0.01293	0.0034

Table A6 summarizes the measure's values in two scenarios: a baseline mode for which we use Model 3 from the main text and the same model that discards *Green Tax Revenue per capita* from the set of predictors. The predictive power of our model decreases when excluding *Green Tax Revenue per capita* as the MSPE increases when omitting it from the estimation. Hence, it is not only the case that our core variable of interest is statistically significant at conventional levels, but also has power to predict levels of *Environmental Input Efficiency*.

(8) Inclusion of environmental non-governmental organizations

In theory, environmental non-governmental organizations (ENGOs) might not always lobby for higher environmental taxes, because this can lead to production moving "offshore" to countries with laxer regulation. This, in turn, could affect the environment within the ENGOs' own borders when pollution spills across countries (Conconi 2003; Aidt 2005).

There is also some ambiguity about the circumstances and whether ENGOs can effectively motivate governments to pursue more “environmental-friendly” policies (e.g. Betsill 2002, 2006; Betsill and Corell 2001; 2008; Raustiala 1997; Newell 2000; Gulbrandsen and Andresen 2004). Nevertheless, Binder and Neumayer (2005) find that greater leverage of ENGOs is associated with significantly and substantially lower levels of Sulphur dioxide, smoke, and heavy particulates emissions. There is also some evidence that the strength of a country’s environmental movement affects the international commitments it is willing to agree on in the form of treaties, although the impact can be conditional on a number of domestic factors (e.g. Bernauer et al. 2013; Böhmelt and Betzold 2013) and do not necessarily materialize when care is taken to allow for selection bias (Böhmelt 2013).

Table A7. The impact of ENGOs

	Model 10
Lagged Dependent Variable	0.800 (0.025)***
Green Tax Revenue per capita	0.025 (0.005)***
ENGO Leverage	3.069 (0.884)***
Manufacturing (% of GDP)	-0.001 (0.001)
Unemployment	0.003 (0.001)***
Democracy	-0.008 (0.005)
Economic Globalization	-0.000 (0.000)
Green Party Dummy	-0.001 (0.014)
$\mathbf{W}y^{Geography}$	0.251 (0.064)***
Observations	459
Fixed Effects	Yes
Overall R^2	0.976

Standard errors in parentheses; constant included in estimation, but omitted from presentation.

* p<0.10, ** p<0.05, *** p<0.01

Nevertheless, we examined the influence of ENGOs. We measure ENGOs and their potential for political leverage by the number of ENGOs registered in a country divided by population. The data for this variable (*ENGO Leverage*, which is multiplied by 10,000 to avoid very large coefficients) are taken from Bernauer et al. (2013) and were originally coded from information for 1973-2006 in the archives of the International Union for Conservation of Nature (IUCN). The IUCN considers itself as “the world’s largest and most important conservation network”, with a “mission to influence, encourage, and assist societies throughout the world to conserve the integrity and diversity of nature” (IUCN 2006). Its members include national and international ENGOs, government agencies, and scientists from more than 181 countries. By dividing the number of ENGOs by population (as taken from the World Bank Development Indicators), we create a measure of “representation per citizens”. Better representation and, hence, higher values of that measure should translate into more influence and, arguably, better environmental quality.

While the organization’s network extends to most countries in the world, the IUCN is essentially an umbrella organization where membership is not mandatory and ENGOs do not have to register. The data we use may thus omit some ENGOs, but this measurement approach seems more systematic and efficient than ENGO data from other sources. Furthermore, IUCN’s large network of relationships with non-governmental organizations increases our confidence that we have a reasonably valid and reliable proxy for the potential political leverage of ENGOs (see also Bernauer et al. 2013). As demonstrated in Table A7, we obtain some evidence for the claim that the leverage of green civil society may be associated with better environmental quality.

Table A8. The impact of veto players

	Model 11
Lagged Dependent Variable	0.756 (0.023)***
Green Tax Revenue per capita	0.011 (0.005)**
Veto Players	-0.009 (0.024)
Manufacturing (% of GDP)	-0.003 (0.001)**
Unemployment	0.003 (0.001)***
Democracy	-0.005 (0.005)
Economic Globalization	-0.000 (0.000)
Green Party Dummy	-0.011 (0.012)
$\mathbf{W}y^{Geography}$	0.179 (0.081)**
Observations	613
Fixed Effects	Yes
Overall R^2	0.972

Standard errors in parentheses; constant included in estimation, but omitted from presentation.

* p<0.10, ** p<0.05, *** p<0.01

(9) Inclusion of a veto-player variable

The literature on environmental politics provides several arguments for why veto players may not only affect green taxation, but also the environmental performance of a country. Fredriksson and Ujhelyi (2006), for example, argue that a large number of veto players in a political system makes lobbying more costly for ENGOs and, consequently, this lowers the chances of states committing to environmental treaties. Similarly, the environmental performance of a state could suffer. Perkins and Neumayer (2007) or Cao and Prakash (2012) demonstrate theoretically and empirically that veto players, i.e. more political constraints on the executive, have a negative effect on environmental outcome measures.

To examine these mechanisms in our context, we took Henisz's (2002) *POLCONIII* index: "[b]uilding on a simple spatial model of political interaction, the index captures the structure of government in a given country, together with the political views represented by different levels of government. It measures the extent to which political actors are constrained in their future policy choices by the existence of other political actors with veto power" (Perkins and Neumayer 2007, 28).

Table A8 summarizes our results: we take the main text's Model 3 as our foundation and introduce *Veto Players*. The findings clearly highlight that our argument and the corresponding empirical expectations also when controlling for Henisz's (2002) *POLCONIII* index,

Table A9. Institutions and electoral systems

	Model 12 Parliamentary	Model 13 Prop. Rep.
Lagged Dependent Variable	0.717 (0.025)***	0.713 (0.026)***
Green Tax Revenue per capita	0.026 (0.006)***	-0.008 (0.022)
Parliamentary Dummy	-0.055 (0.054)	
PR Dummy		0.025 (0.028)
Parliamentary Dummy * Revenue per capita	-0.040 (0.009)***	
PR Dummy * Revenue per capita		0.014 (0.022)
Manufacturing (% of GDP)	-0.004 (0.001)***	-0.003 (0.001)**
Unemployment	0.003 (0.001)***	0.003 (0.001)***
Democracy	-0.009 (0.005)*	-0.007 (0.005)
Economic Globalization	0.000 (0.000)	0.000 (0.000)
Green Party Dummy	-0.012 (0.012)	-0.010 (0.012)
$\mathbf{W}y^{Geography}$	0.205 (0.079)***	0.224 (0.080)***
Observations	582	593
Fixed Effects	Yes	Yes
Overall R^2	0.960	0.972

Standard errors in parentheses; constant included in estimation, but omitted from presentation.

* p<0.10, ** p<0.05, *** p<0.01

(10) The role of institutions and electoral systems

Lobbying indicates demand for policy changes that might affect the effectiveness of green taxes. However, there is also the matter of supply. Environmental improvement is a public good. The degree to which political systems supply public goods varies systematically, depending on whether they have majoritarian or proportional electoral systems and whether they are presidential or parliamentary (for an overview, see Böhmelt et al. 2015).

Large district magnitudes, which are typical of proportional representation systems, encourage the provision of public goods, as they induce parties to build broad constituencies of support. Moreover, proportional representation favors green parties and, in a coalition government, these might bargain for more effective green taxes, which their electoral constituency desires (Milesi-Ferretti et al. 2002). In contrast, majoritarian systems, typically associated with a small district magnitude, encourage parties to target swing constituencies (Persson and Tabellini 2004; 2005). In turn, representatives under majoritarian rules have incentives to bring geographically targeted benefits to their area (Persson and Tabellini 2005, 18), e.g. they might seek to protect a heavy-energy industry important for local employment (see also Scruggs 2003, 176f).

However, there are arguments suggesting that proportional representation may actually produce more targeting of benefits (Persson et al. 2007). For instance, Böhmelt et al. (2015, 99) claim that “proportional representation systems support more parties, which raises the chances for coalition governments that are usually characteristic of parliamentary systems. Still, parties with smaller vote shares have the possibility to influence government policies. A larger number of political parties also limits their spatial mobility and results in vote-maximizing positions of some parties away from the political center”. Hence, due to the way in which proportional representation influences party structure, these systems may actually provide fewer public goods, including environmental ones. Relatively little work has been done in the environmental politics literature to systematically test such propositions, however (but see Scruggs 2003; Bernauer and Koubi 2009), and there are theoretical arguments both ways. We still seek to control for the influence of majoritarian vs. proportional representation in our context.

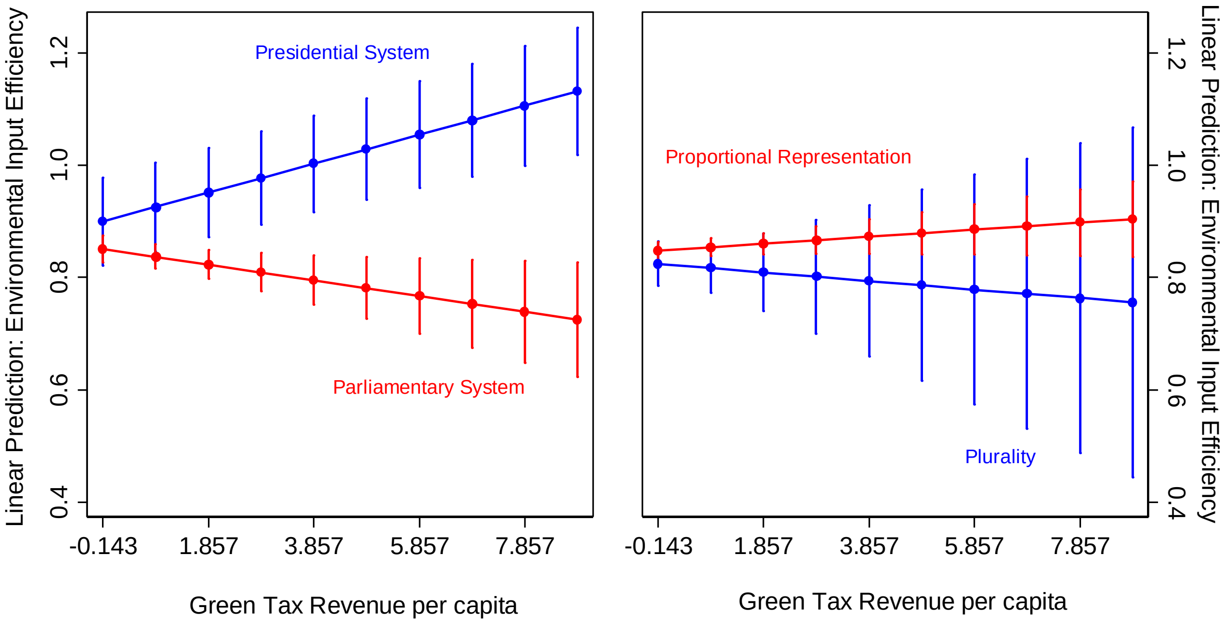
As Gerring et al. (2009) point out, the debate about whether parliamentary or presidential systems provide better governance has a long and inconclusive history. For example, in relatively unaccountable systems, politicians could not be clearly blamed for the failure of green taxation to work efficiently. On one hand, the division of powers cuts against accountability in presidential systems; on the other hand, coalition governments in parliamentary systems make it harder for voters to identify who is to blame. Still, based on the "logic of political survival", Bueno de Mesquita et al. (2005) predict that public good provision may be higher in presidential systems. Moreover, because of vote-of-confidence requirements in parliamentary systems, party cohesion is higher than in presidential systems, where the president does not need to maintain majority support. Party cohesion in parliamentary systems tends to lead to programs benefitting broad social groups, whereas fragmentation in presidential systems may favor programs targeted toward specific interests of powerful officeholders (Persson and Tabellini 2005, 25) and pork-barrel politics delivering benefits to representatives' constituents (Persson and Tabellini 2004). In the absence of a clear argument one way or another (Gerring et al. 2009), the question of whether parliamentary or presidential systems lead to better governance is an empirical one.

We measure presidential or parliamentary governments with data from the World Bank's Database of Political Institutions (Beck et al. 2001). According to this data set, countries in which the legislature elects the chief executive are parliamentary systems. Systems with presidents who are elected through popular vote, either directly or by an electoral college (whose *only* function is to elect the political leader), and where there is no prime minister, are classified as presidential. We created a dichotomous variable (*Parliamentary Dummy*) that receives a value of 0 in case a country has a presidential system and the value of 1 if a country has a parliamentary system. "Mixed regimes" and systems that are not classified as either parliamentary or presidential are omitted from the analysis.

The type of electoral system is also captured with data from the World Bank's Database (Beck et al. 2001). Plurality systems are identified on the basis of voting institutions in which legislators are elected using a "winner-takes-all" rule. Conversely, proportional representation is coded if candidates are elected based on the percentage of votes received by their party, and/or if the World Bank's "sources identified the respective electoral system as proportional representation" (Beck et al. 2001). Similar to the democratic government-form variable, we created a binary item (*PR Dummy*) that takes on the value of 0 for plurality systems and 1 for proportional representation. Mixed electoral systems are omitted.

Table A9 summarizes our findings. Note that the variable on the form of government and the electoral system, respectively, is interacted with the item on environmental tax revenue. In light of this, Figure A2 graphically illustrates the conditional effects. First, with regard to the form of government (Model 12 and left panel in Figure A2), the results demonstrate that the positive and significant effect we identified for the "unconditional models" in the main text persists for *Green Tax Revenue per capita*: environmental taxes do indeed push states closer to the input efficiency frontier. However, the effect is more strongly pronounced in presidential systems. This lends support to those studies in the literature arguing that presidential systems are, in fact, more likely than parliamentary ones to provide public goods, including environmental ones.

Figure A2. The interaction of green taxation with institutions and electoral systems



Note: Vertical bars pertain to 90 percent confidence intervals.

Coming to the type of a state's electoral system (Model 13 and the right panel in Figure A2), we find little evidence that there are crucial differences between proportional representation and majoritarian systems. Note, however, that the positive and statistically significant effect of *Green Tax Revenue per capita* persists. In addition, also recall that we include fixed effects in both models summarized in Table A9, and any effect stemming from variables that hardly change over time may be picked up by the unit fixed effects. There are two main reasons, however, to present the analysis pertaining to Table A9 here. On one hand, electoral and government systems do hardly vary over time, but they are not completely time-invariant. In our sample, Italy changed the electoral system in 2005/2006, while Croatia, Bulgaria, and Israel implemented changes in their system of government. So there is variation in electoral and government systems, even if not as much as it would be ideal. On the other hand, the previous literature highlighted the importance of electoral and government systems for environmental politics at the outcome level. Omitting an analysis that focuses on these items or discarding a discussion of this altogether would limit the results' generalizability.

(11) Controlling for state capacity

Our sample comprises OECD countries and a few other relatively rich countries over which we think that it is plausible to make comparisons, because their governments could adopt good practice, even if they do not do so. However, state capacity could vary too much across our sample for us to be able to assume that all the cases could, in principle, adopt good-practice policies. To control for this, we re-estimated the main model (Model 3 in the main text), while including different measures of state capacity at a time.

Table A10. Controlling for state capacity

	Model 14	Model 15	Model 16
Lagged Dependent Variable	0.752	0.747	0.753
	(0.023)***	(0.024)***	(0.023)***
Green Tax Revenue per capita	0.011	0.010	0.011
	(0.005)**	(0.005)**	(0.005)**
Manufacturing (% of GDP)	-0.003	-0.003	-0.003
	(0.001)**	(0.001)**	(0.001)**
Unemployment	0.003	0.003	0.003
	(0.001)***	(0.001)***	(0.001)***
Democracy	-0.005	-0.005	-0.005
	(0.005)	(0.005)	(0.005)
Economic Globalization	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Green Party Dummy	-0.010	-0.010	-0.011
	(0.012)	(0.012)	(0.012)
$\mathbf{W}y^{Geography}$	0.185	0.188	0.183
	(0.082)**	(0.081)**	(0.081)**
Relative Political Extraction (Agriculture)	-0.018		
	(0.033)		
Relative Political Extraction (GDP)		-0.035	
		(0.031)	
Relative Political Extraction (OECD)			-0.017
			(0.032)
Observations	613	613	613
Fixed Effects	Yes	Yes	Yes
Overall R^2	0.972	0.972	0.972

Standard errors in parentheses; constant included in estimation, but omitted from presentation.

* p<0.10, ** p<0.05, *** p<0.01

Table A11. A closer examination of the "double-dividend" argument

	Model 17
Lagged Dependent Variable	0.731 (0.031)***
Green Tax Revenue per capita	-0.073 (0.026)**
Tax Revenue (% of GDP)	-0.002 (0.002)
Tax Revenue (% of GDP) * Green Tax Revenue per capita	0.003 (0.001)**
Manufacturing (% of GDP)	-0.007 (0.002)***
Unemployment	0.004 (0.001)***
Democracy	-0.008 (0.006)
Economic Globalization	0.000 (0.000)
Green Party Dummy	-0.007 (0.015)
$\mathbf{W}y^{Geography}$	0.192 (0.085)**
Observations	485
Fixed Effects	Yes
Overall R^2	0.960

Standard errors in parentheses; constant included in estimation, but omitted from presentation.

* p<0.10, ** p<0.05, *** p<0.01

We made use of three different, yet interrelated political extraction variables in the "Relative Political Performance Data Set" by Kugler and Tammen (2012).[1] All three items approximate "the ability of governments to appropriate portions of the national output to advance public goals" and capture general government tax revenues per GDP as a function of several covariates. While a first one is based on the covariates of mining revenue per GDP, agriculture revenue per GDP, and exported goods and service value per GDP, the second variable omits the component on agriculture revenue per GDP. The latter item is also modified by using adjusted OECD data. The three variables' pairwise correlations range in [0.651; 0.887]. Table A10 summarizes our findings. On one hand, our core finding remains unaltered: green taxation is *positively* associated with environmental input efficiency. On the

[1] Available at: https://dataverse.harvard.edu/dataset.xhtml?persistentId=hdl:1902.1/16845.

other hand, the three state-capacity items do not reach conventional levels of statistical significance.

(12) A closer examination of the "double-dividend" argument

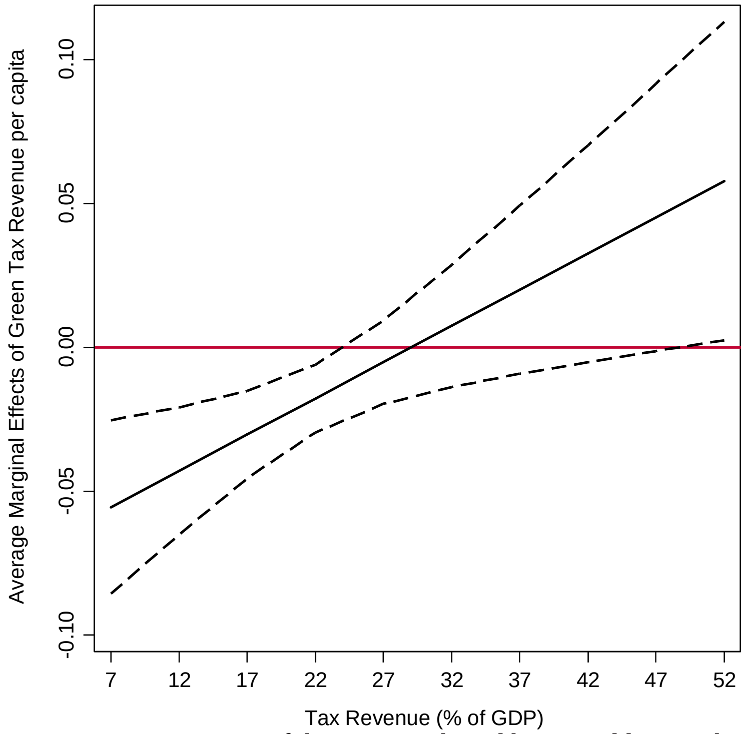
We sought to examine this more closely by introducing the variable *Tax Revenue (% of GDP)* from the World Bank Development Indicators. This item refers to compulsory transfers to the central government for public purposes. Certain compulsory transfers such as fines, penalties, and most social security contributions are excluded. Refunds and corrections of erroneously collected tax revenue are treated as negative revenue.[2] We interact *Green Tax Revenue per capita* with *Tax Revenue (% of GDP)*, although we do not expect a specific sign for the coefficient estimate. The tax variable only captures tax revenue as such, or changes in it over time; it does not code how much of the environmental tax revenue is being recycled in the overall tax burden of citizens, and we are also not aware of any data set that may have this information. Hence, regardless of whether the double-dividend claim holds or not, it seems important to us that *Green Tax Revenue per capita* must remain robust when including *Tax Revenue (% of GDP)* and interacting it with the environmental tax measure. Table A11 and Figure A3 summarize our findings based on this revised model.

On one hand, Table A11 shows that the core variable's interaction with *Tax Revenue (% of GDP)* is positively signed and statistically insignificant. Interestingly, *Tax Revenue (% of GDP)* is negatively signed, i.e. a higher tax burden is associated with lower environmental input efficiency. This finding on its own, however, seems to lend support to the double-dividend debate. On the other hand, Figure A3 sheds more light on the interaction: *Green Tax Revenue per capita* has a positive impact on the input efficiency dependent variable, but only for relatively high values of *Tax Revenue (% of GDP)*. In fact, the impact of green taxation

[2] Available at: http://data.worldbank.org/indicator/GC.TAX.TOTL.GD.ZS.

on our outcome variable is statistically insignificant or negative for *lower* values of total tax revenue. Regardless of this, the positive effect of *Green Tax Revenue per capita* remains, but it seems from the interaction that a sufficiently large amount of revenue must exist; otherwise, and as demonstrated by the negative impact of environmental taxes for low levels of overall tax revenue by GDP, *Green Tax Revenue per capita* may not necessarily be conducive to more environmental efficiency.

Figure A3. The interaction of green taxation with *Tax Revenue (% of GDP)*



Notes: Dashed lines pertain to 90 percent confidence interval. Red horizontal line marks average marginal effect of 0.

(13) Assessing reverse causality using three-stage least-squares regression (3SLS)

The explanatory variables in the main model have not been temporally lagged. On one hand, this is justified by the inclusion of the lagged dependent variable that addresses any potentially lagged effect of the covariates (Keele and Kelly 2006). On the other hand, there are also strong reasons to believe that an instant effect of environmental taxes does exist. In theory, green taxation induces changes in relative prices so consumers and producers substitute other things, it changes real incomes, which affect consumption patterns, and it induces investment. At least the first two effects are (partly) instantaneous.

Table A12. Simultaneous equation model

	Model 18 Efficiency	Model 18 Green Tax
Lagged Dependent Variable	0.722 (0.026)***	0.155 (0.037)***
Green Tax Revenue per capita	0.053 (0.030)*	
Manufacturing (% of GDP)	-0.003	-0.003 (0.001)**
Environmental Input Efficiency		0.061 (0.260)
Unemployment		0.017 (0.008)**
Democracy		-0.062 (0.032)*
Economic Globalization		0.012 (0.003)***
Green Party Dummy		
$\mathbf{W}y^{Geography}$	0.088 (0.084)	
Constant		
Observations		657
Fixed Effects		Yes

Standard errors in parentheses; constant included in estimation, but omitted from presentation.

* p<0.10, ** p<0.05, *** p<0.01

Still, we estimate a model using 3SLS to determine whether there is a problem due to simultaneity (see Ward 2006). We explored possible specifications by running multiple models similar to that in the main article. In 3SLS, instruments for endogenous variables are generated by regressing each such variable on *all* exogenous variables in the system. Here, the endogenous variables are *Environmental Input Efficiency* and *Green Tax Revenue per capita*. The regression model summarized in Table A12 is then a re-estimate of Model 3 in the paper using 3SLS. Note that the variables included in the equations must differ in some aspects for the model to be identified. Those items included in one, but not the other equation then influence the other equation's outcome indirectly through their dependent variable. For example, Model 18 assumes that *Economic Globalization* affects *Environmental Input Efficiency* only through *Green Tax Revenue per capita*.

While the findings are similar to the main results in our article, the estimate of *Environmental Input Efficiency* in the associated equation for *Green Tax Revenue per capita* is not significant. This supports the view that causality flows from *Green Tax Revenue per capita* to *Environmental Input Efficiency*, but not the other way round.

Table A13. Bootstrapped standard errors

	Model 19
Lagged Dependent Variable	0.984 (0.010)***
Green Tax Revenue per capita	0.008 (0.003)**
Manufacturing (% of GDP)	-0.000 (0.001)
Unemployment	0.001 (0.000)*
Democracy	0.000 (0.001)
Economic Globalization	0.000 (0.000)
Green Party Dummy	0.001 (0.004)
$\mathbf{W}y^{Geography}$	0.140 (0.086)*
Observations	657
Bootstrapped Standard Errors	Yes
Overall R^2	0.975

Standard errors in parentheses; constant included in estimation, but omitted from presentation.

* p<0.10, ** p<0.05, *** p<0.01

(14) Bootstrapped standard errors

The dependent variable changes over time as a function of both within-subject changes, but also the relative position of each country in relation to a shifting set of comparator countries. Given this interdependence of cases, the errors might not be independent and identically distributed. We thus considered bootstrapping the standard errors to address this.

According to Guan et al. (2003, 71), "[b]ootstrapping is a nonparametric approach for evaluating the distribution of a statistic based on random re-sampling". The procedure is thus based on random sample draws (with replacement) repeatedly from the sample data. The results are summarized in Table A13, but our overall conclusion on the impact of green taxation does not change in light of this estimation.

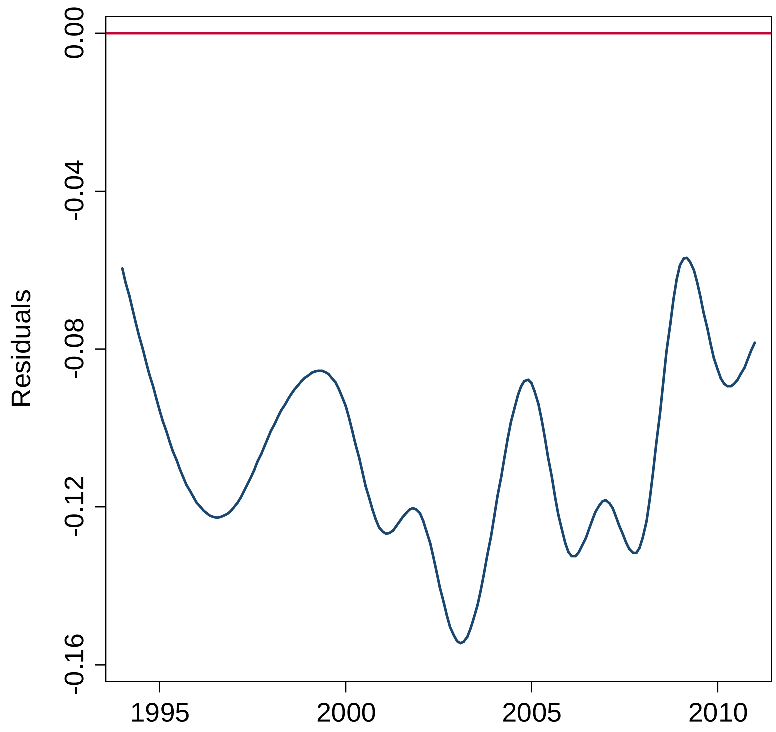
(15) Examination of non-stationarity and cointegration

We also examined whether cointegration might be an issue. Combined variables are cointegrated when there is a stationary linear combination of nonstationary random variables. Cointegration generates spurious regressions and might lead to misleading results. As described by Tol (2012):

> "[a] regression analysis seeks to explain as much as possible of the observed variation in the dependent variable by the variations in the independent variables. The variance of a trending variable is dominated by its trend. If an independent variable has a trend as well, then its variance too is dominated by the trend. More importantly, the trend in any independent variable can explain a large share of the trend in the dependent variable. This implies that, in a regression analysis, the confidence in the parameter estimates is overstated. That is, a regression analysis will find a statistically significant relationship even when there is none".

To this end, Figure A4 presents the median spline of the residuals derived from a simple OLS model in which *Environmental Input Efficiency* is the outcome variable and *Green Tax Revenue per capita* is the only predictor. As shown there, however, the median spline does not converge toward 0. Thus, the residuals are not stationary, and it seems unlikely that the two variables are cointegrated.

Figure A4. Residuals analysis



Notes: Figure presents the median spline for the residuals of an OLS regression; the horizontal solid line denotes a residual value of 0.

We also employed a formal check (see also Engle and Granger 1987; Johansen 1988; Tol 2012): the Augmented Dickey Fuller test, which takes potential serial correlation in the error term into account – this is achieved by introducing lagged terms of the dependent variable. The procedure for this test is as follows: regress one I (1) variable on another using least squares. Then test the residuals for nonstationarity using the test. If the series are cointegrated, the test statistic is statistically significant. The null hypothesis is that the residuals are nonstationary. Rejection of this leads to the conclusion that the residuals are stationary and the series are cointegrated. Table A14 shows the results of the Dickey Fuller test: since the test statistic is larger than all the rejection regions (regardless of the lag structure employed), we have little reason to reject the null hypothesis that the residuals are nonstationary. That is, cointegration is unlikely to be a problem in our analyses.

Table A14. Augmented Dickey Fuller test

Lags	DF-GLS tau Test Statistic	1% Critical Value	5% Critical value	10% Critical value
7	-1.405	-3.770	-6.020	-4.383
6	-0.720	-3.770	-4.391	-3.191
5	-2.044	-3.770	-3.438	-2.535
4	-1.192	-3.770	-3.012	-2.929
3	-0.599	-3.770	-2.965	-2.340
2	-0.997	-3.770	-3.151	-2.558
1	-1.081	-3.770	-3.421	-2.823

(16) Controlling for inflation, government debt, education, and employing a different operationalization for green parties

We control for unemployment as it correlates with growth. An anonymous reviewer raised the point that inflation, public sector debt, and educational levels are associated with growth as well, and should be controlled for. Using data from the World Bank, we thus control for all these influences in three additional models. First, inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. Second, debt is the entire stock of direct government fixed-term contractual obligations to others outstanding on a particular date. It includes domestic and foreign liabilities such as currency and money deposits, securities other than shares, and loans. It is the gross amount of government liabilities reduced by the amount of equity and financial derivatives held by the government. Third, for education, we use total enrolment in primary education, regardless of age, expressed as a percentage of the population of official primary education age. This item can exceed 100 percent due to the inclusion of over-aged and under-aged students because of early or late school entrance and grade repetition. Especially the last two variables suffer a lot from missing values and, hence, we linearly interpolated these for the final variables in the models of Table A15.

Table A15. Additional Controls and Alternative Operationalization for *Green Party Dummy*

	Model 20	Model 21	Model 22	Model 23
Lagged Dependent Variable	0.762	0.752	0.757	0.758
	(0.023)***	(0.023)***	(0.023)***	(0.023)***
Green Tax Revenue per capita	0.011	0.011	0.011	0.011
	(0.005)**	(0.005)**	(0.005)**	(0.005)**
Manufacturing (% of GDP)	-0.003	-0.003	-0.003	-0.003
	(0.001)**	(0.001)**	(0.001)**	(0.001)**
Unemployment	0.003	0.004	0.003	0.003
	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Democracy	-0.005	-0.005	-0.005	-0.005
	(0.005)	(0.005)	(0.005)	(0.005)
Economic Globalization	-0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Green Party Dummy	-0.011	-0.010	-0.011	
	(0.012)	(0.012)	(0.012)	
$\mathbf{W}y^{Geography}$	0.190	0.173	0.188	0.177
	(0.081)**	(0.081)**	(0.083)**	(0.081)**
Inflation	0.000			
	(0.000)			
Public Sector Debt		-0.000		
		(0.000)		
Education			-0.001	
			(0.002)	
CMP PER501 – Environmental References				-0.001
				(0.001)
Observations	613	613	613	613
Fixed Effects	Yes	Yes	Yes	Yes
Overall R^2	0.973	0.972	0.973	0.973

Standard errors in parentheses; constant included in estimation, but omitted from presentation.

* p<0.10, ** p<0.05, *** p<0.01

In addition, it has also been suggested that the green-party variable might be too conservative. Country-years with a green party member in parliament are relatively few, typically with limited influence, and to a large extent determined by the type of electoral system. A better variable might then be the item *per501* in the Comparative Manifestos Project (CMP) data (Budge et al. 2001; Klingemann et al. 2006; Volkens et al. 2013), which we average over all parties in a given country-year to produce an estimate of the saliency of environmental issues in the parliament (i.e. how much all parties refer to environmental issues). The CMP data do also have a few missing values, which we interpolate by 0s, thus assuming that parties have not made specific references to the environment in these country-years. Table A15 (Model 23) summarizes our findings.

As demonstrated in the models pertaining, however, the effect of our core variable remains unaltered. *Green Tax Revenue per capita* continues to exert a positive and statistically significant effect on environmental efficiency. On the other hand, none of the variables additionally included or the different operationalization for the green-party variable is able to reach conventional levels of statistical significance.

(17) Incorporating information on different income groups into the dependent variable

As discussed over the course of the article, our sample comprises OECD countries and a few other relatively rich countries over which we think that it is plausible to make comparisons, because their governments could adopt good practice, even if they do not do so. However, we also considered changing the operationalization of our dependent variable by including information on income groups, and then using only countries within these clusters as potential competitors.

Specifically, the World Bank classifies countries into high-income, upper-middle, lower-middle, and low-income countries based on their income levels. Since July 2016, low-income economies are defined as those with a GNI per capita of $1,025 or less in 2015; lower middle-income economies are those with a GNI per capita between $1,026 and $4,035; upper middle-income economies are those with a GNI per capita between $4,036 and $12,475; high-income economies are those with a GNI per capita of $12,476 or more.[3] In light of this information, we changed the specification of our dependent variable as follows (main change marked in bold): the comparator group for i_t (country i in year t) consists of the set of country-years such that, for each member $j_{t'}$, $t' \leq t$, **i_t and j_t belong to the same World Bank**

[3] See https://blogs.worldbank.org/opendata/new-country-classifications-2016.

income group, and the GDP per capita of $j_{t'}$ is at least as high as that of i_t. In words, it is the set of country-years whose members (1) did not have access to more efficient energy technology, (2) belong to the same income group, and (3) were at least as highly developed, so that the structural problems governments faced in reducing emissions were at least as great. This approach should ultimately ensure that countries are more comparable with potential competitors, since we now calculate efficiency scores by income group.

After having calculated this alternative outcome variable, we updated the temporally and spatially lagged dependent variables accordingly and re-estimated our main models. Table A16 presents our results. On one hand, our main result does hold: *Green Tax Revenue per capita* is still positively signed and statistically significant. On the other hand, both *Unemployment* and the spatial lag are no longer significant at conventional levels. In sum, though, this last robustness check does also not alter the substance of our empirics.

Table A16. Alternative specification for outcome variable

	Model 24	Model 25	Model 26
Lagged Dependent Variable	0.636 (0.029)***	0.623 (0.032)***	0.617 (0.032)***
Green Tax Revenue per capita	0.019 (0.006)***		0.015 (0.007)**
Manufacturing (% of GDP)		-0.005 (0.002)**	-0.004 (0.002)**
Unemployment		0.000 (0.000)	0.000 (0.000)
Democracy		-0.006 (0.006)	-0.005 (0.006)
Economic Globalization		0.000 (0.000)	-0.000 (0.001)
Green Party Dummy		0.010 (0.017)	0.011 (0.017)
$\mathbf{W}y^{Geography}$		-0.029 (0.175)	-0.022 (0.175)
Observations	654	602	602
Fixed Effects	Yes	Yes	Yes
Overall R^2	0.904	0.889	0.891

Standard errors in parentheses; constant included in estimation, but omitted from presentation.

* p<0.10, ** p<0.05, *** p<0.01

(18) Simplifying the outcome variable

In the main text, we refer to our outcome variable as capturing "how much CO_2 emissions per capita can be reduced given structural and technological constraints." And: "we assume that in our sample the structural constraints on reducing carbon emissions facing the government of a less-developed country *are no greater than those facing a more developed country.* We also assume that technological possibilities are at least as abundant at a later period of time than they were earlier." As described in the article, to this end, we use CO_2 emissions per capita as the output and GDP per capita as the input. It has also been suggested to "simplify" this measure by removing the population component in the emissions and income variables, and introduce it as a separate input. To this end, only emissions are on the output side of the equation. Table A17 summarizes this last robustness check: we re-estimated the main model and the table and demonstrates that our main finding is unaltered.

Table A17. Alternative specification for outcome variable

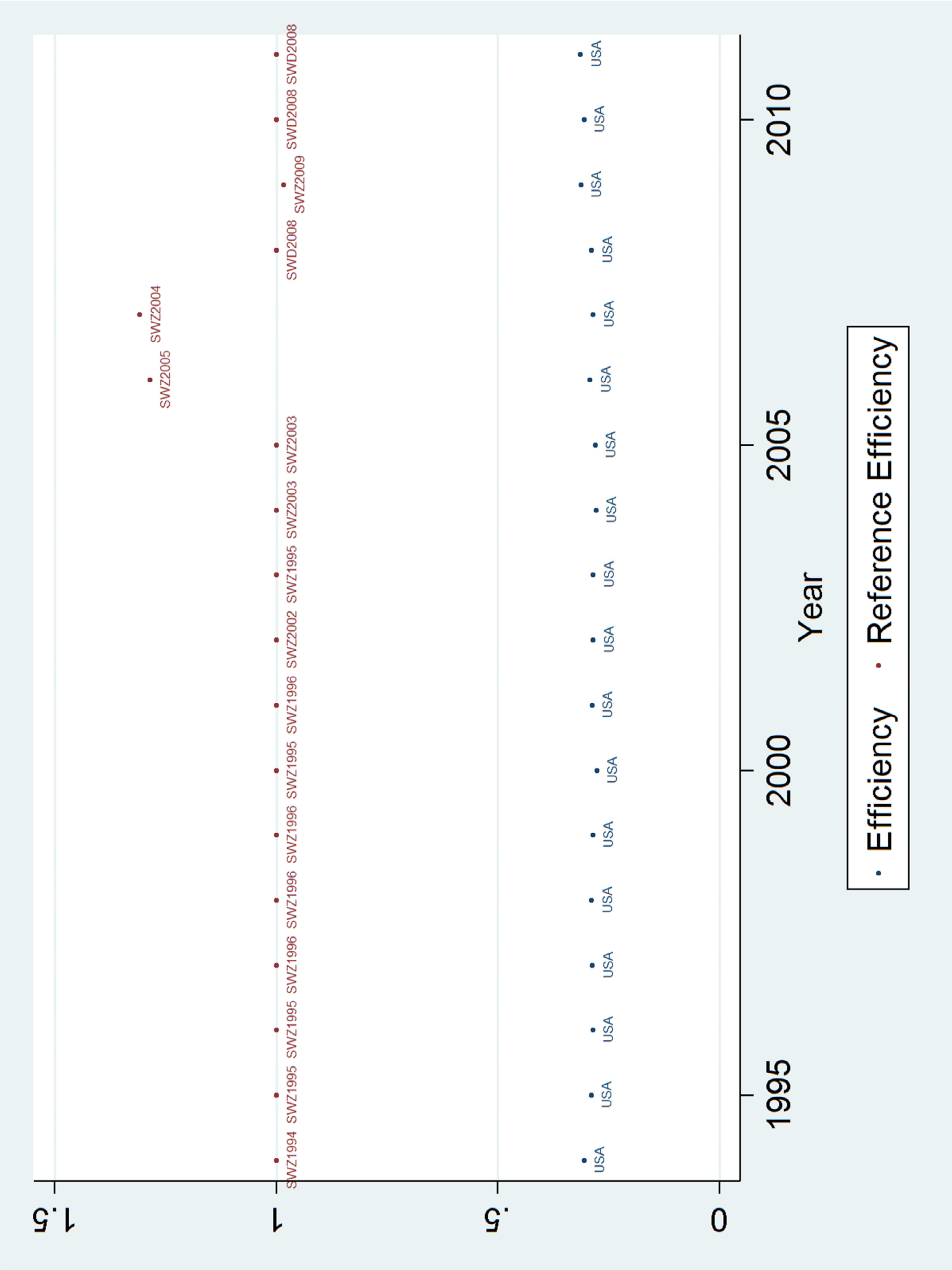
	Model 27
Lagged Dependent Variable	0.487
	(0.034)***
Green Tax Revenue per capita	0.072
	(0.021)***
Manufacturing (% of GDP)	0.003
	(0.006)
Unemployment	-0.001
	(0.005)
Democracy	0.002
	(0.025)
Economic Globalization	0.004
	(0.002)**
Green Party Dummy	0.048
	(0.055)
$\mathbf{W}y^{Geography}$	-0.425
	(0.371)
Observations	613
Fixed Effects	Yes
Overall R^2	0.899

Standard errors in parentheses; constant included in estimation, but omitted from presentation.

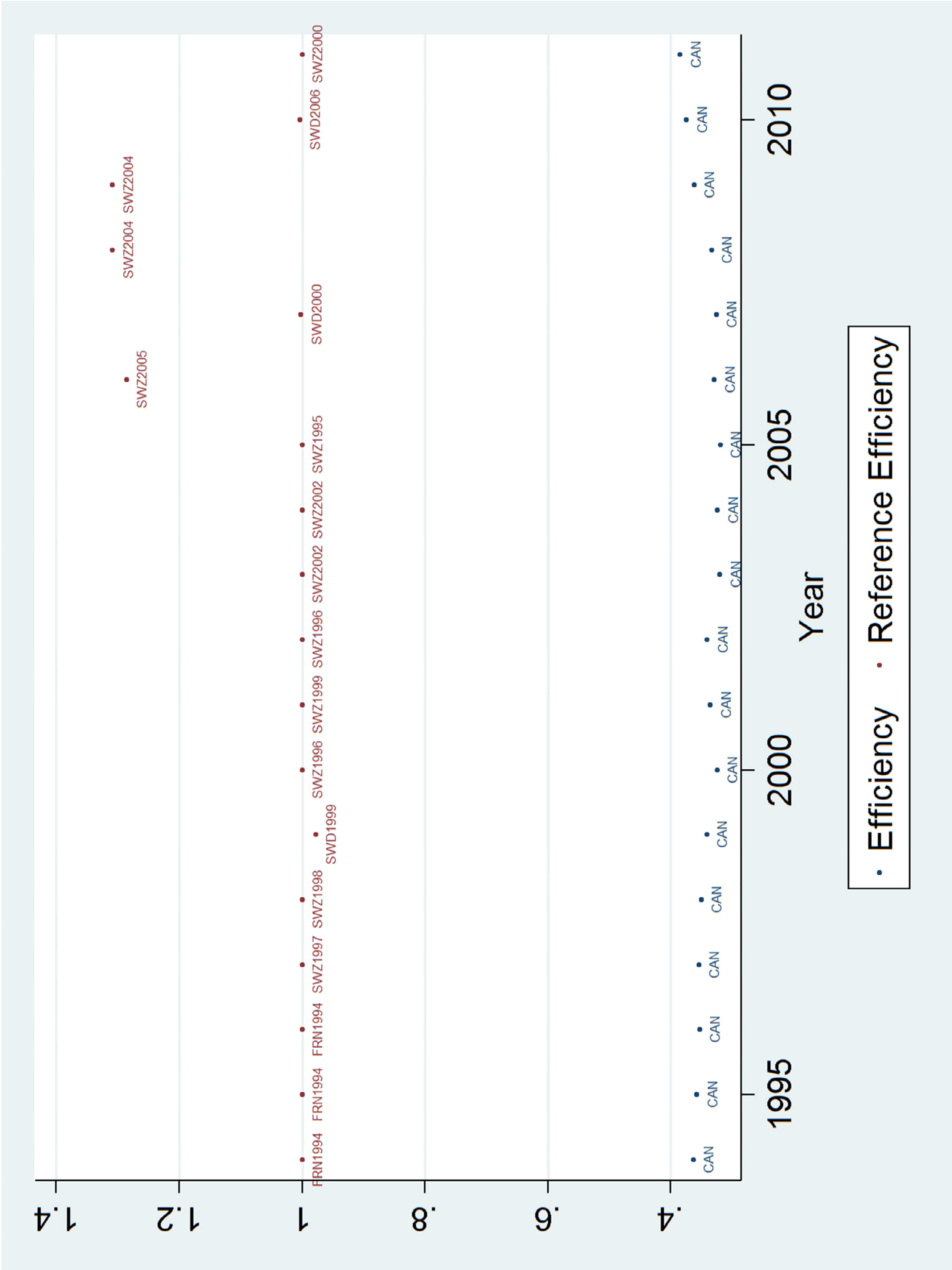
* p<0.10, ** p<0.05, *** p<0.01

(19) Overview of efficiency scores per country and reference states

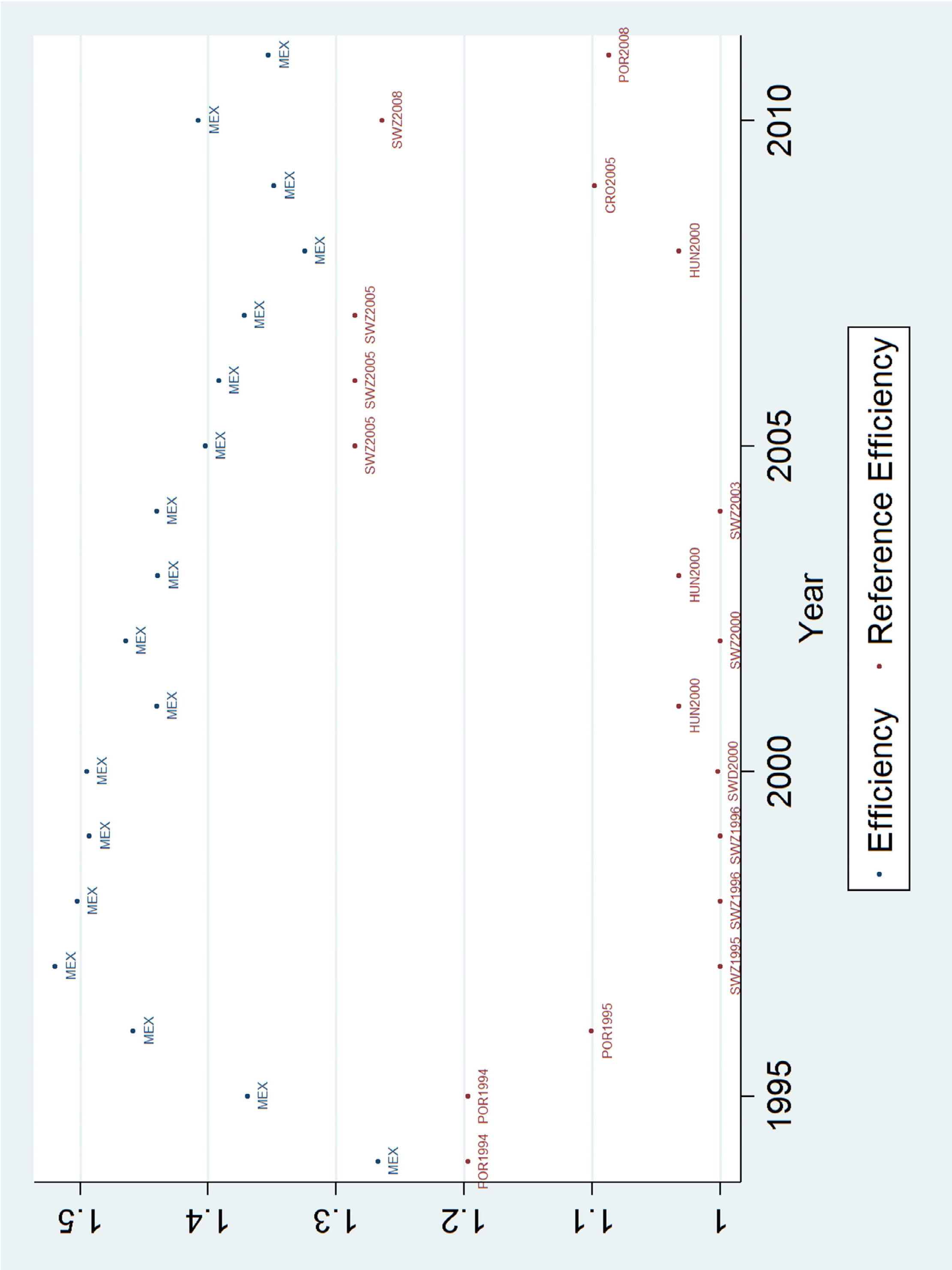
Efficiency of the US over time



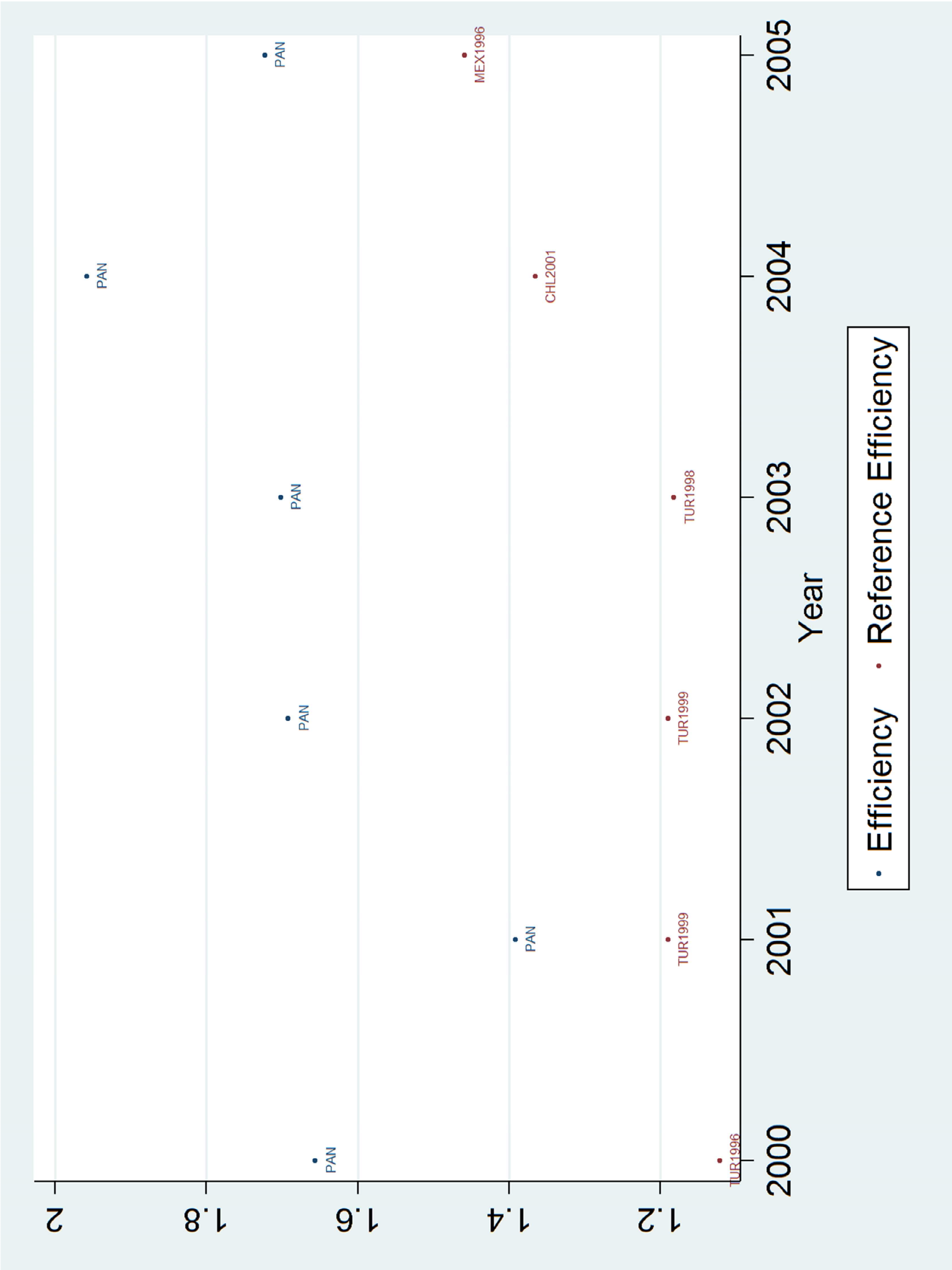
Efficiency of Canada over time



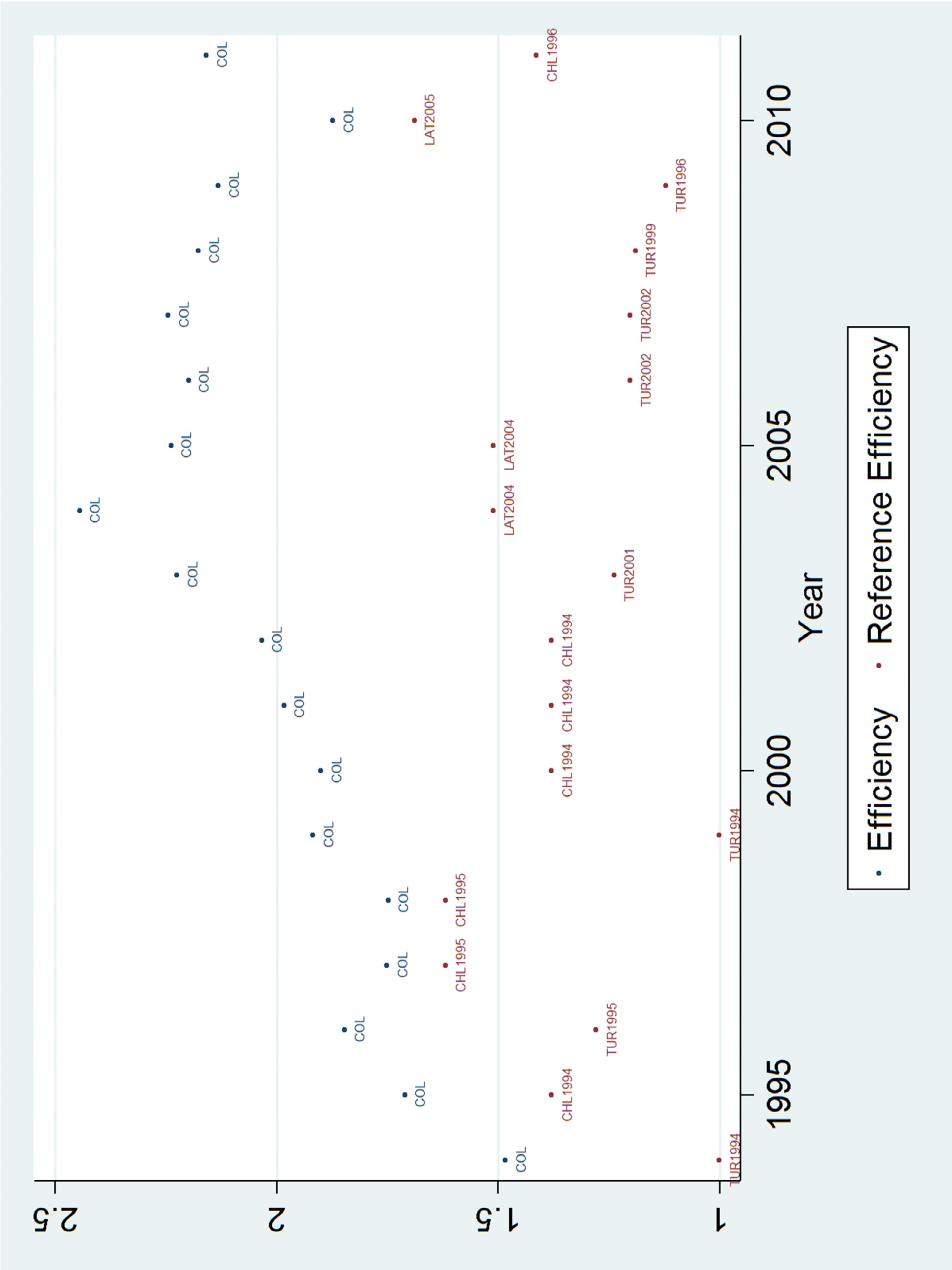
Efficiency of Mexico over time



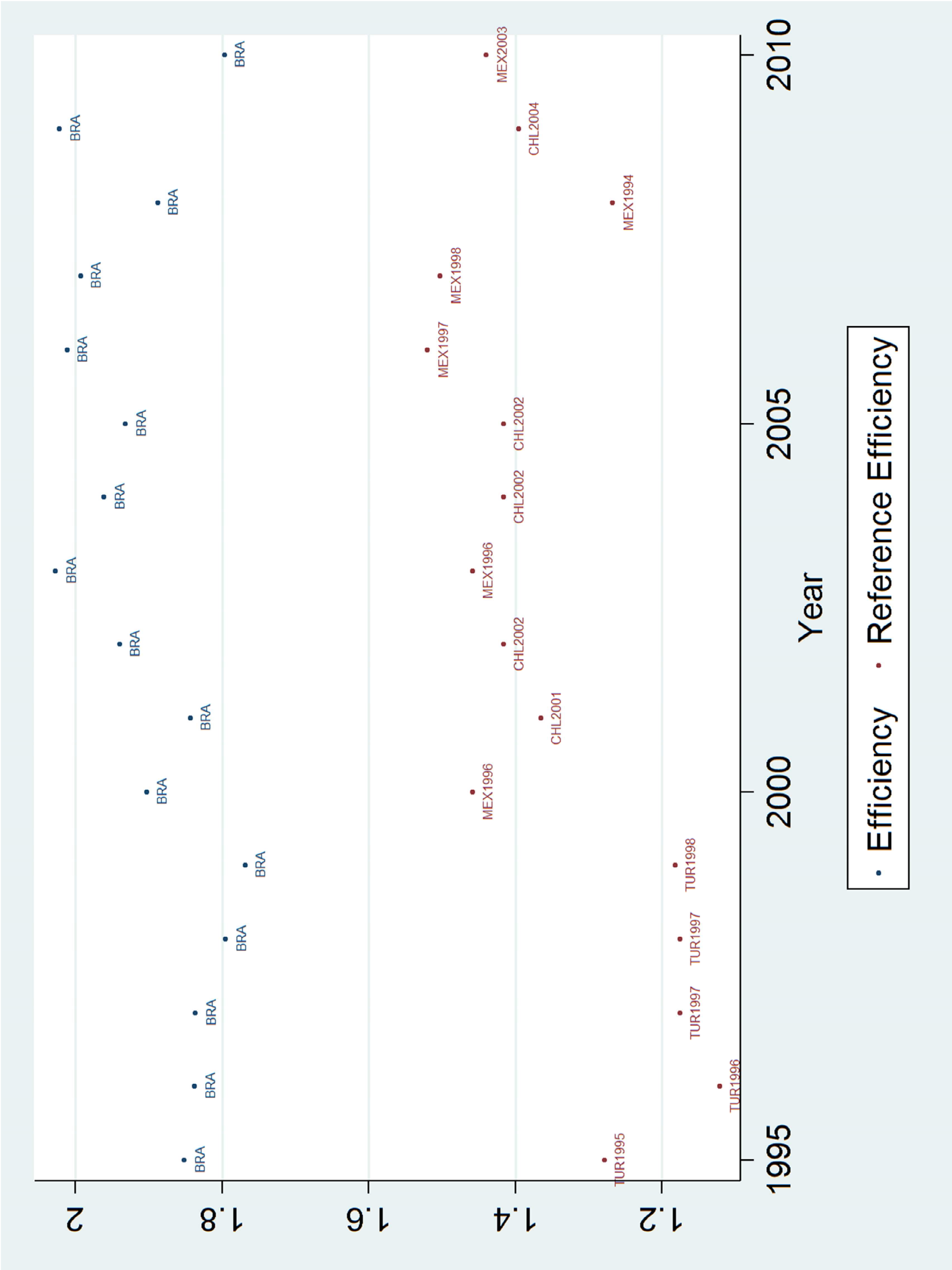
Efficiency of Panama over time



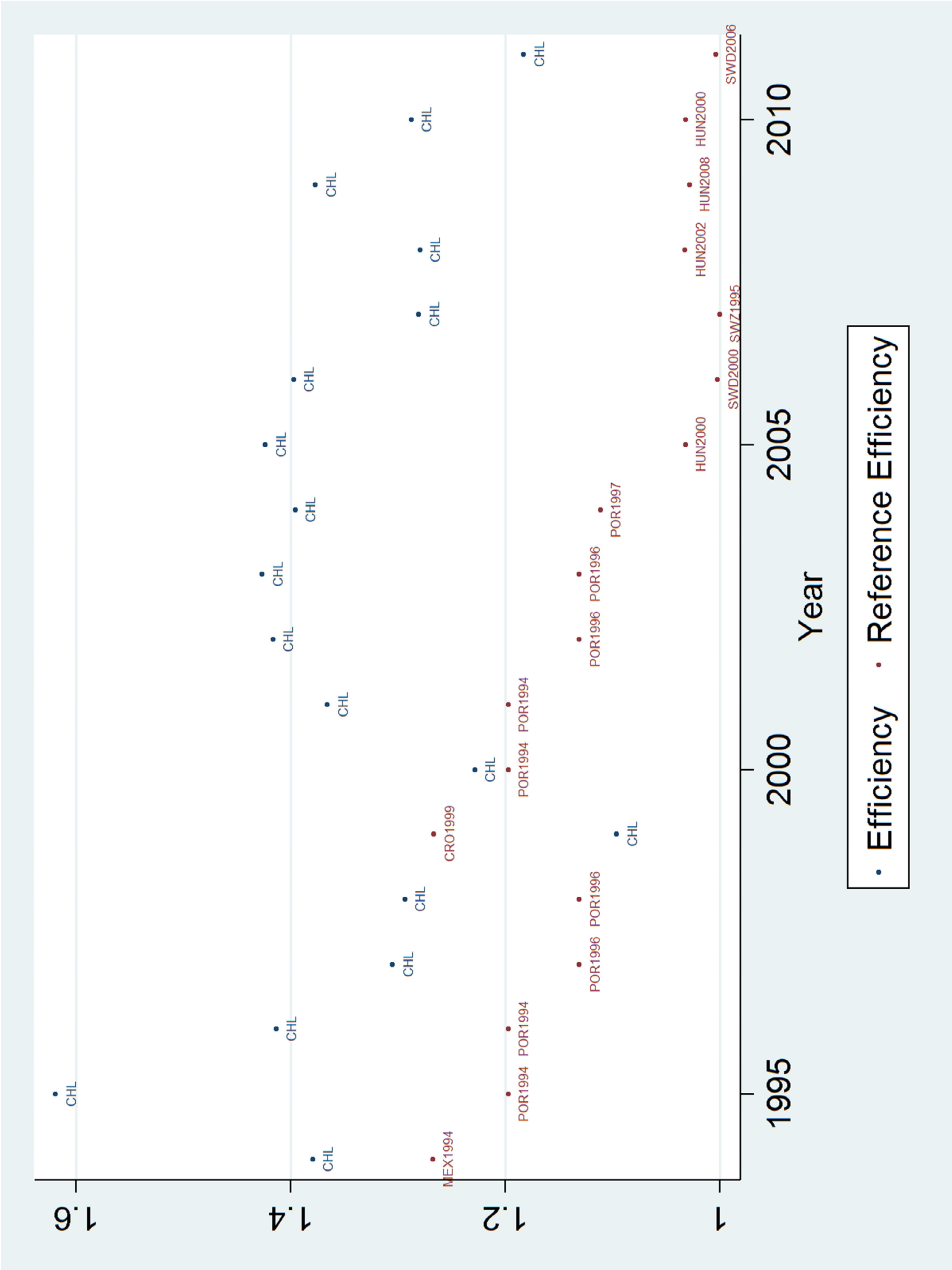
Efficiency of Colombia over time



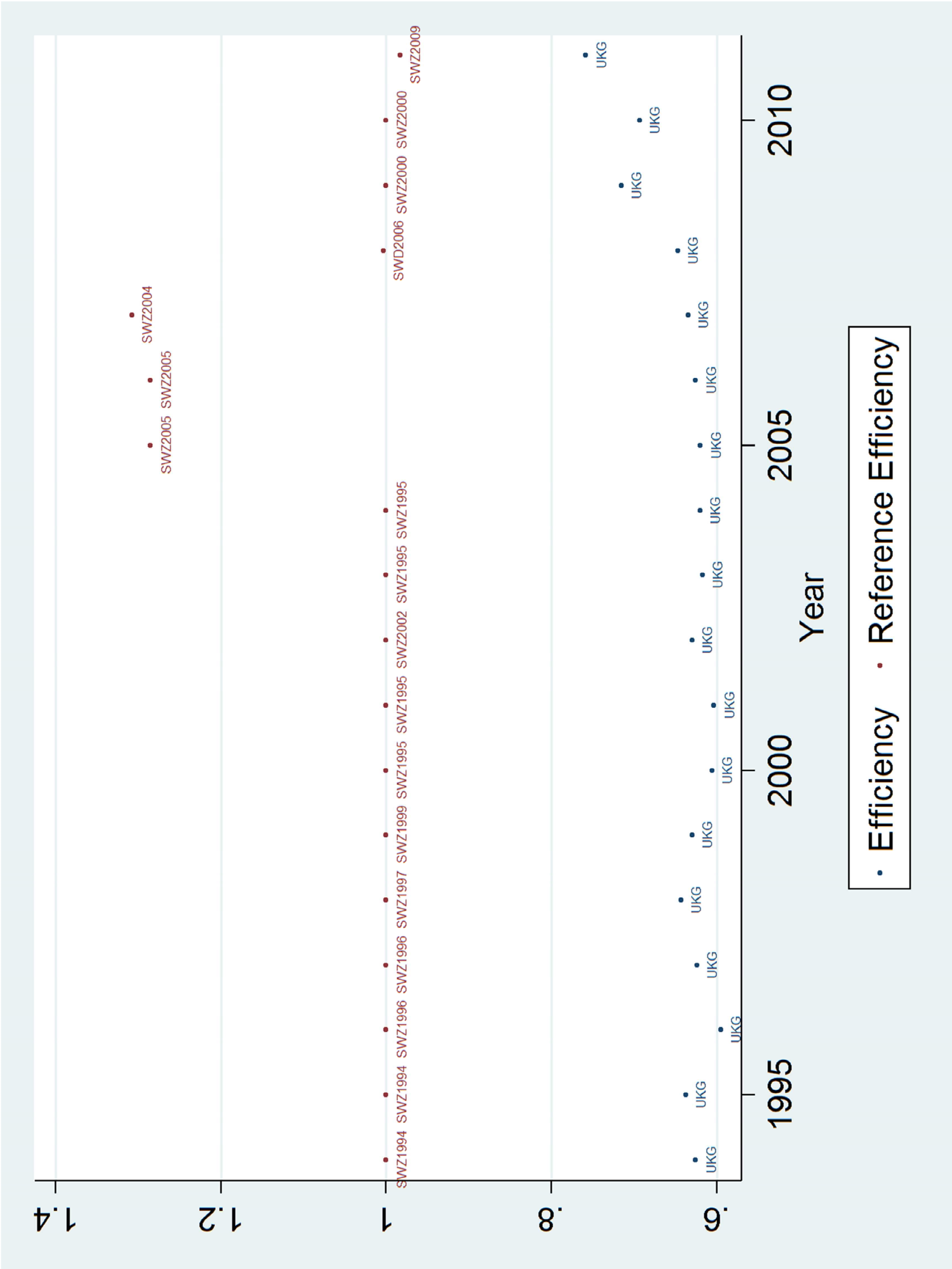
Efficiency of Brazil over time



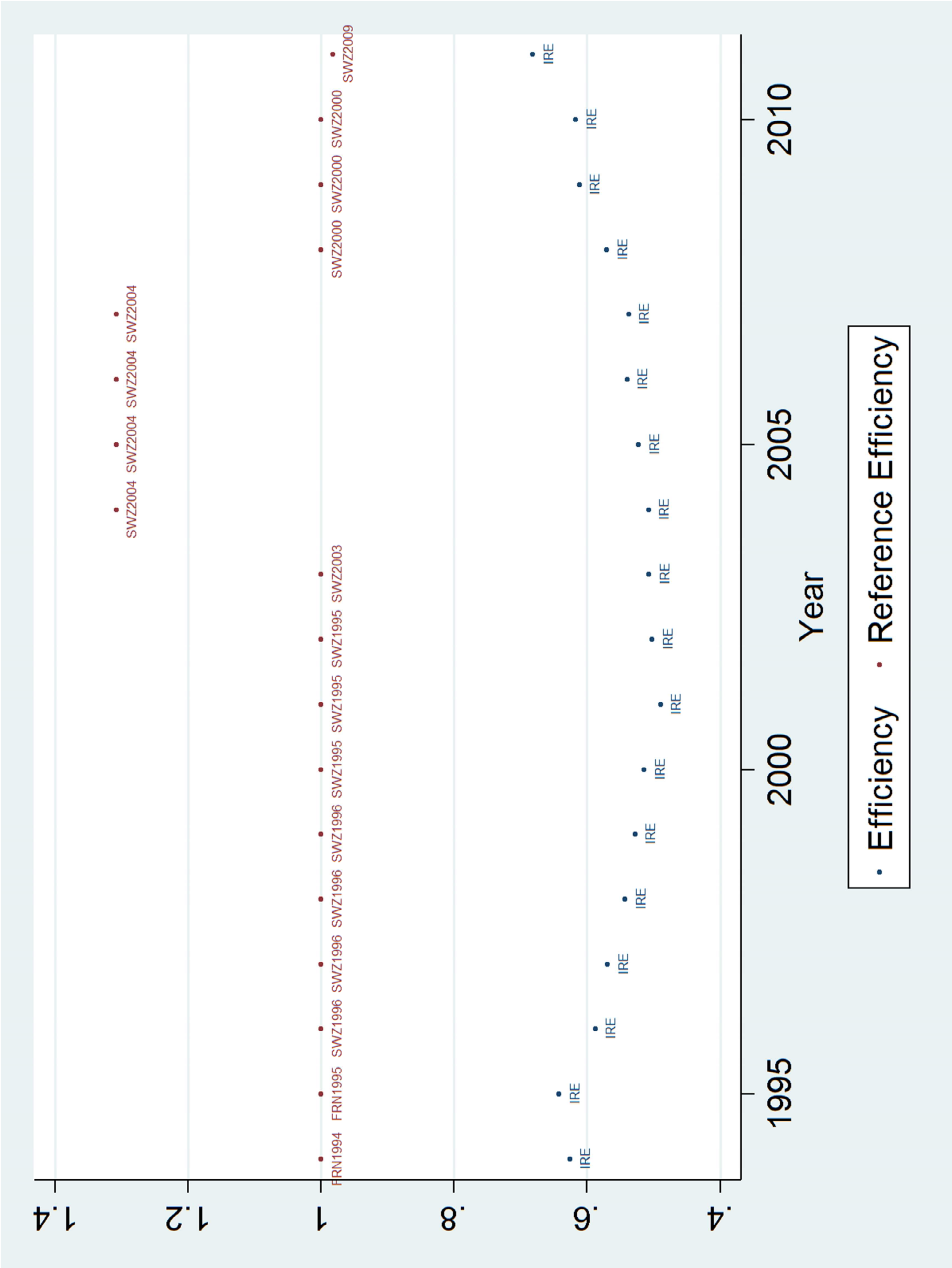
Efficiency of Chile over time



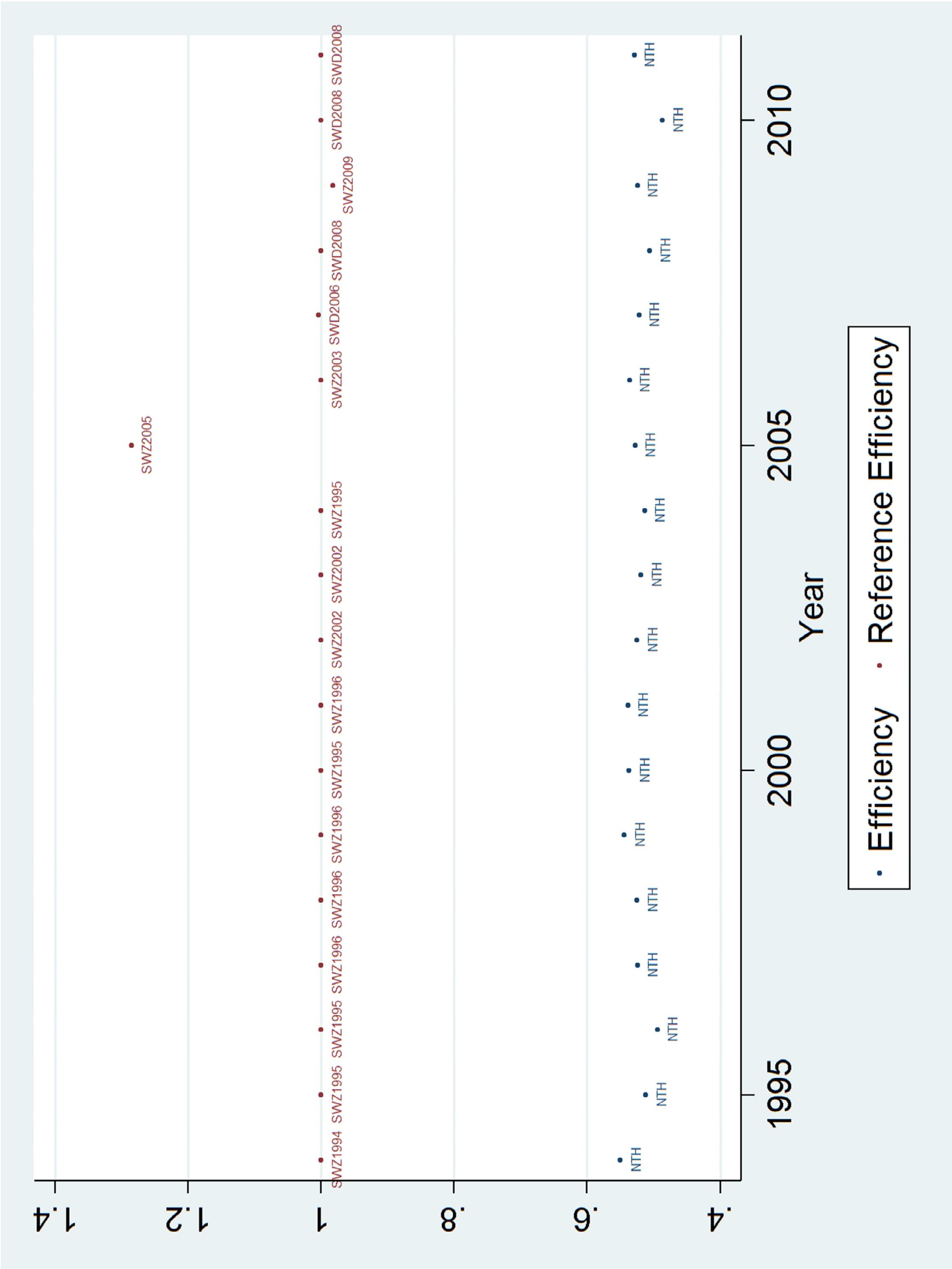
Efficiency of United Kingdom over time



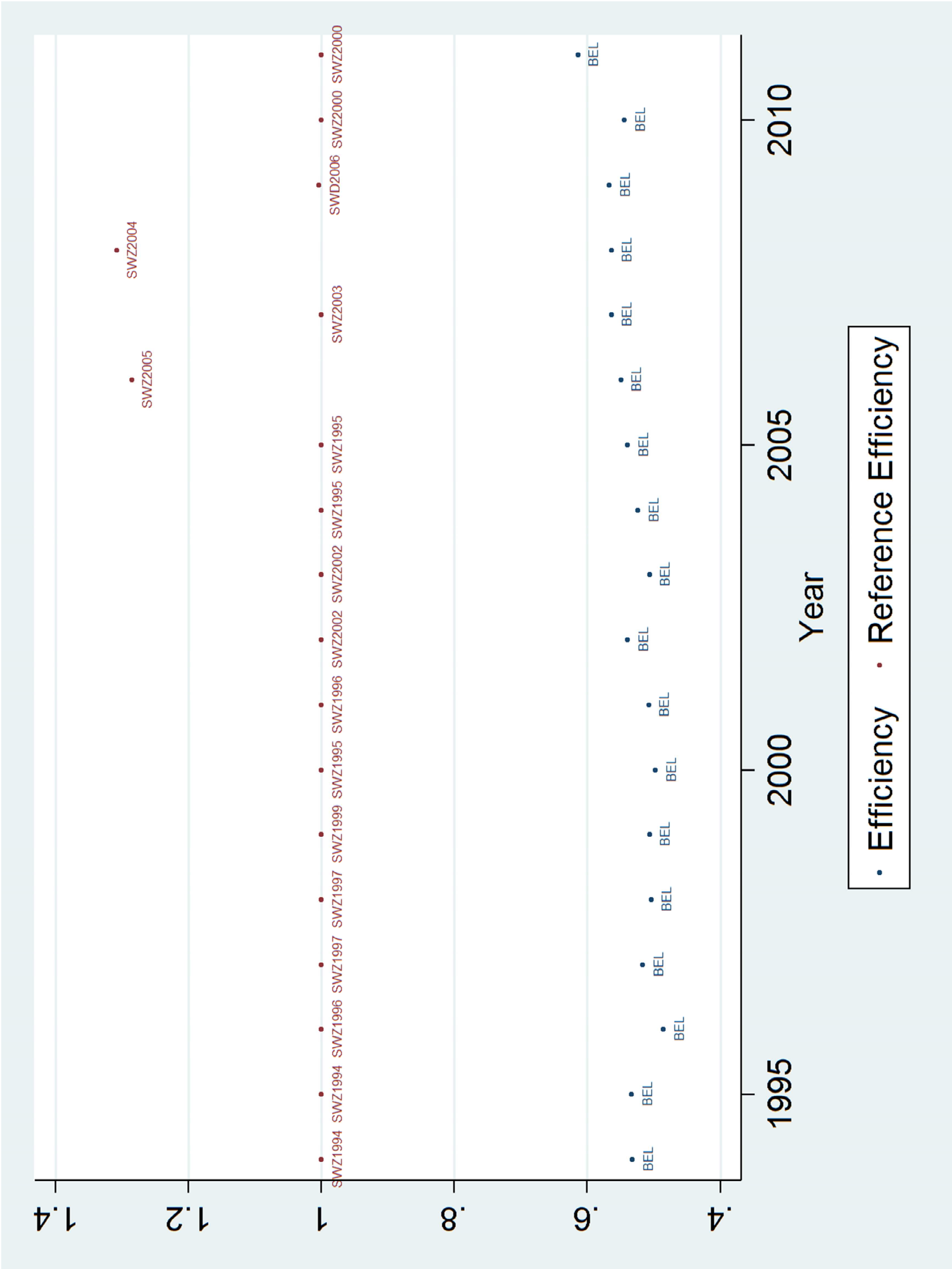
Efficiency of Ireland over time



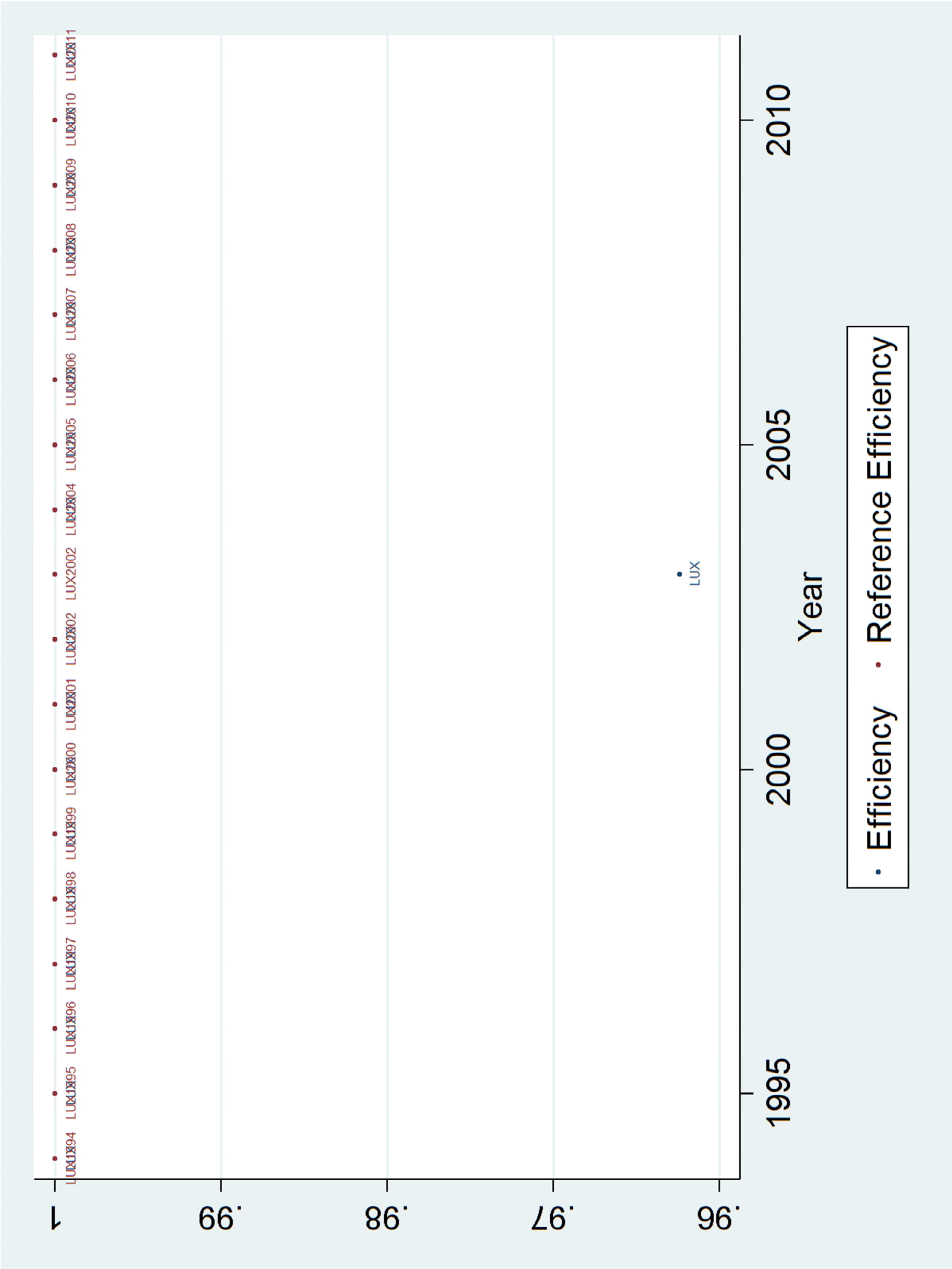
Efficiency of Netherlands over time



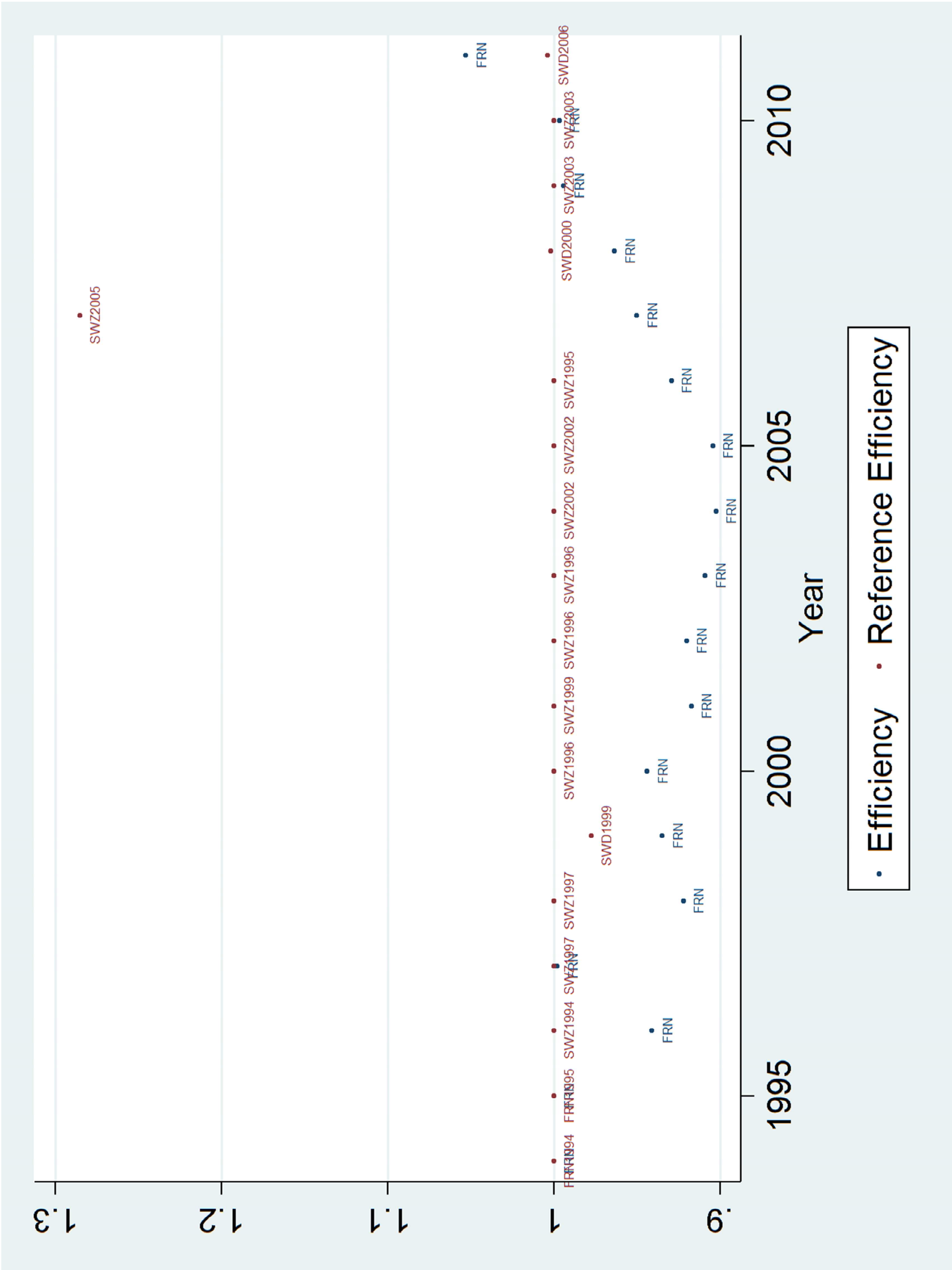
Efficiency of Belgium over time



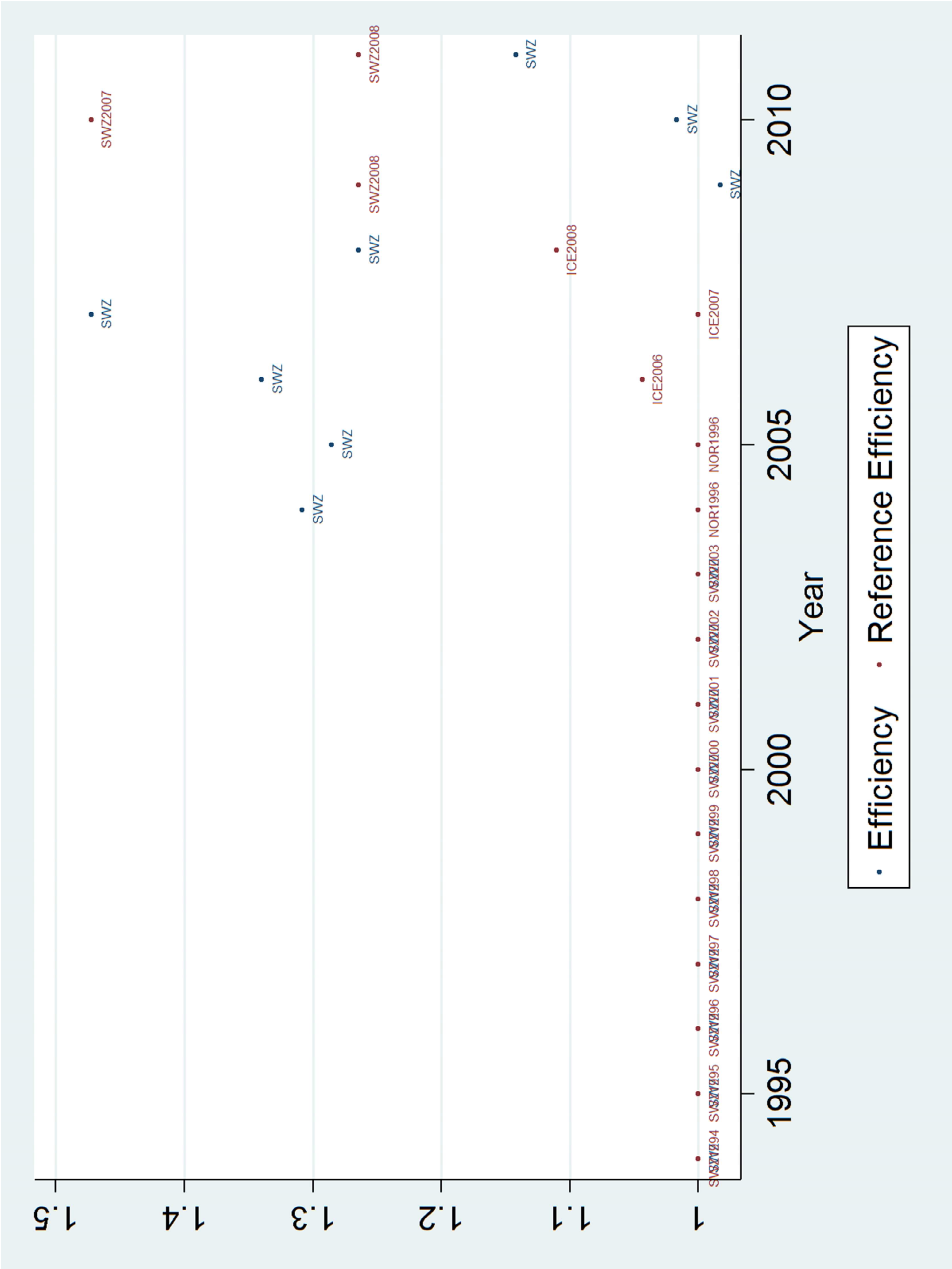
Efficiency of Luxemburg over time



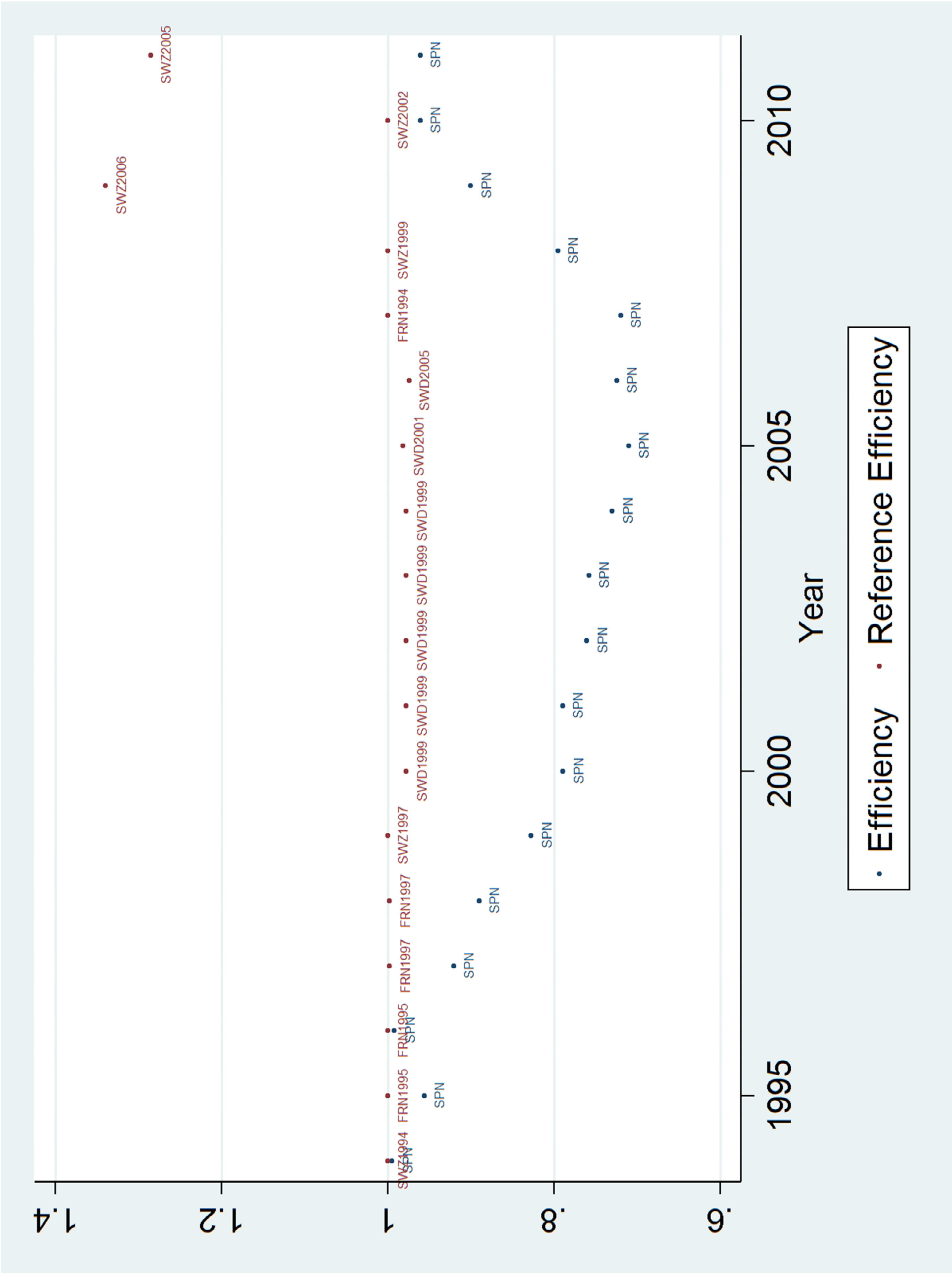
Efficiency of France over time



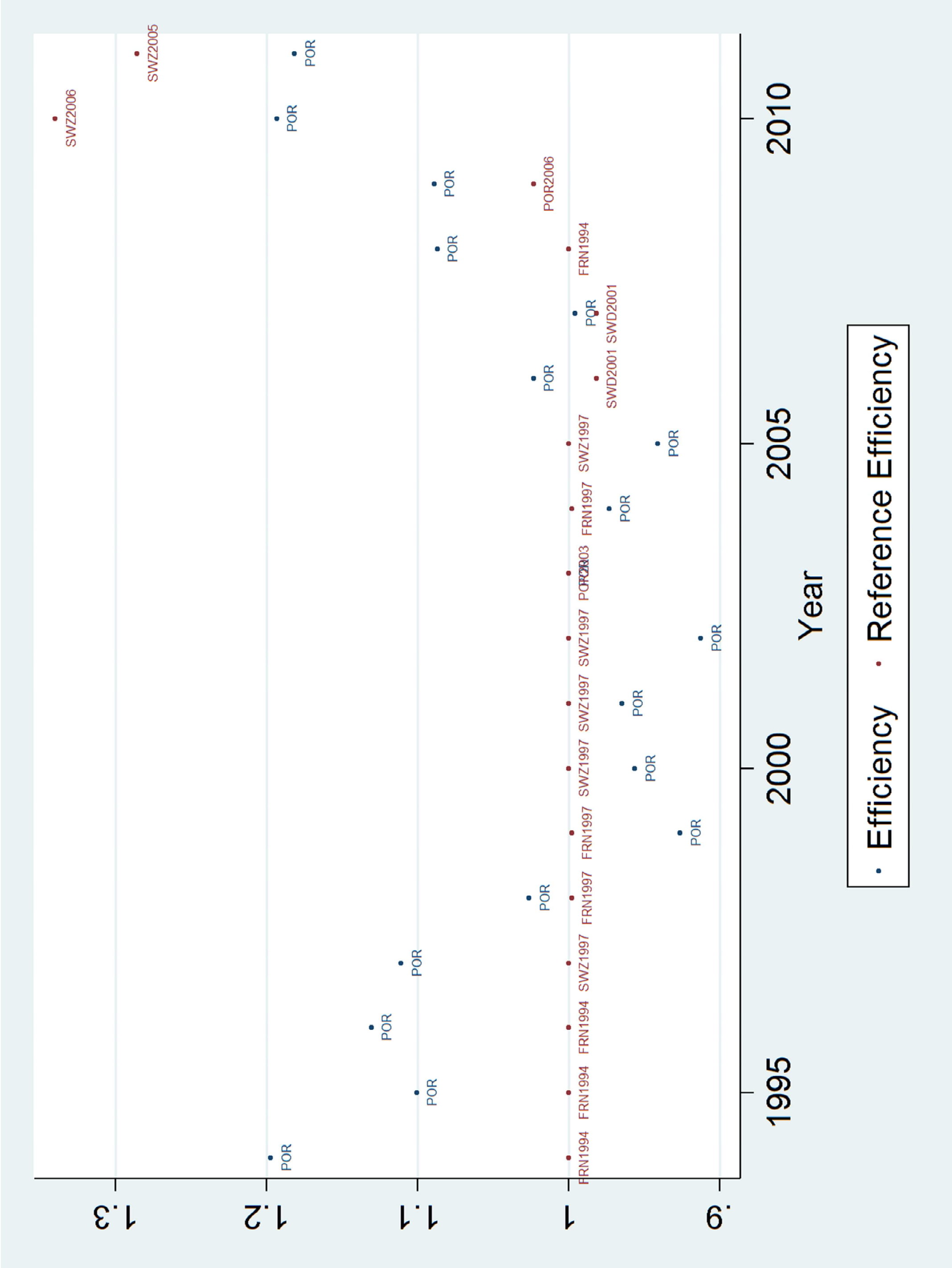
Efficiency of Switzerland over time



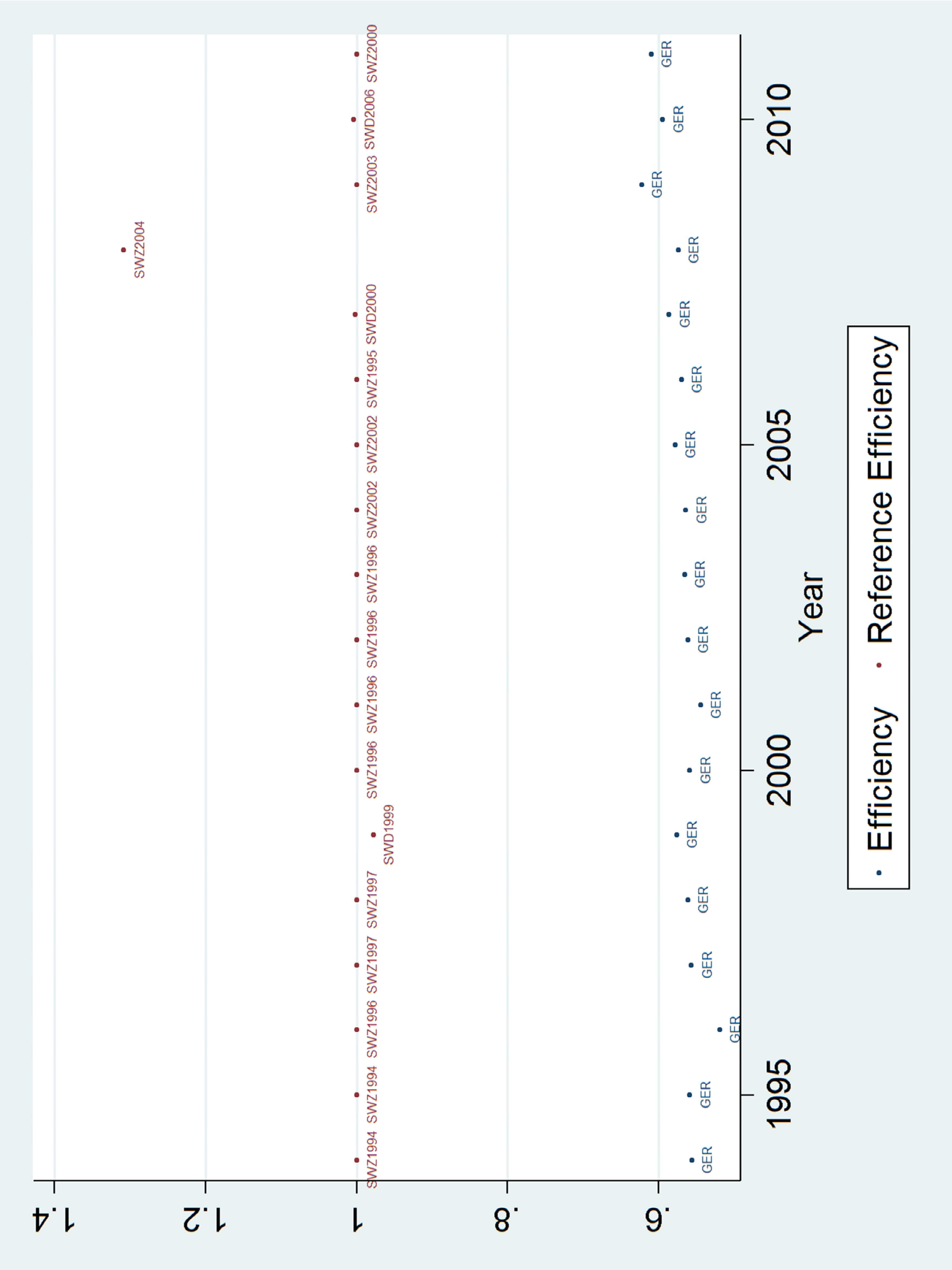
Efficiency of Spain over time



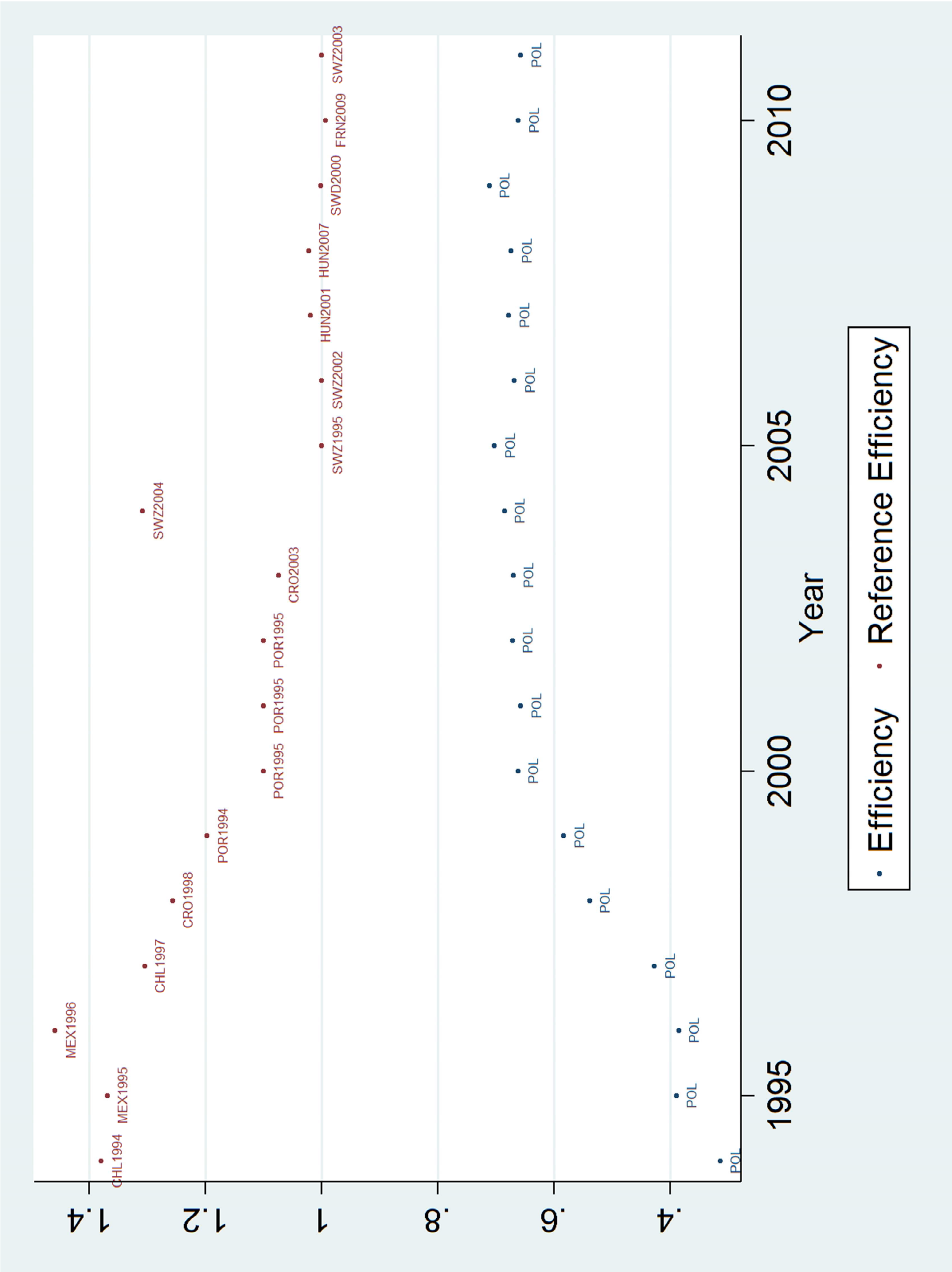
Efficiency of Portugal over time



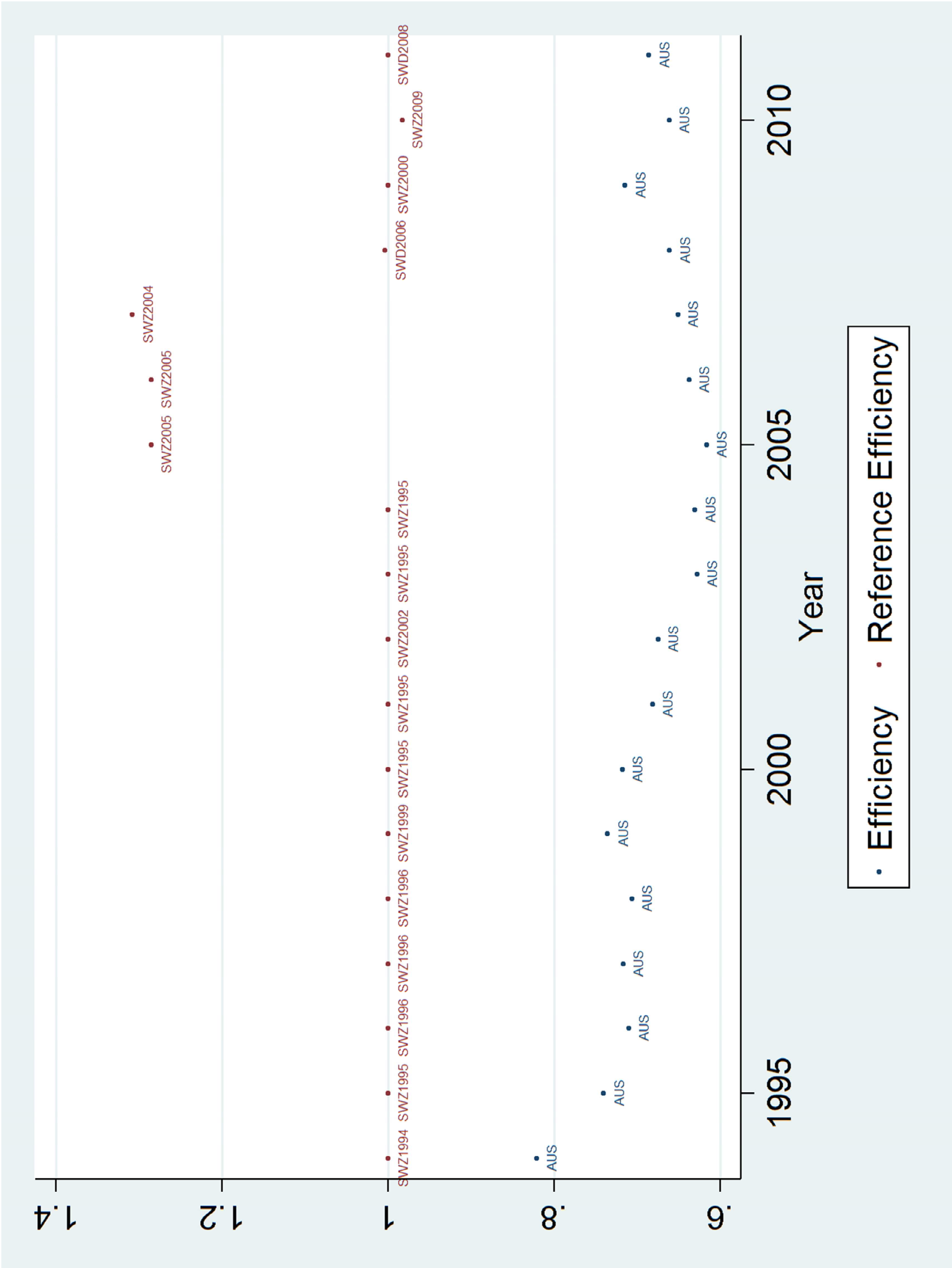
Efficiency of Greece over time



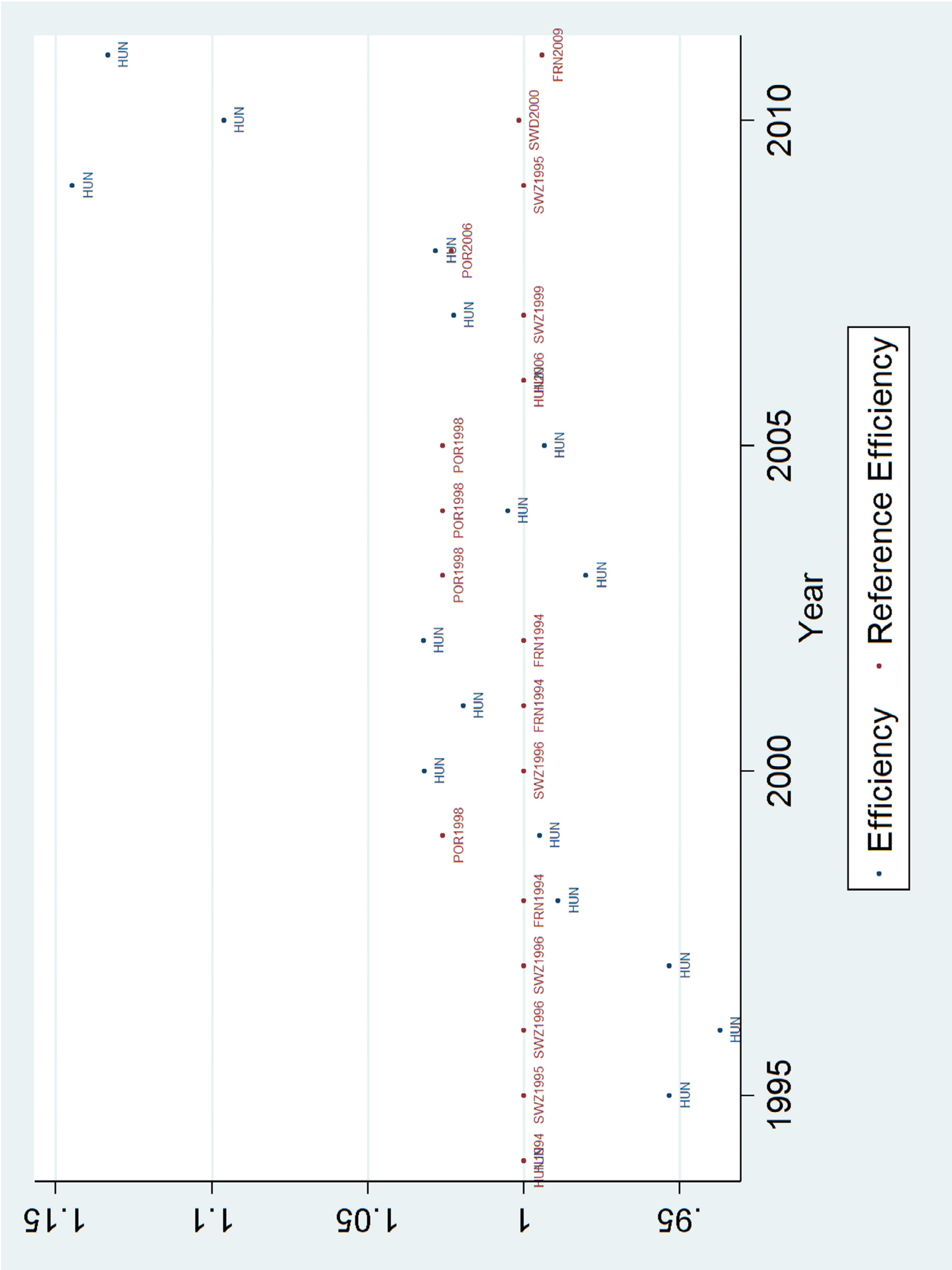
Efficiency of Poland over time



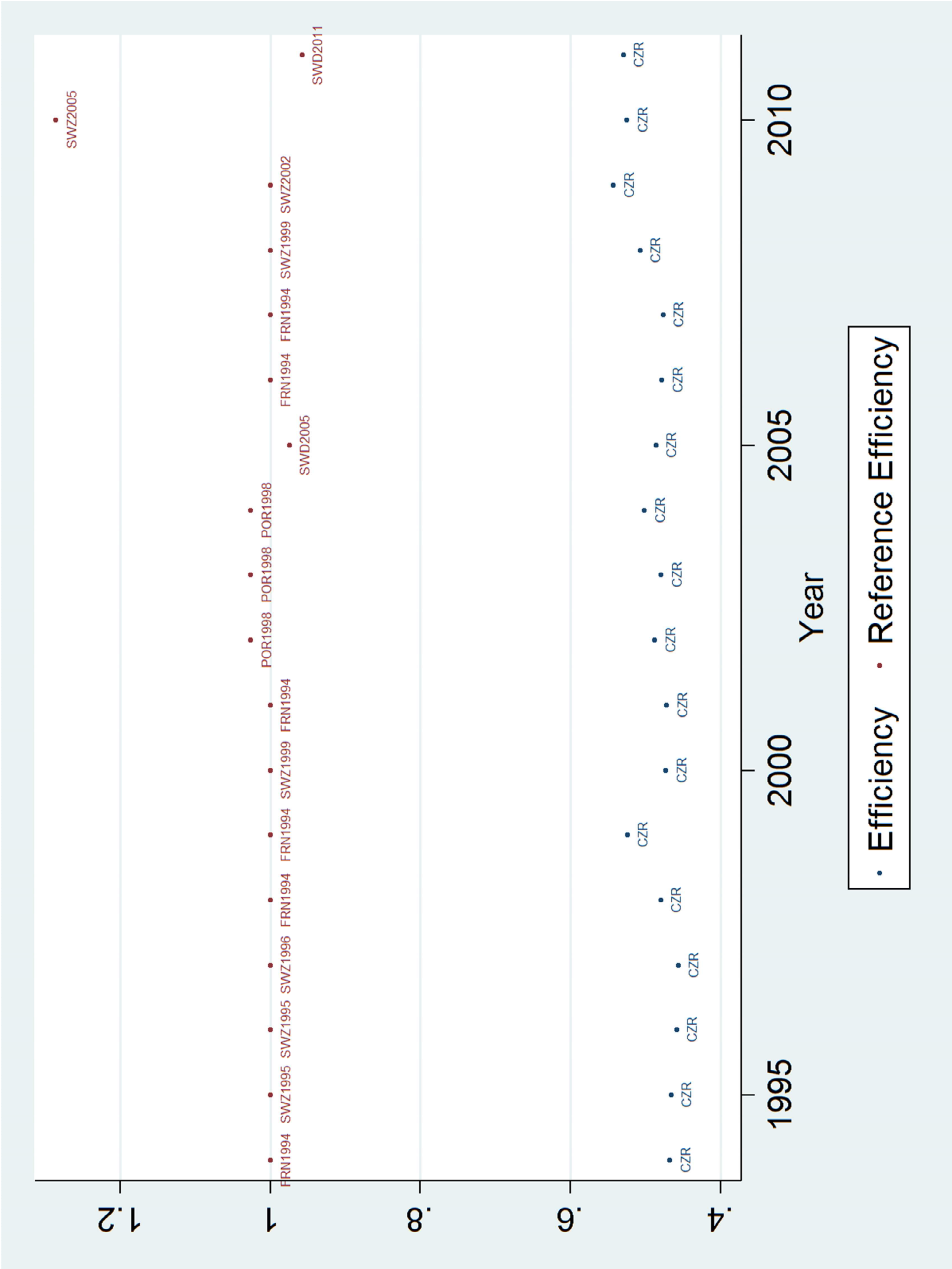
Efficiency of Austria over time



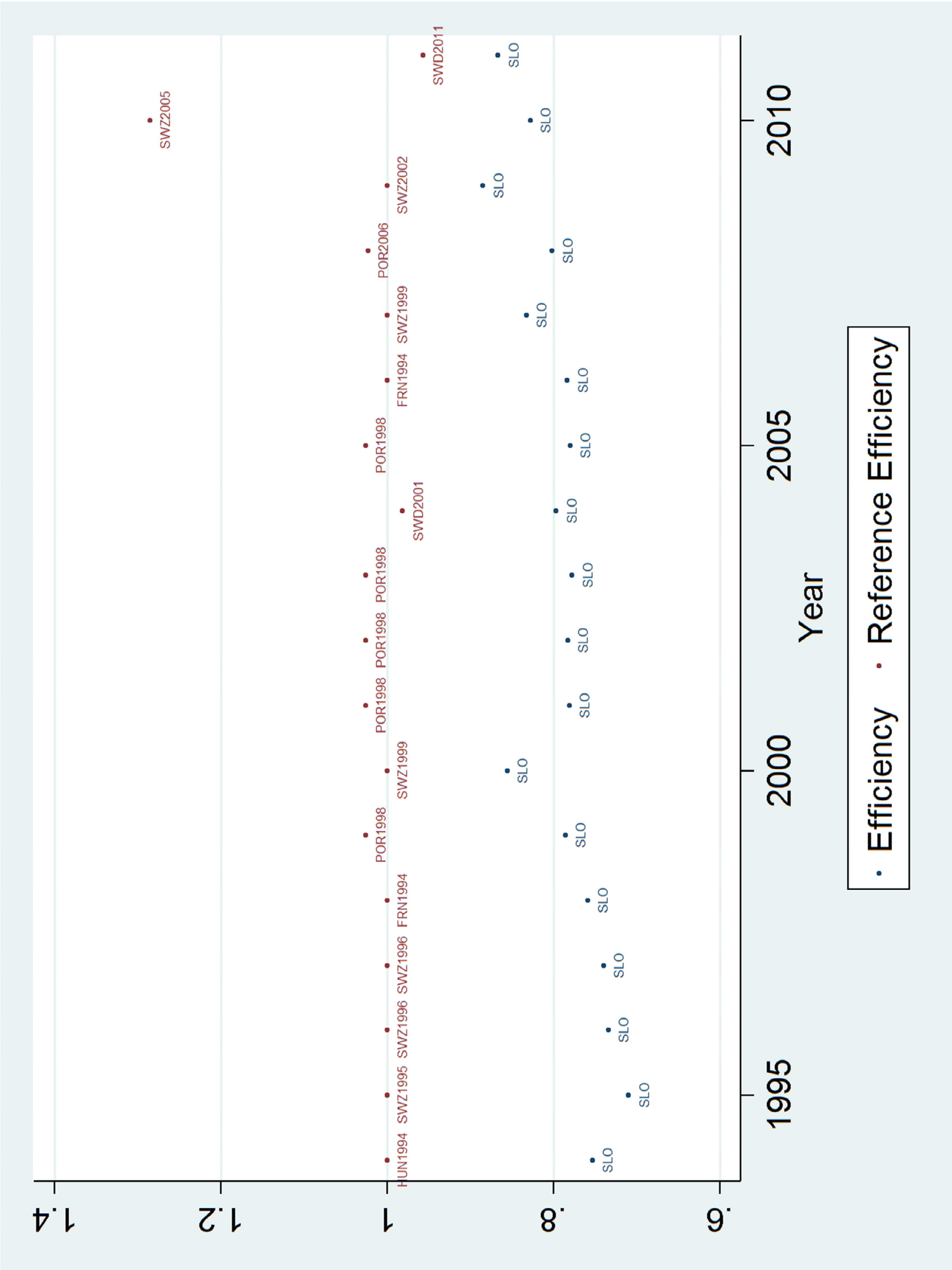
Efficiency of Hungary over time



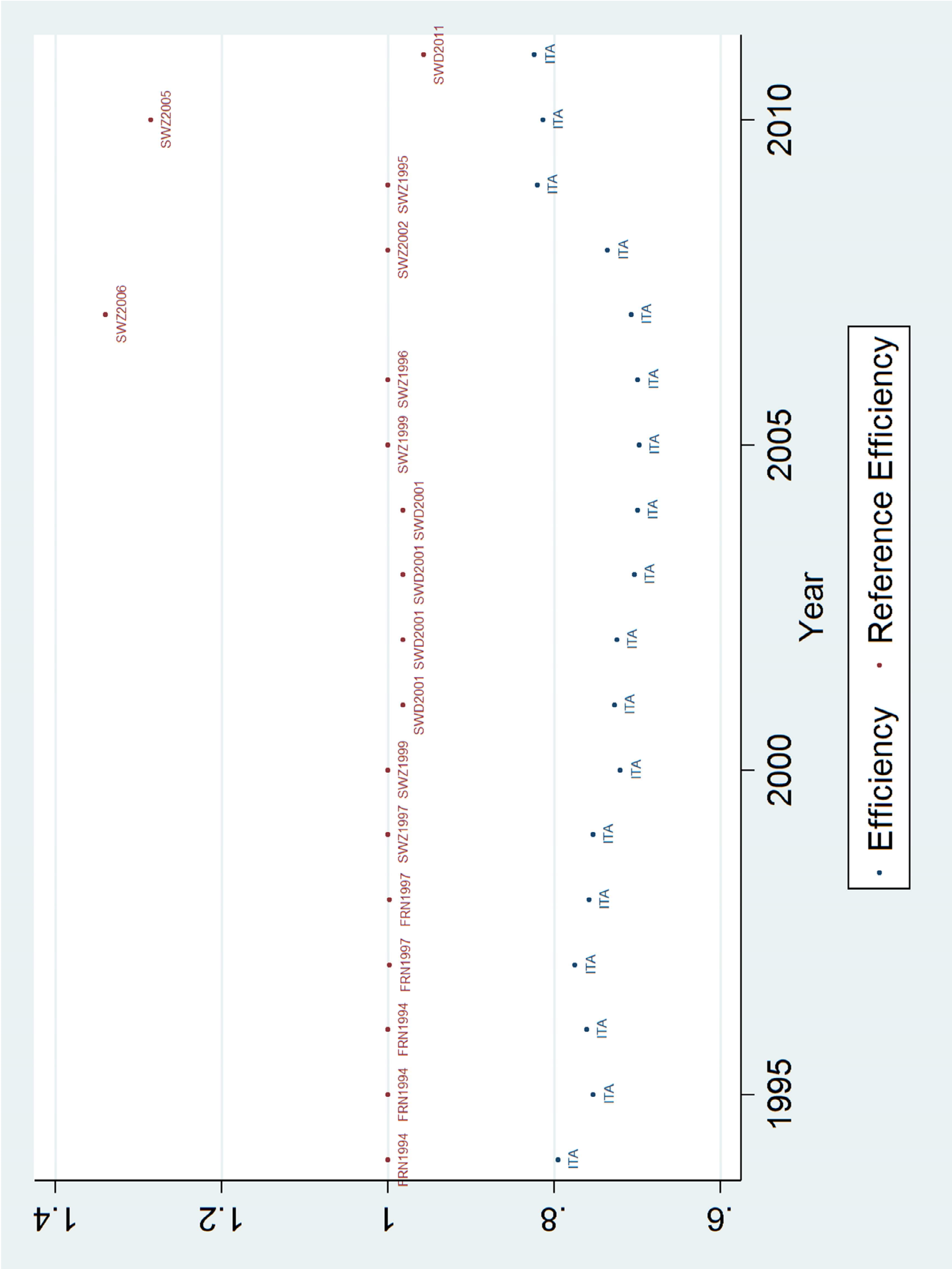
Efficiency of Czech Republic over time



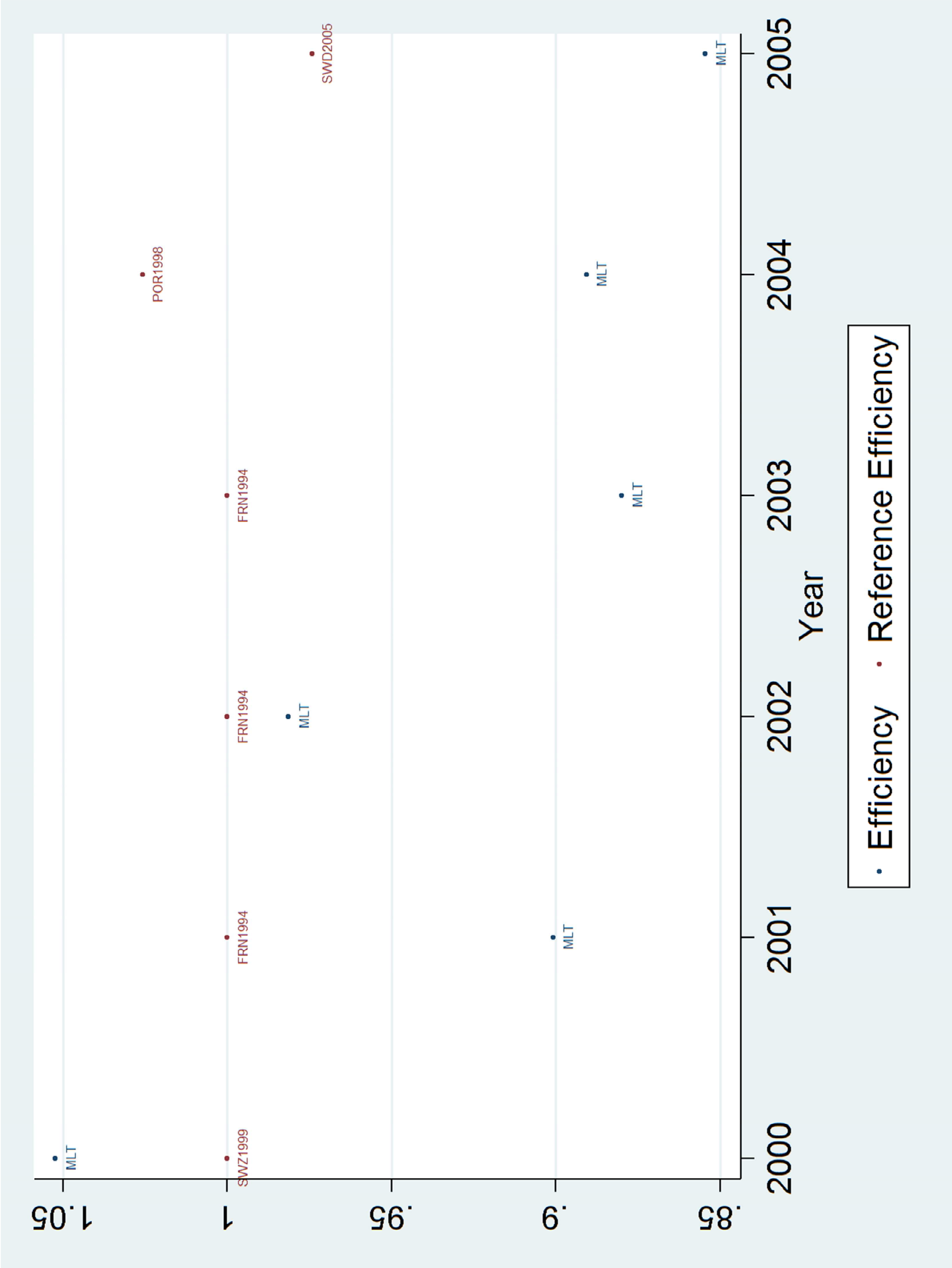
Efficiency of Slovak Republic over time



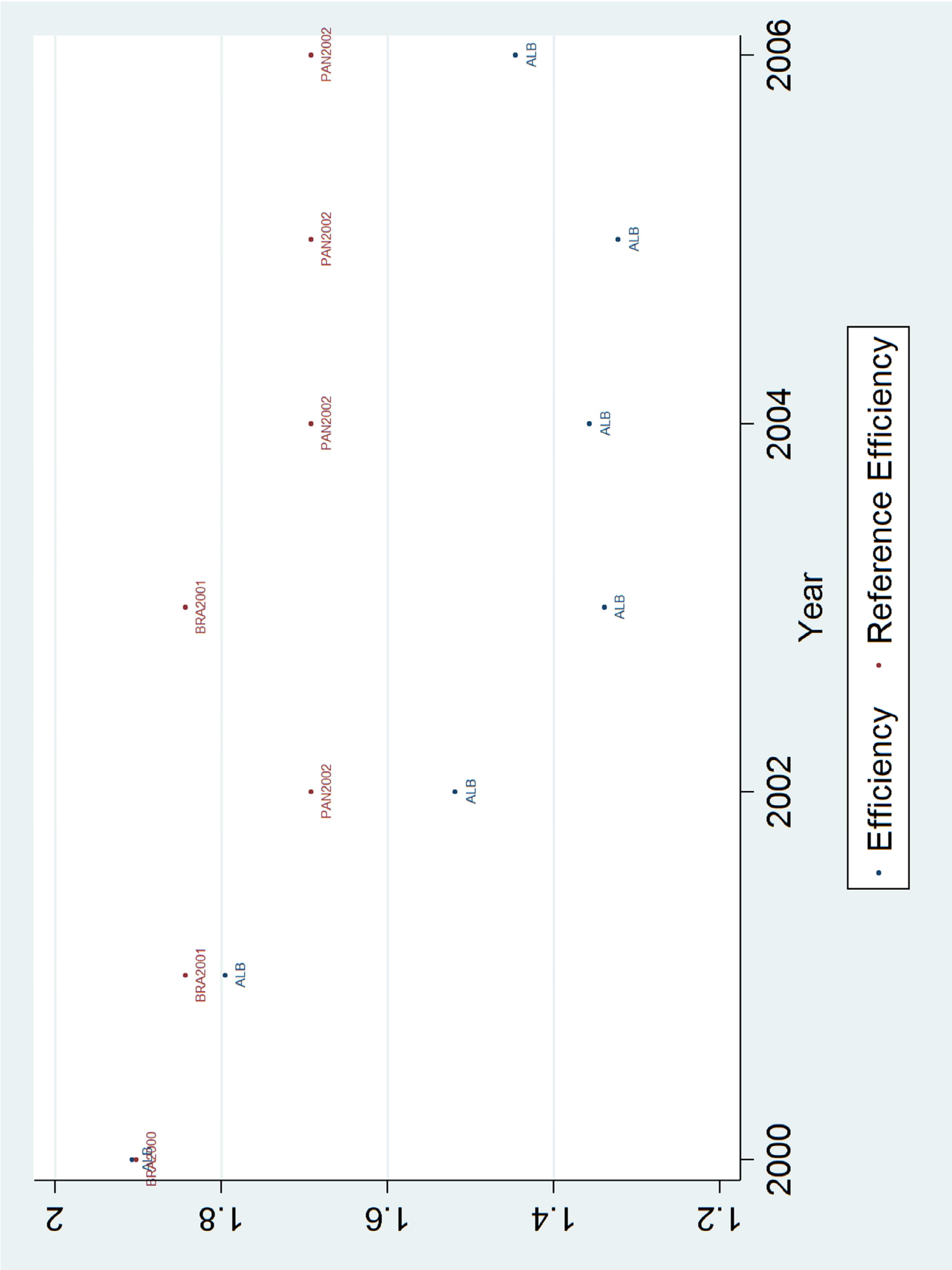
Efficiency of Italy over time



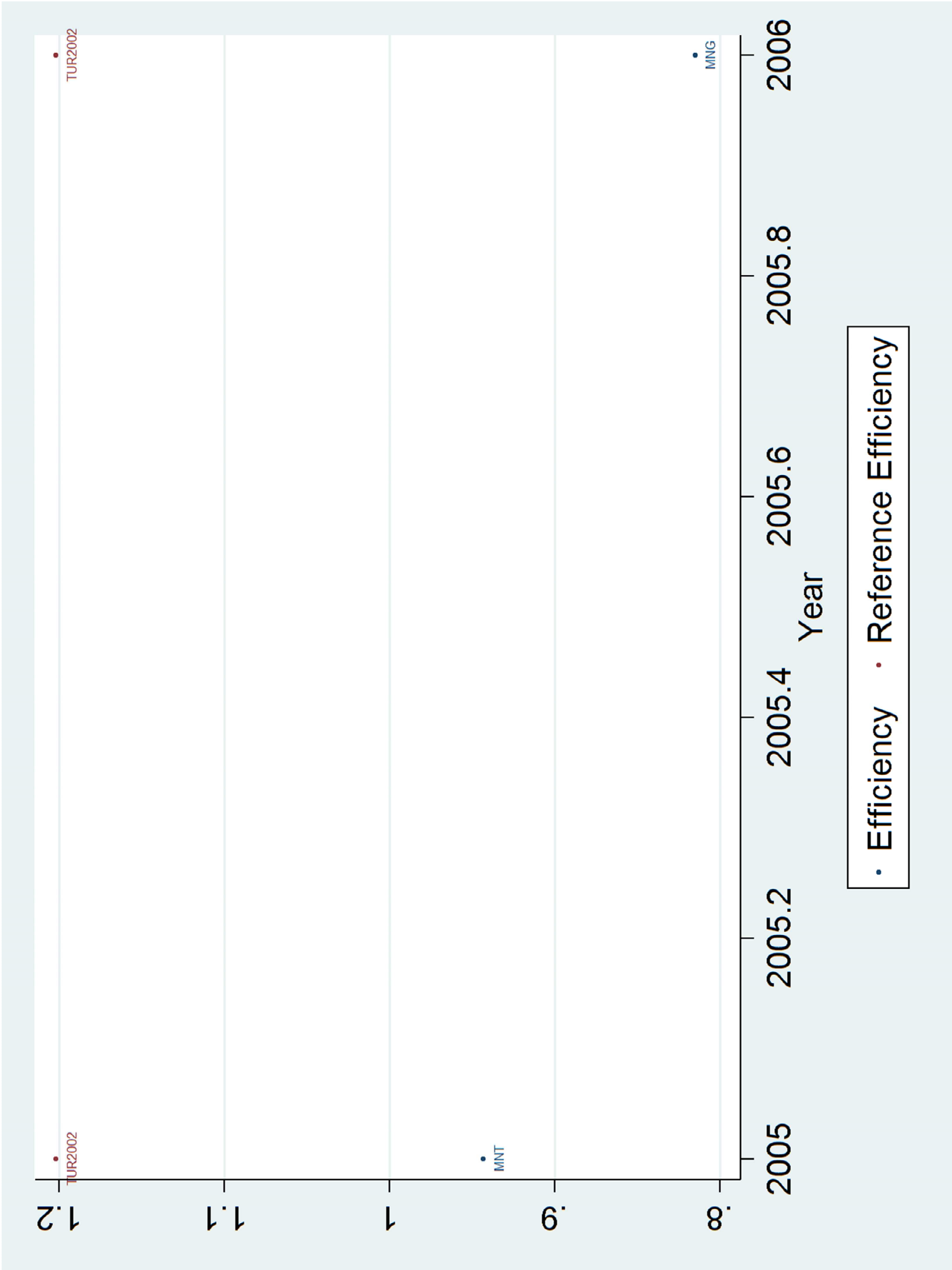
Efficiency of Malta over time



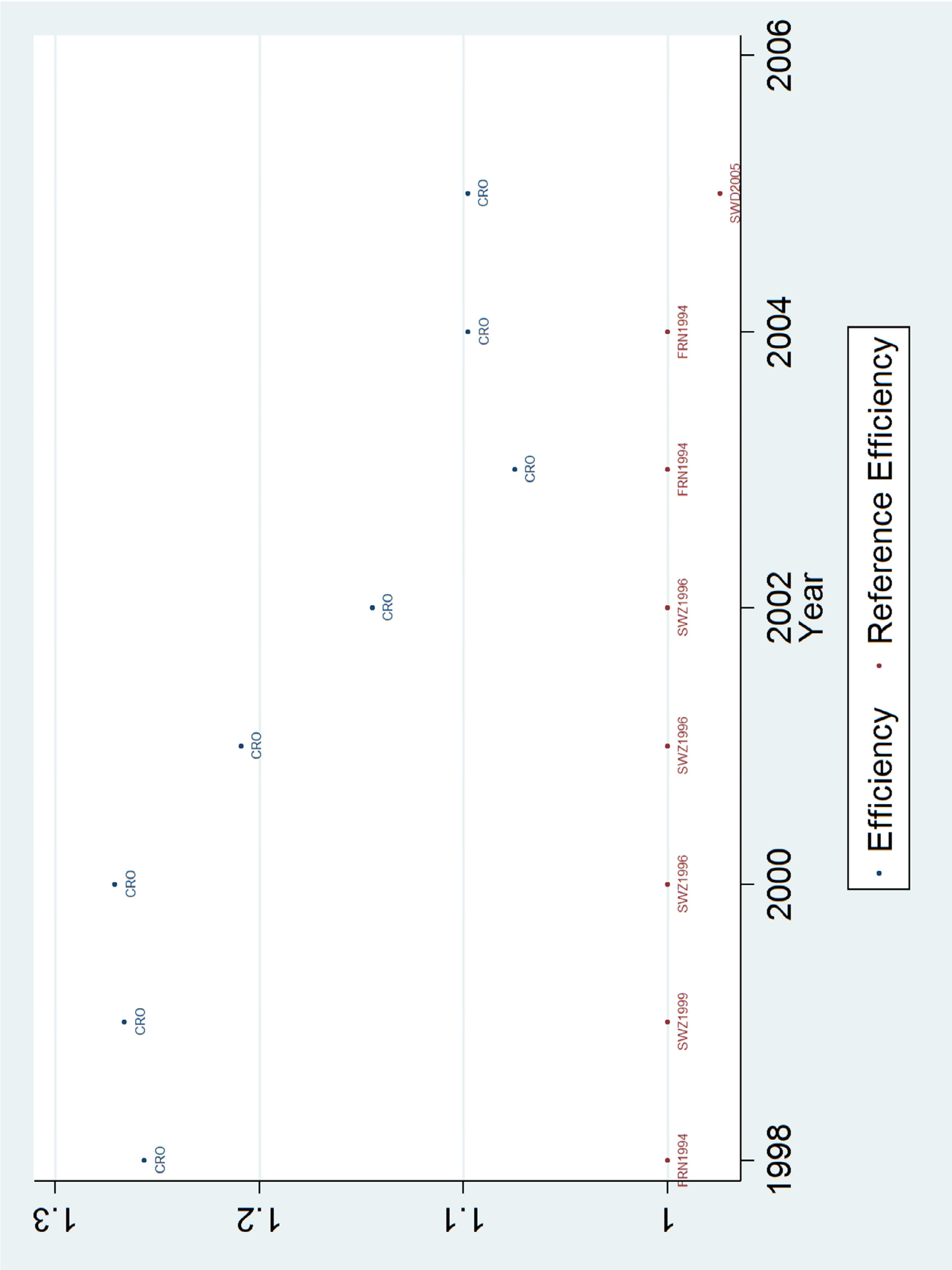
Efficiency of Albania over time



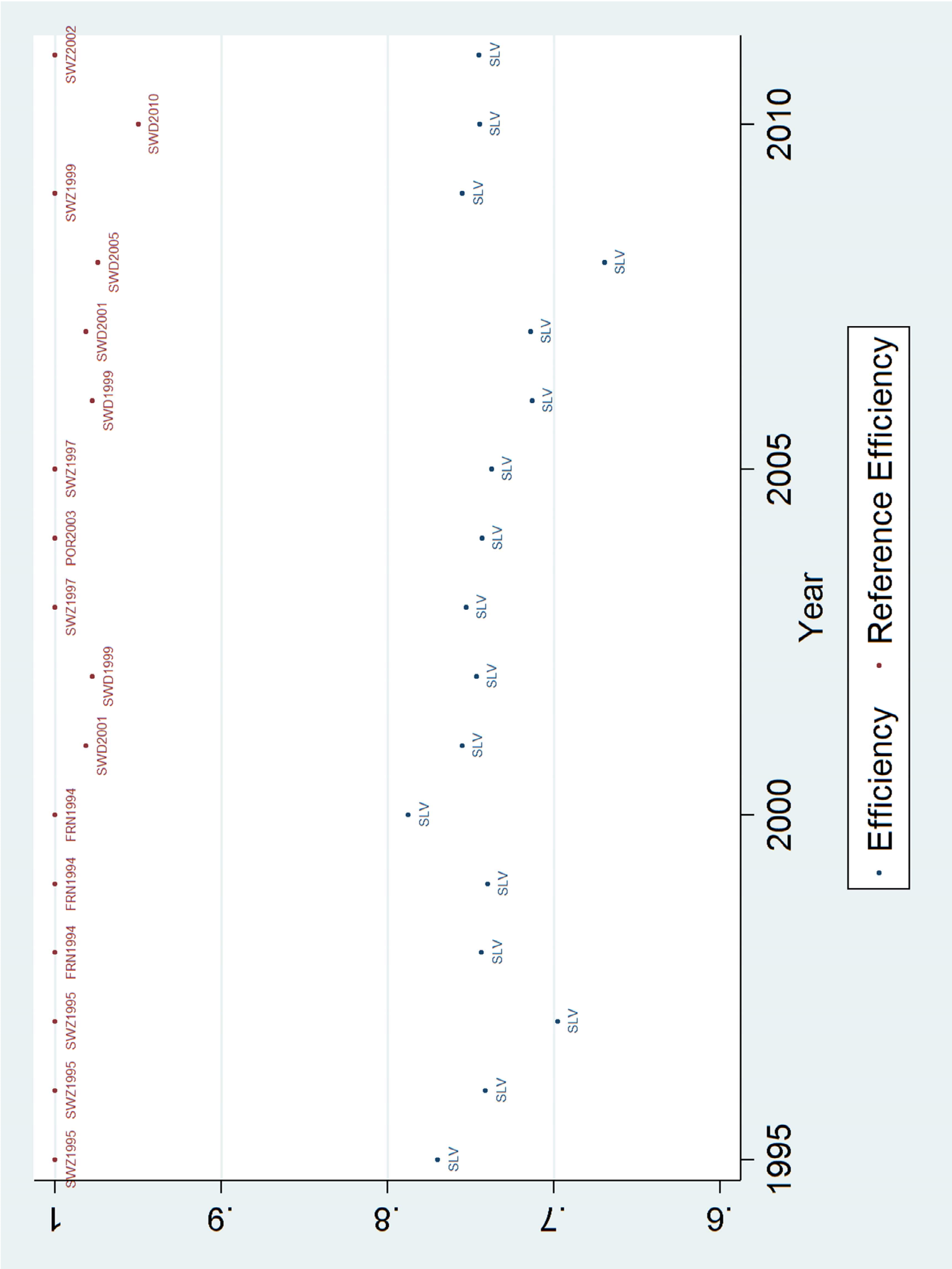
Efficiency of Montenegro over time



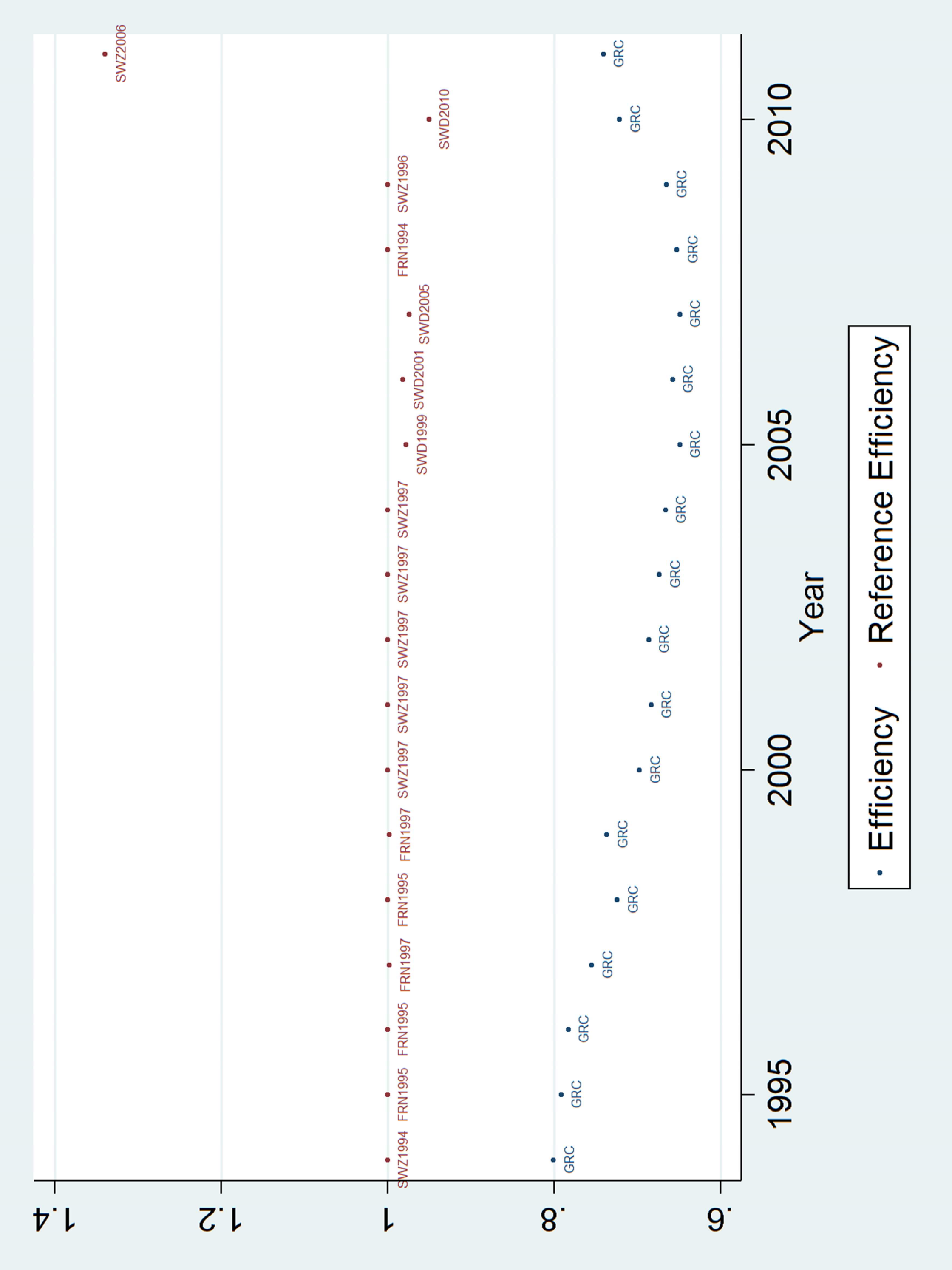
Efficiency of Croatia over time



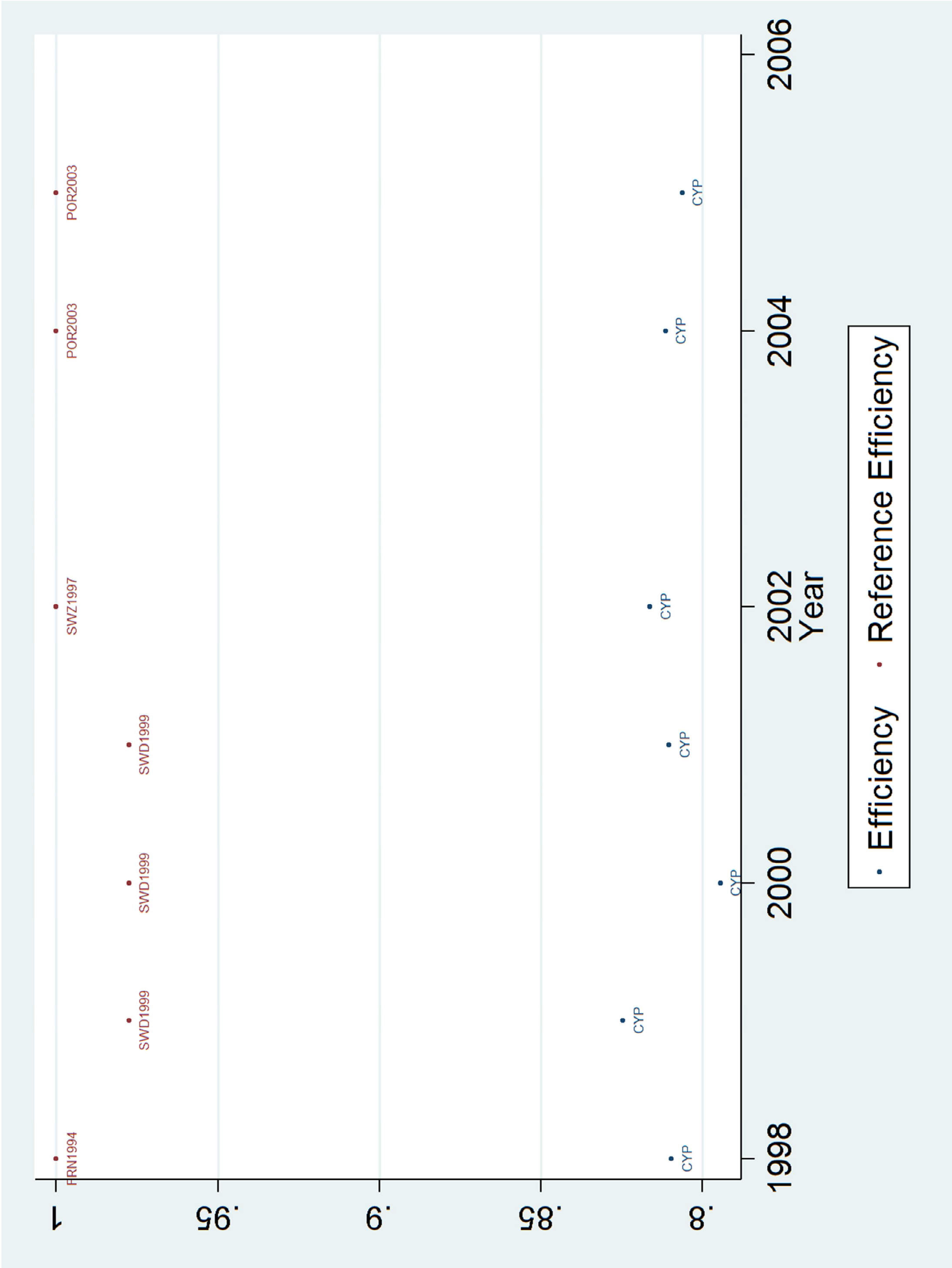
Efficiency of Slovenia over time



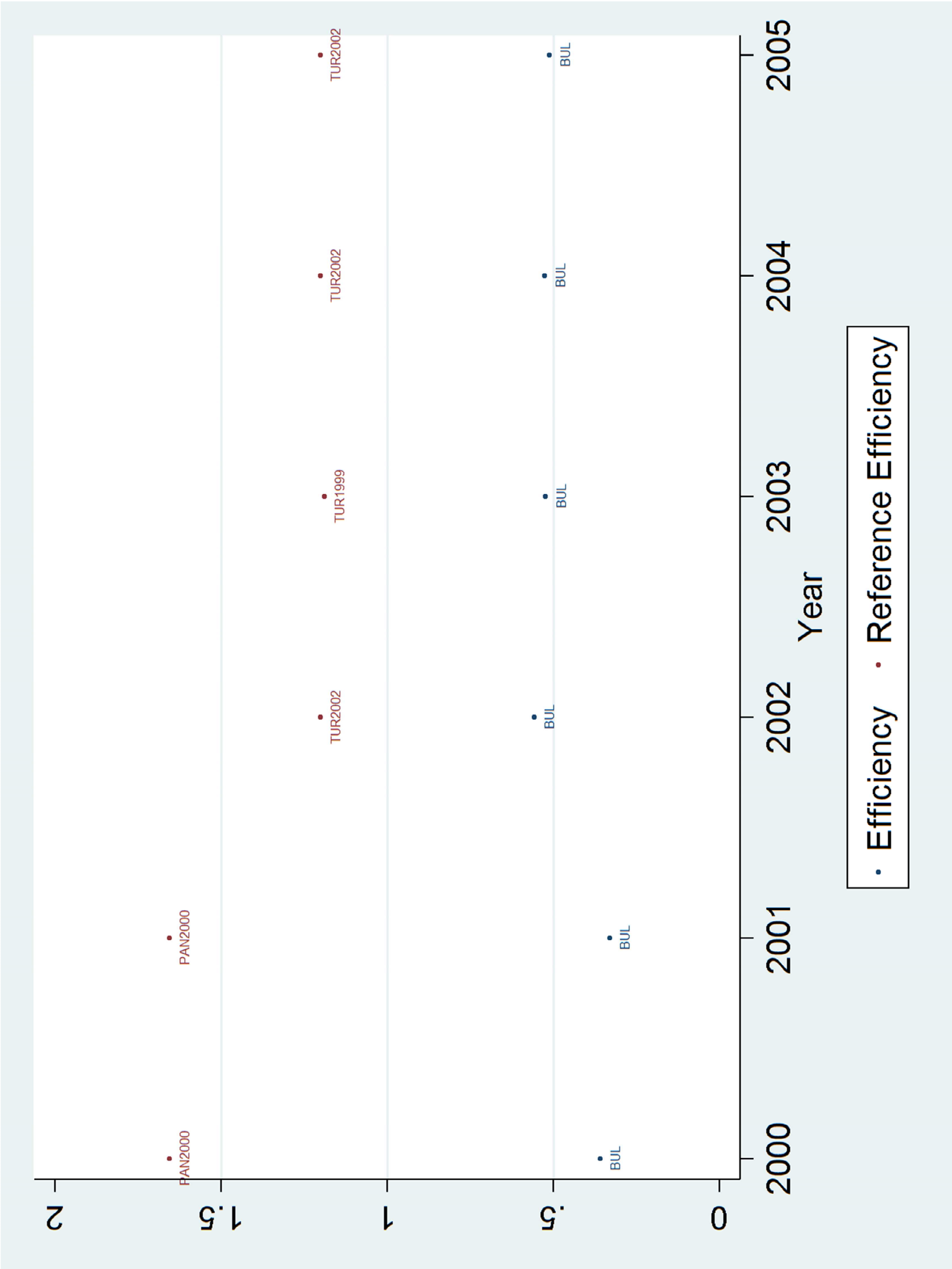
Efficiency of Greece over time



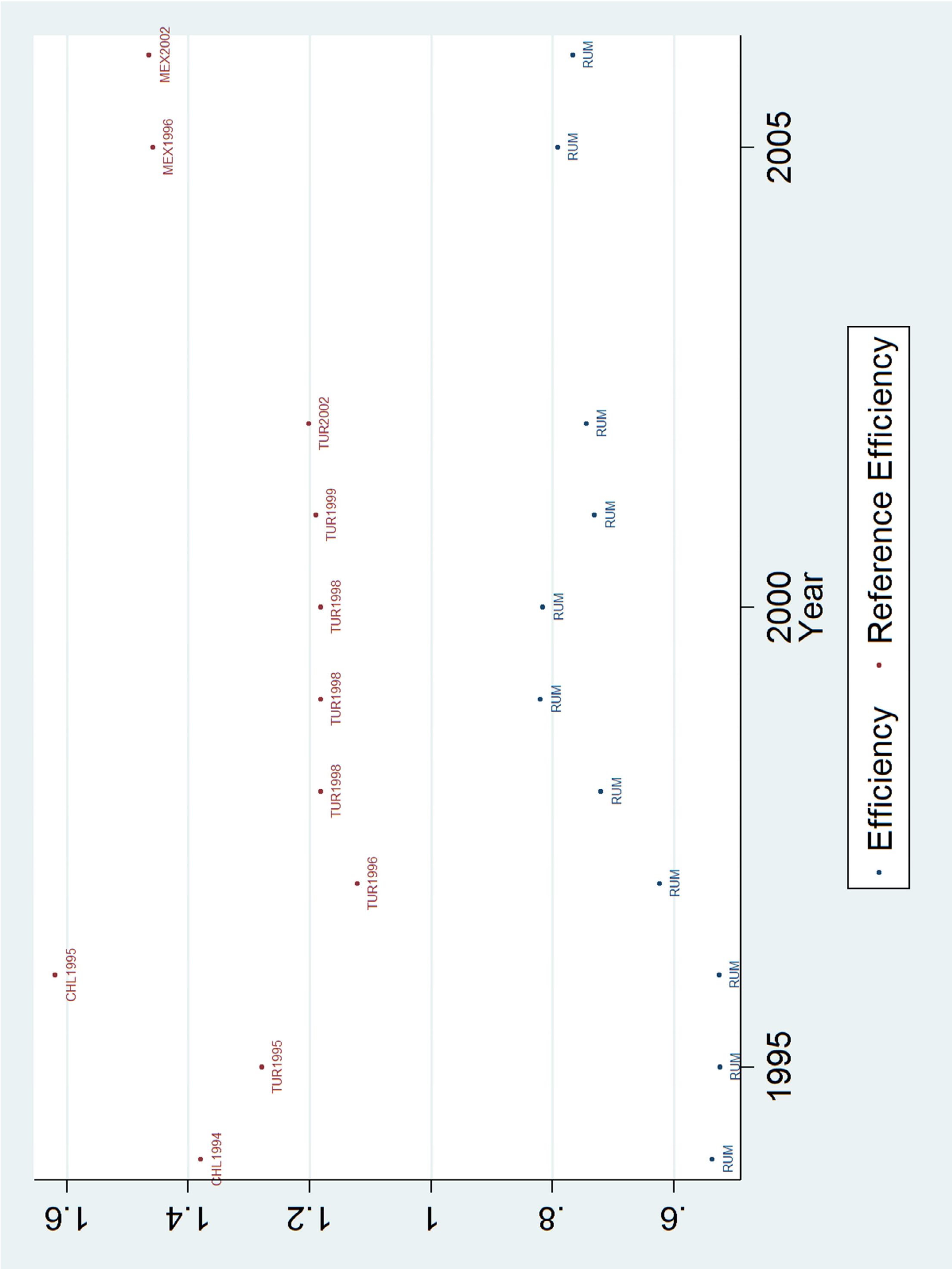
Efficiency of Cyprus over time



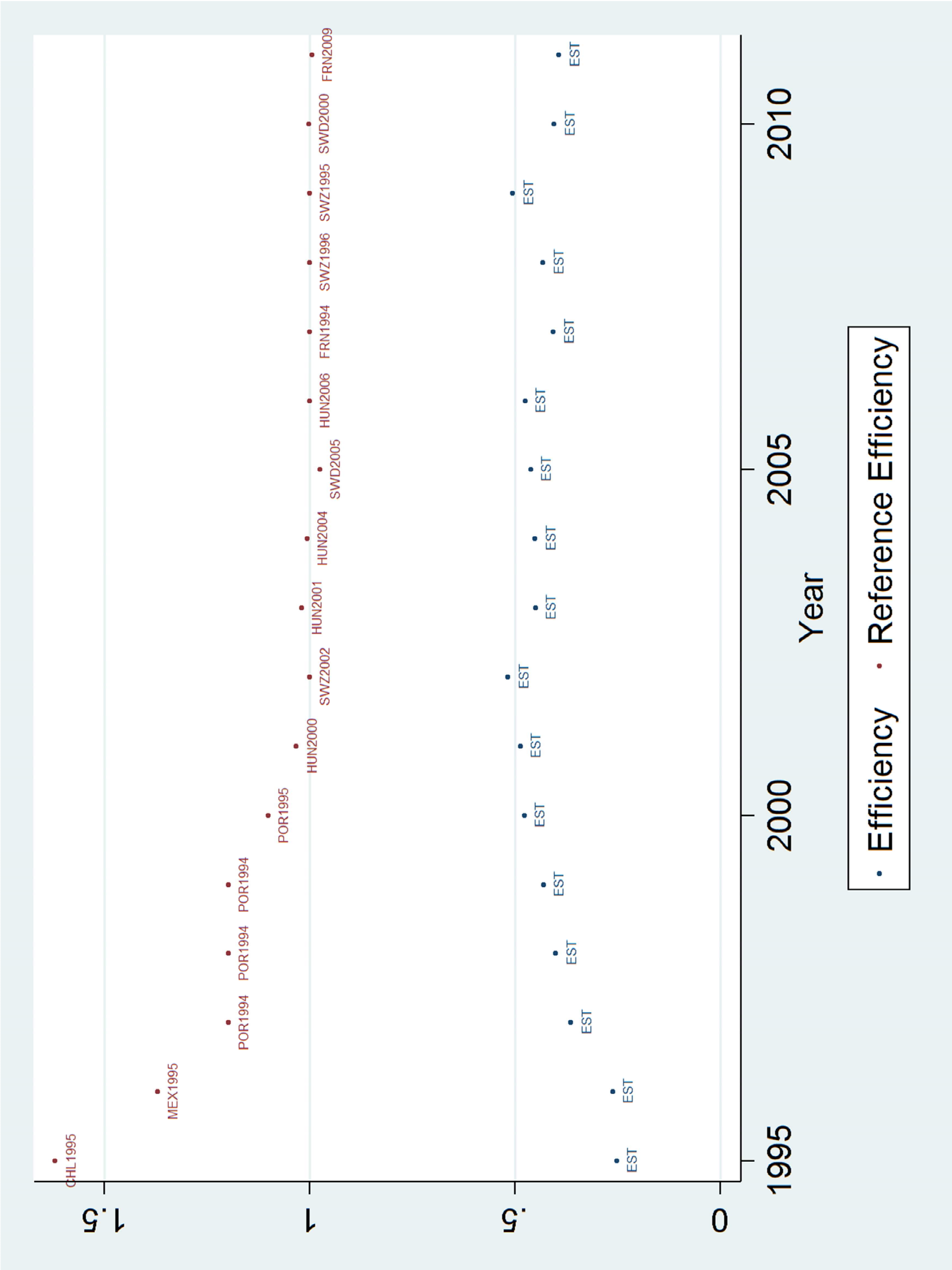
Efficiency of Bulgaria over time



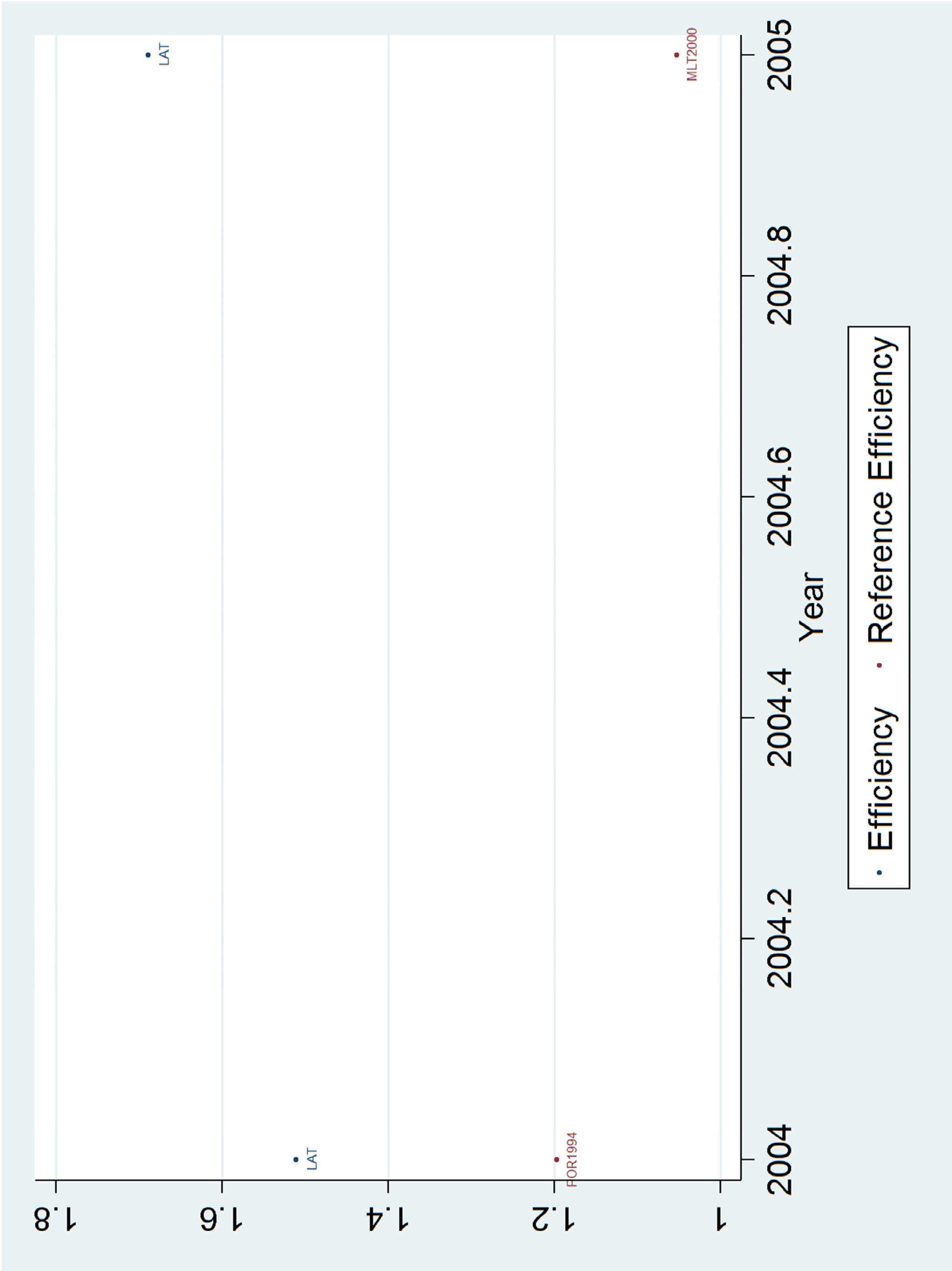
Efficiency of Romania over time



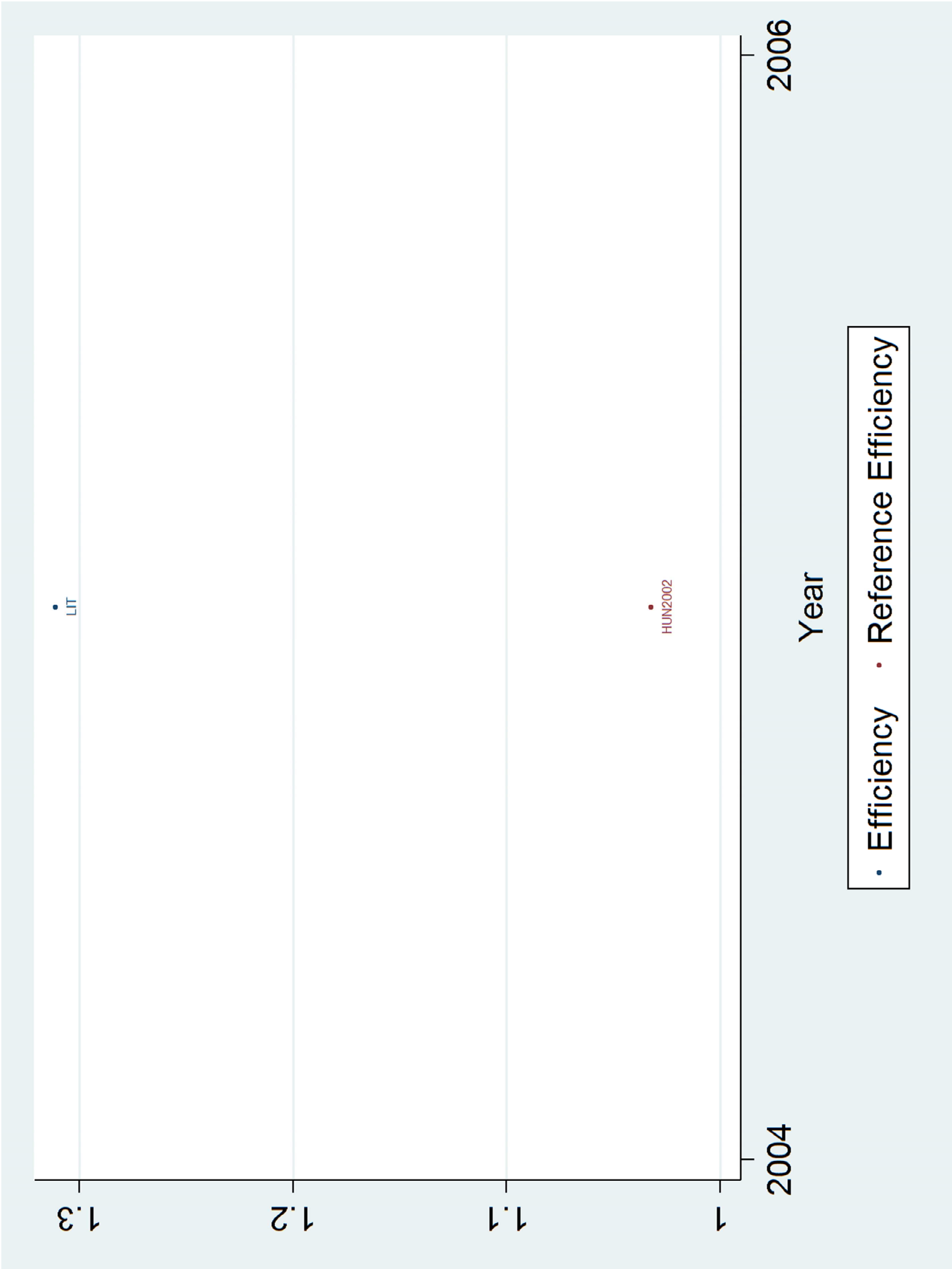
Efficiency of Estonia over time



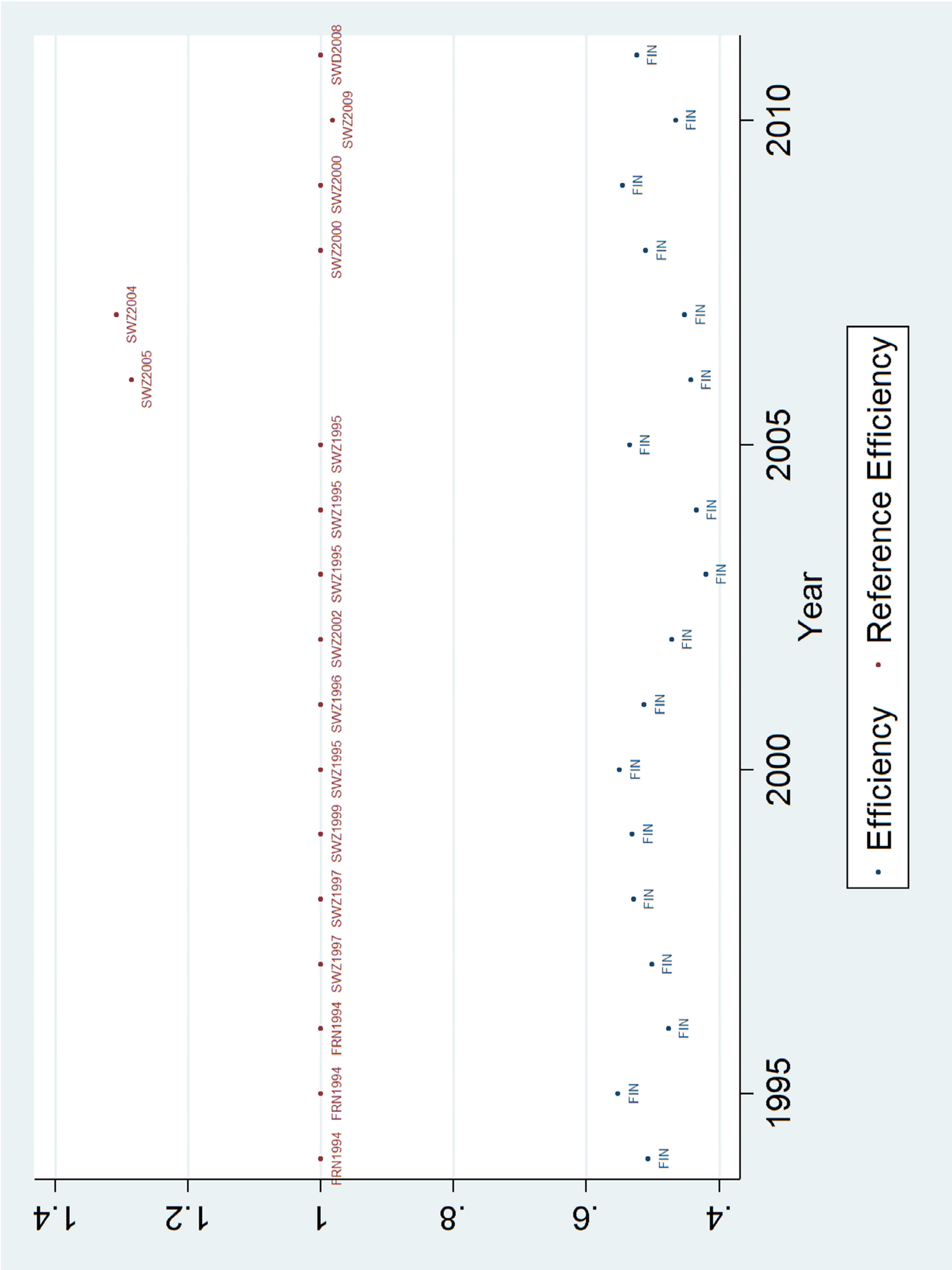
Efficiency of Latvia over time



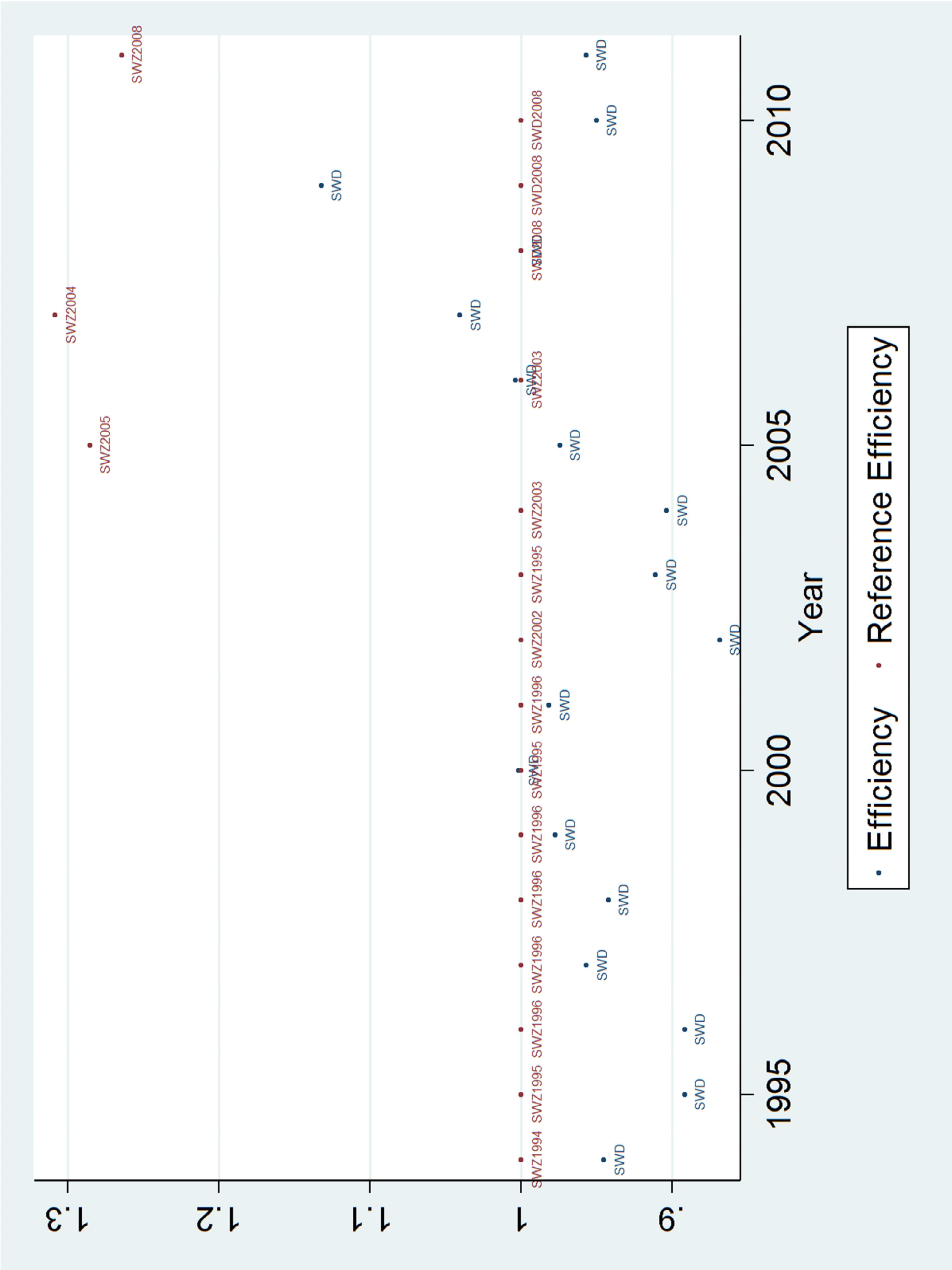
Efficiency of Lithuania over time



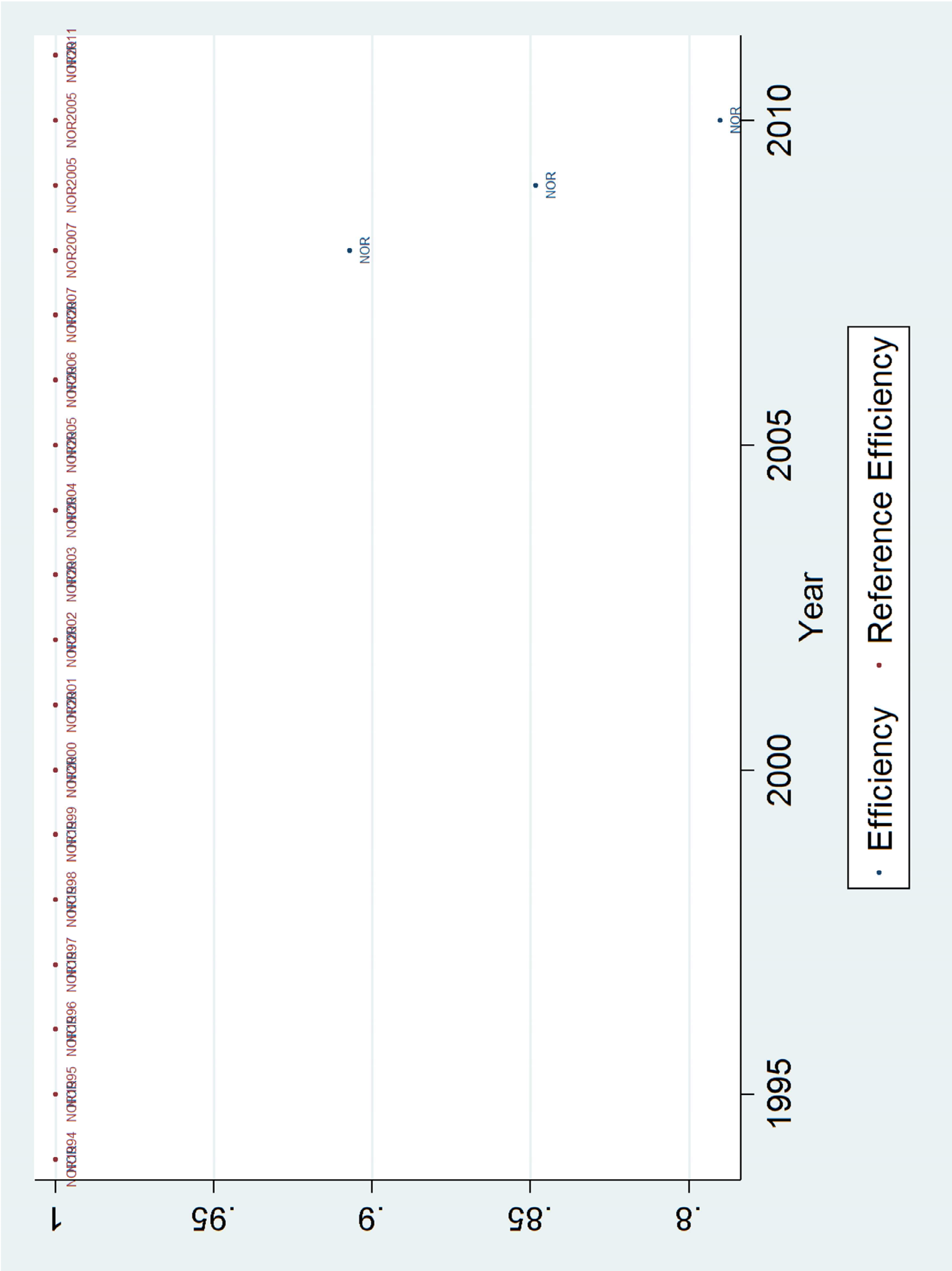
Efficiency of Finland over time



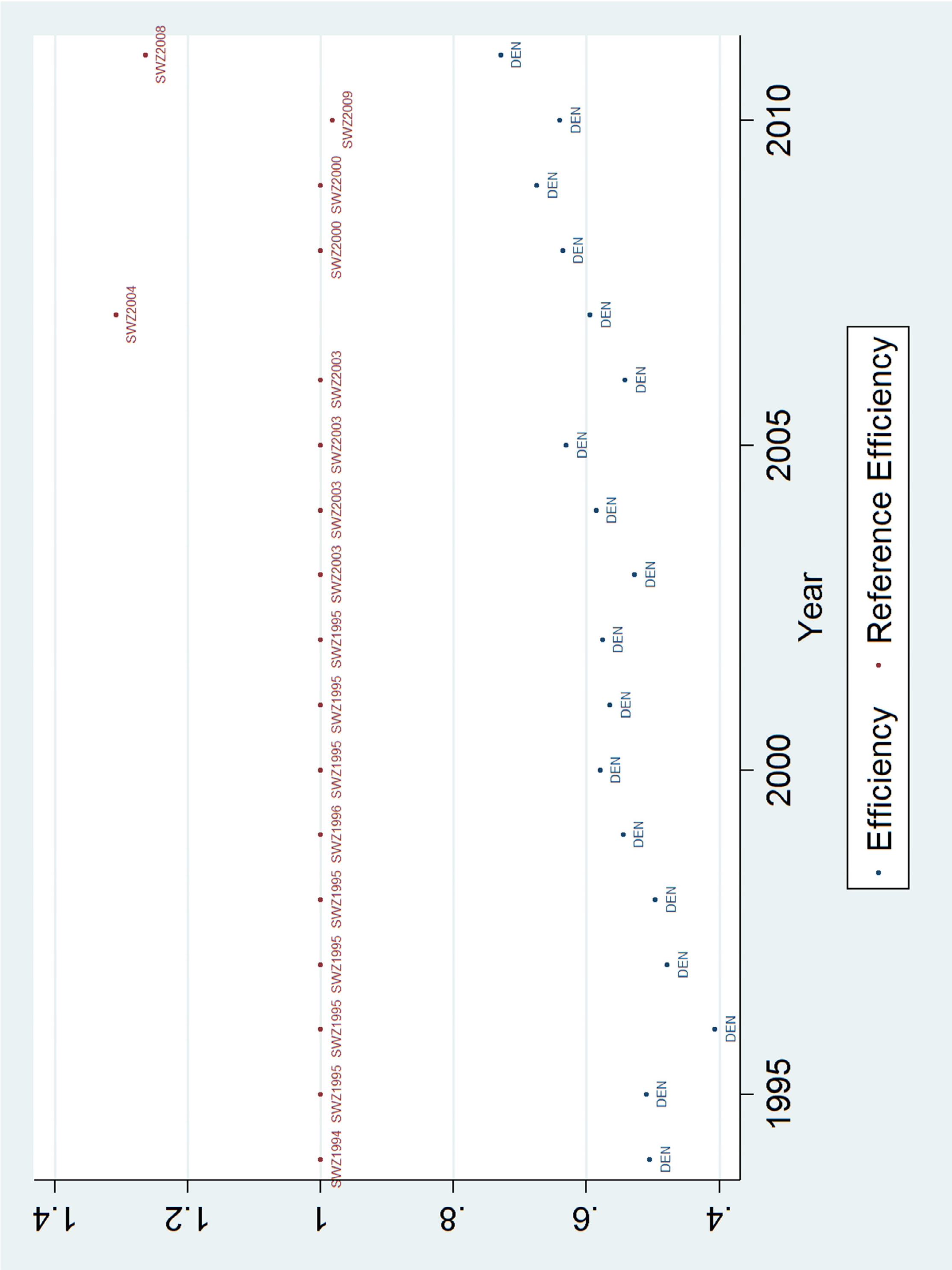
Efficiency of Sweden over time



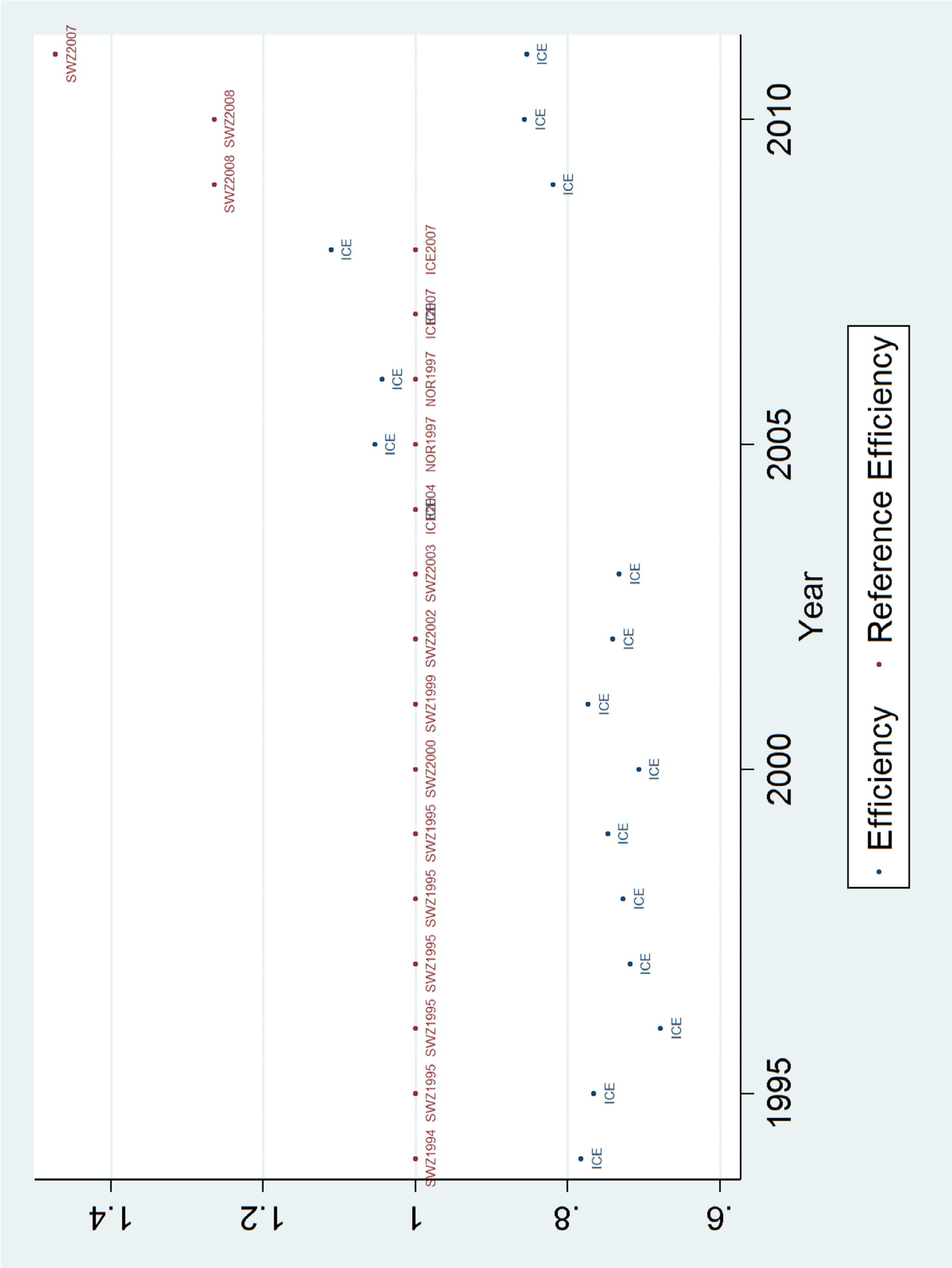
Efficiency of Norway over time



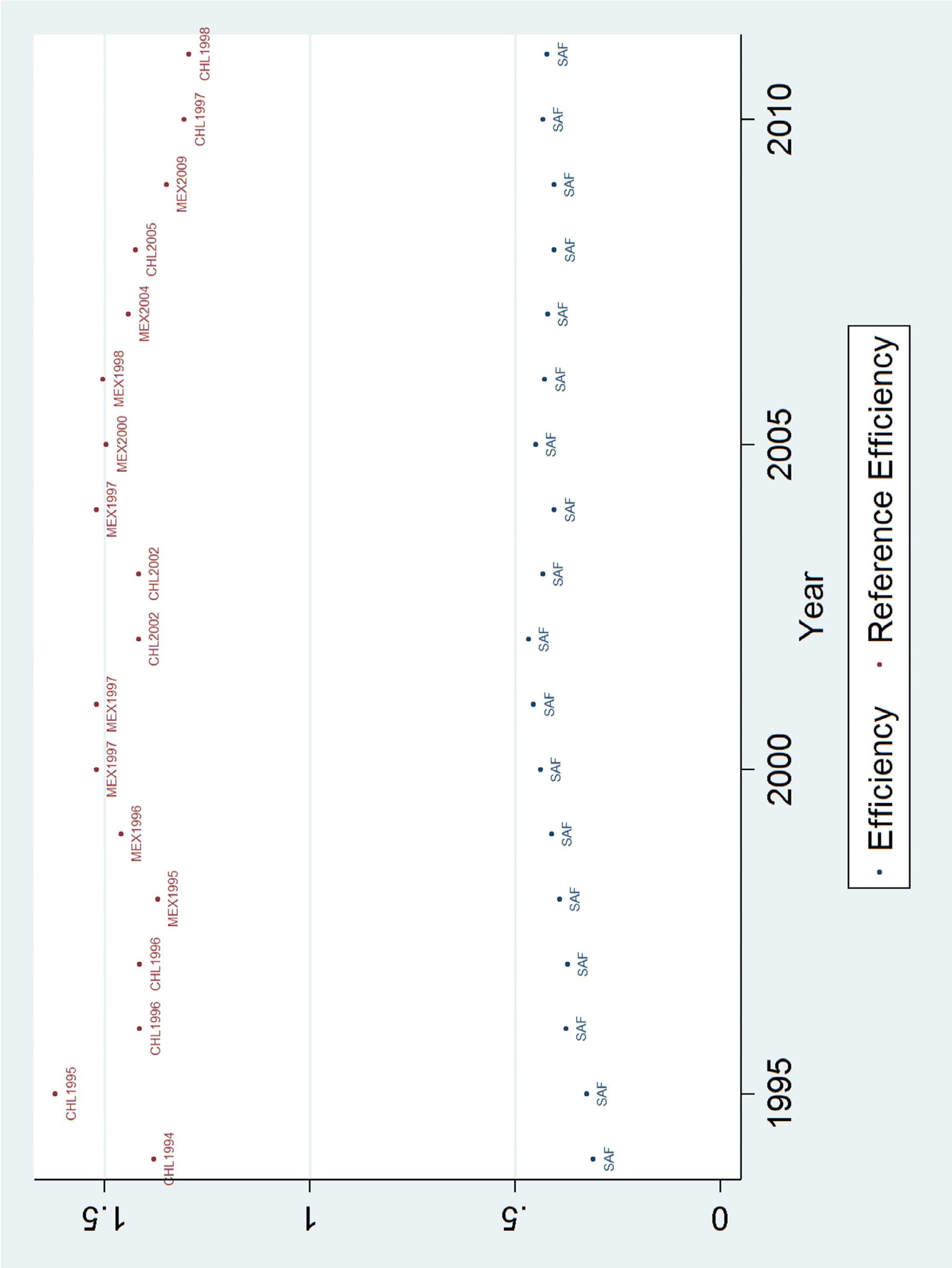
Efficiency of Denmark over time



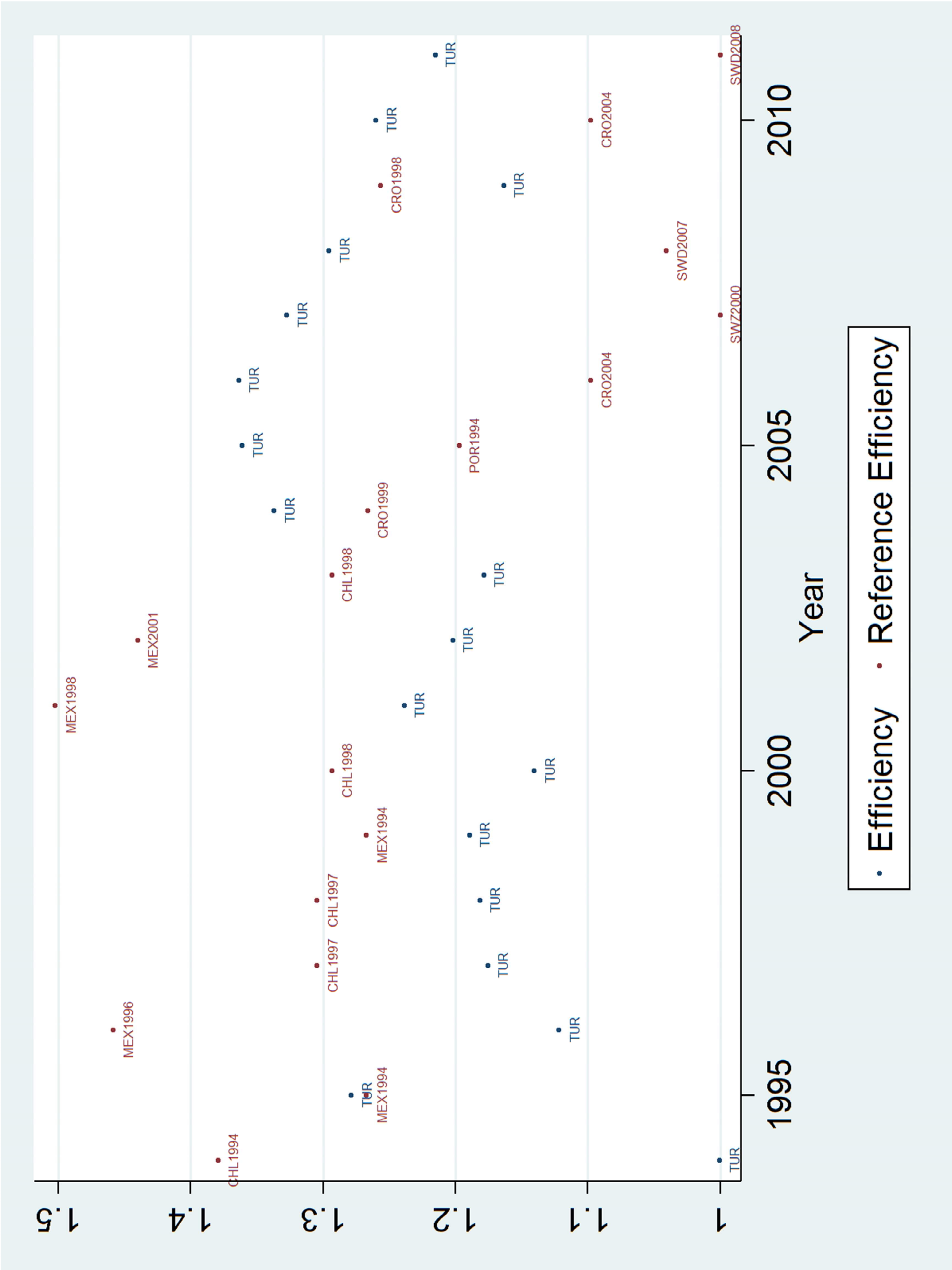
Efficiency of Iceland over time



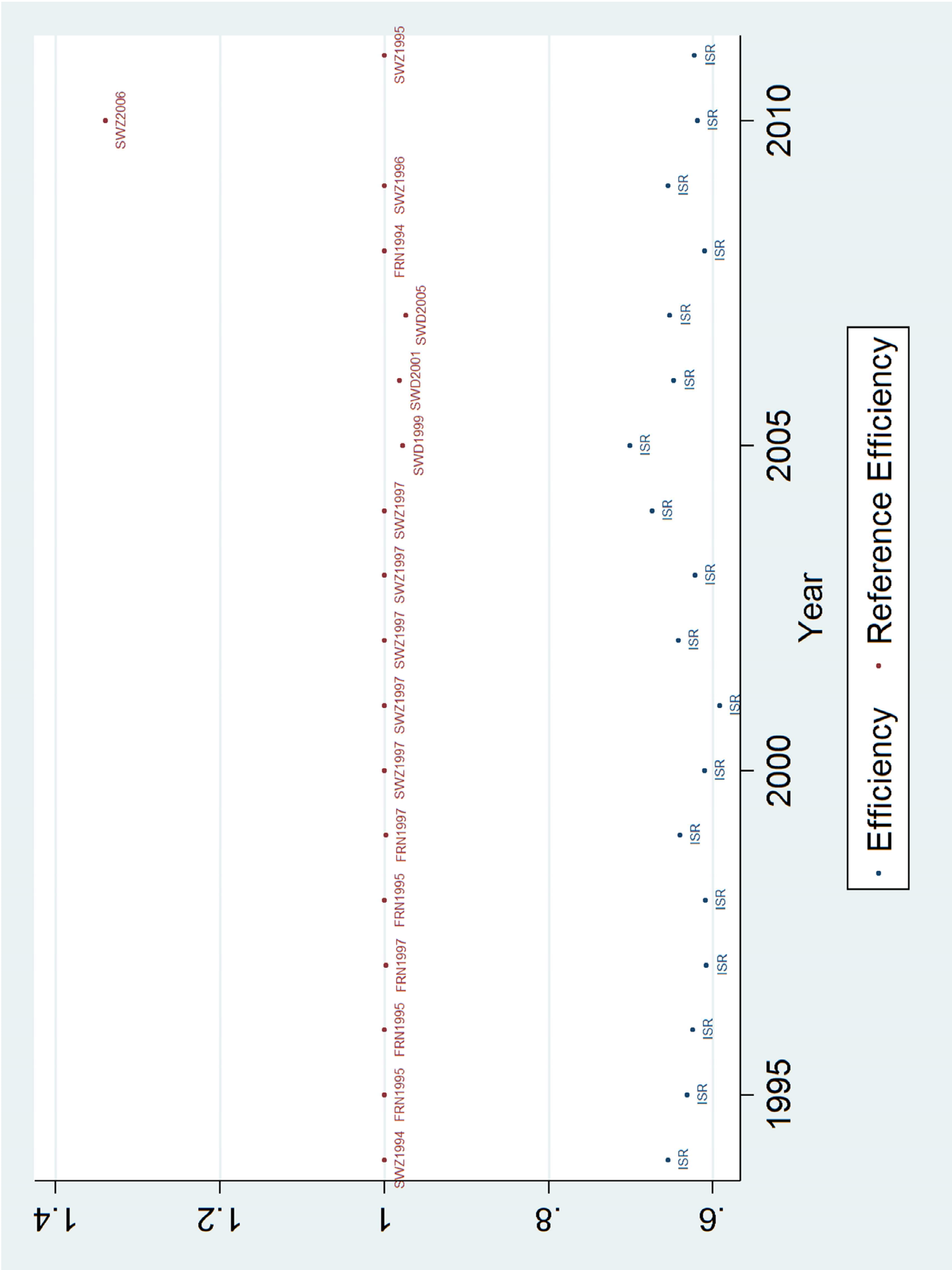
Efficiency of South Africa over time



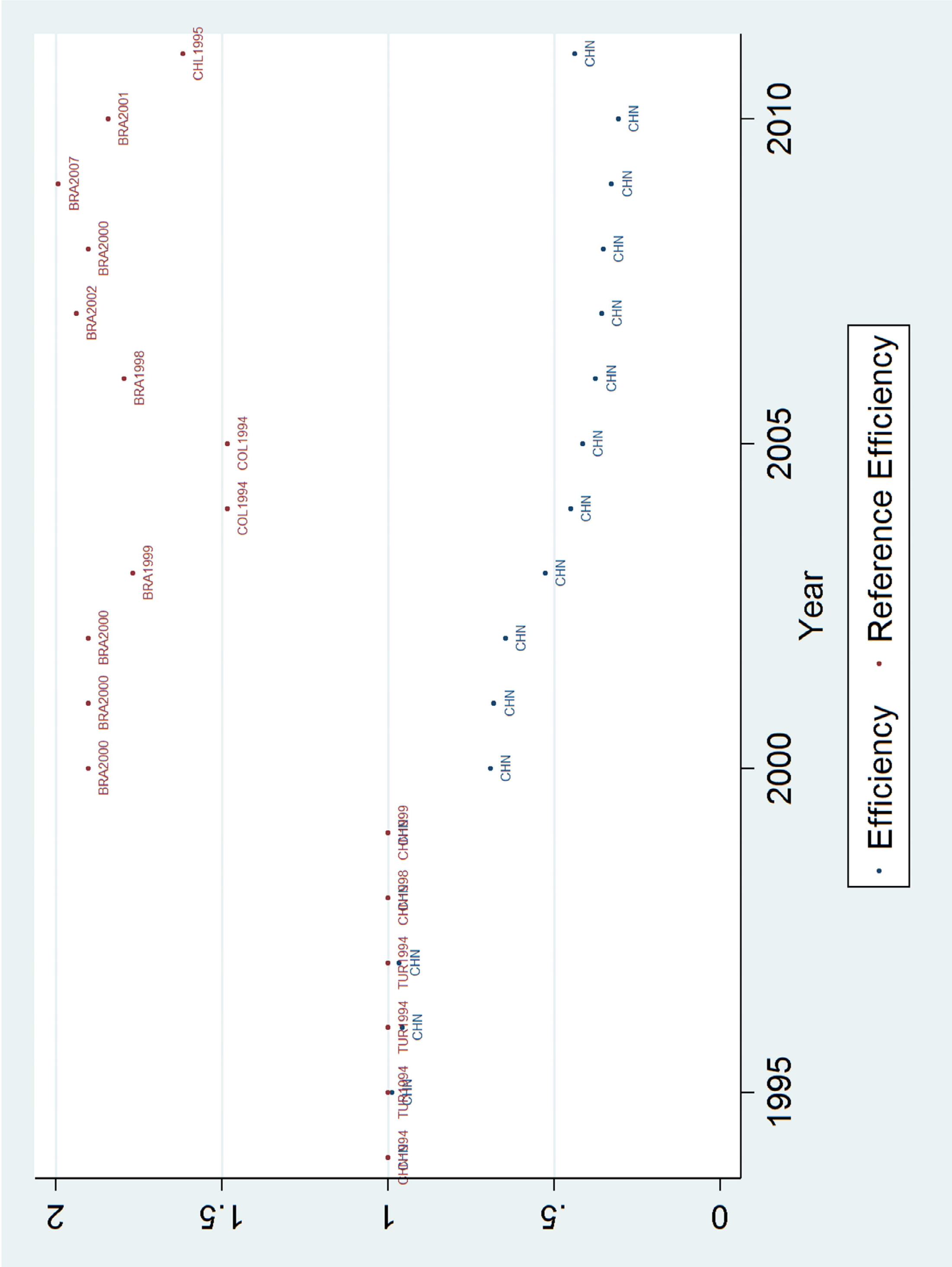
Efficiency of Turkey over time



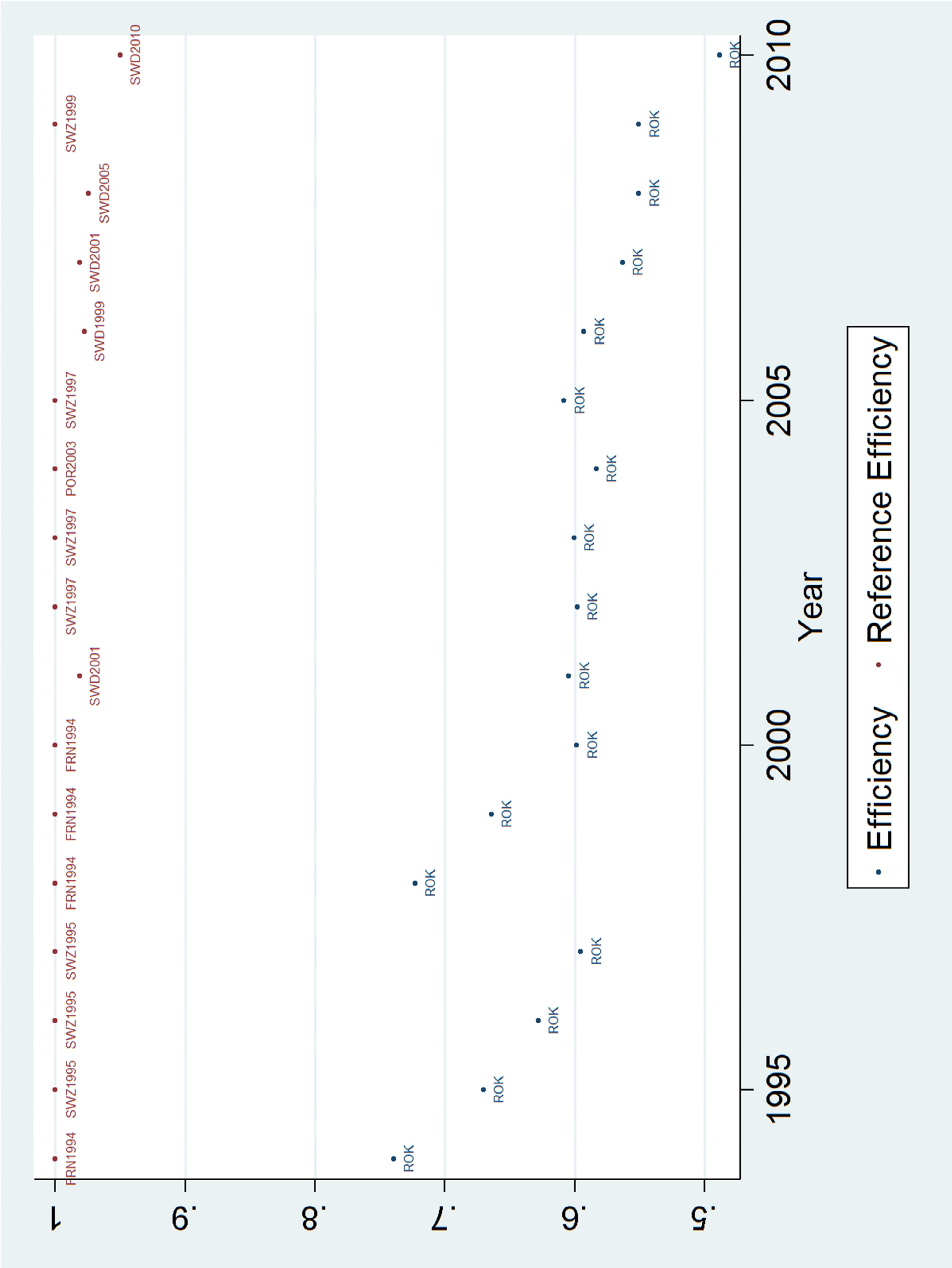
Efficiency of Israel over time



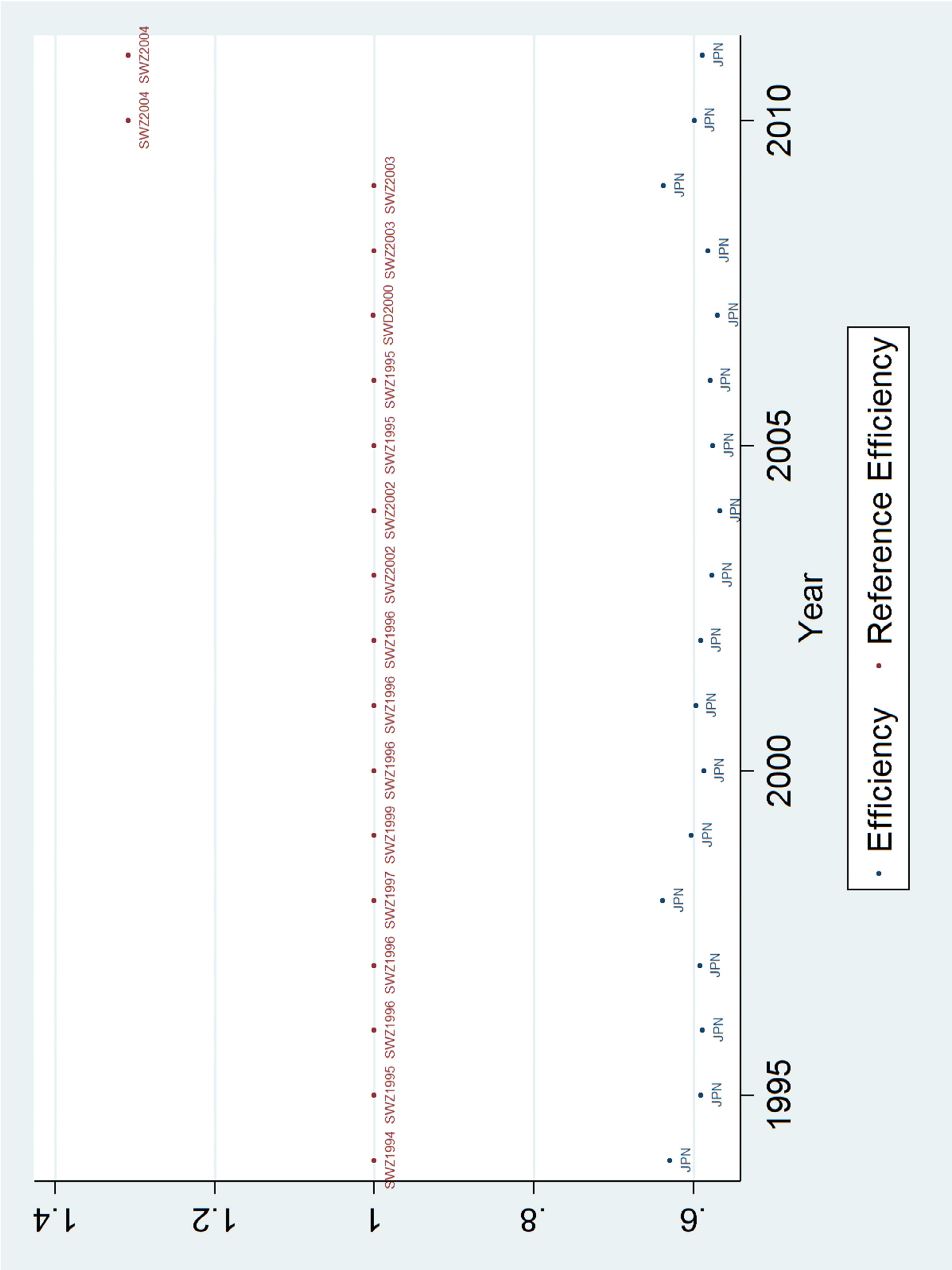
Efficiency of China over time



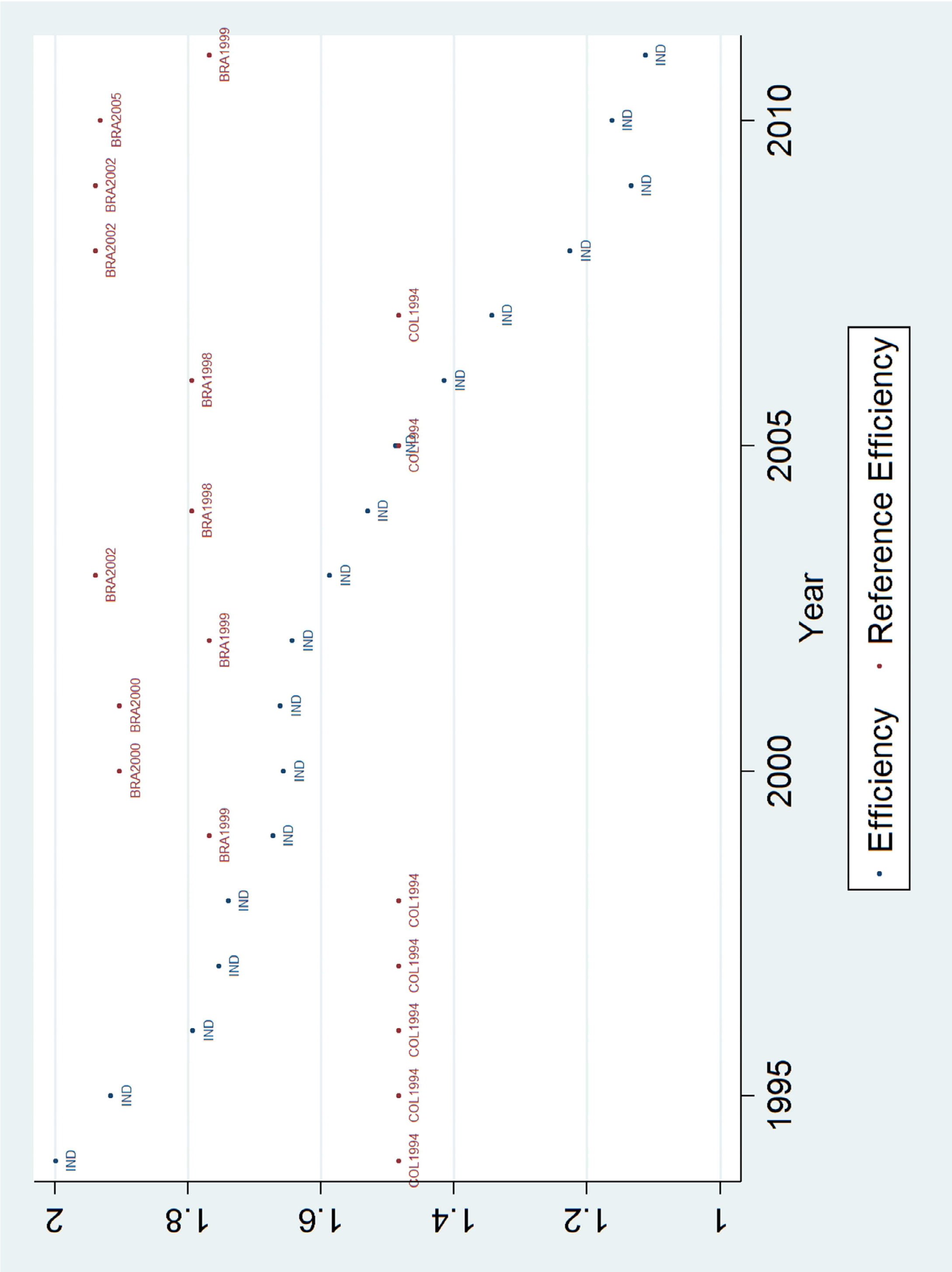
Efficiency of Republic of Korea over time



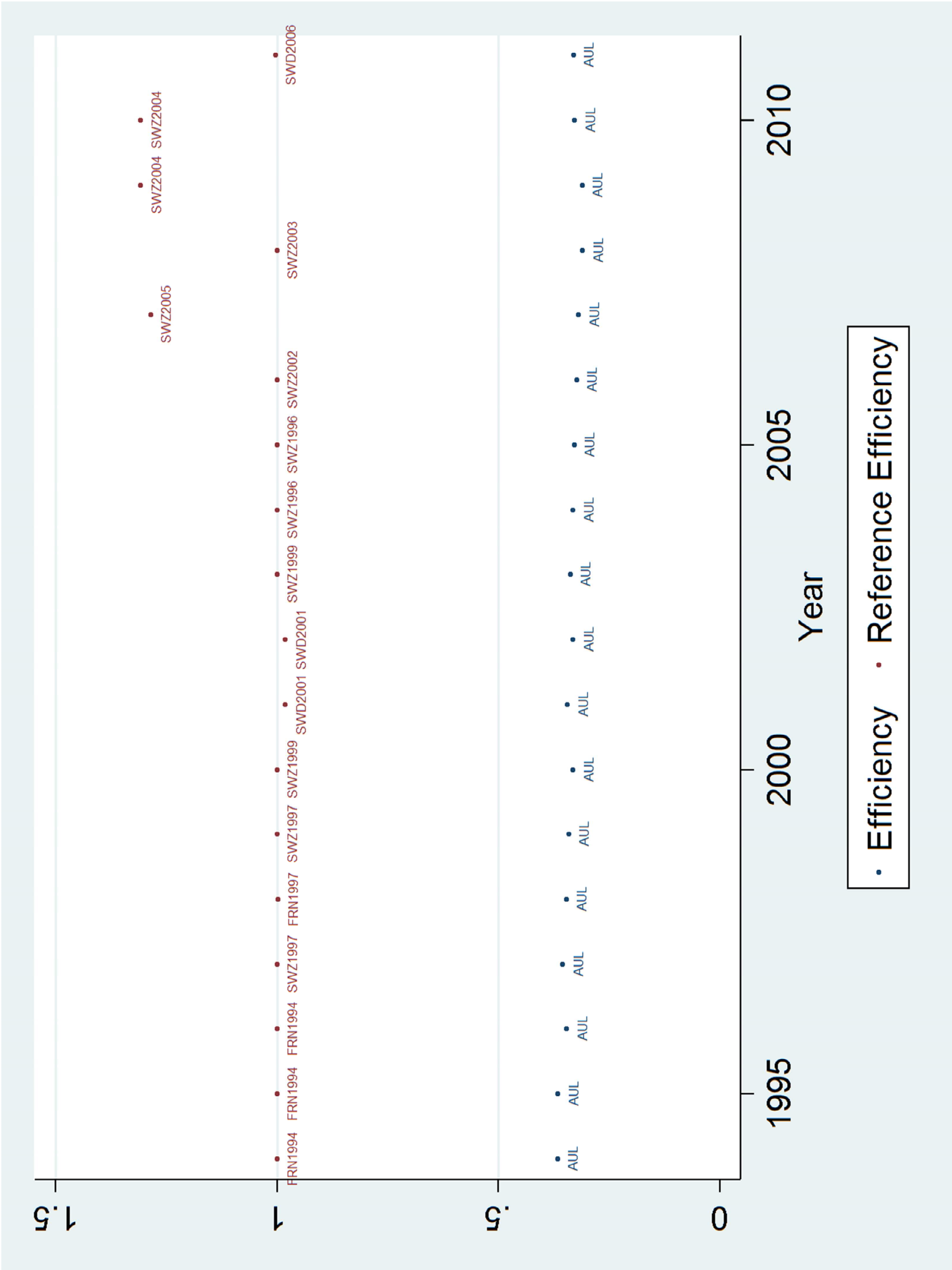
Efficiency of Japan over time



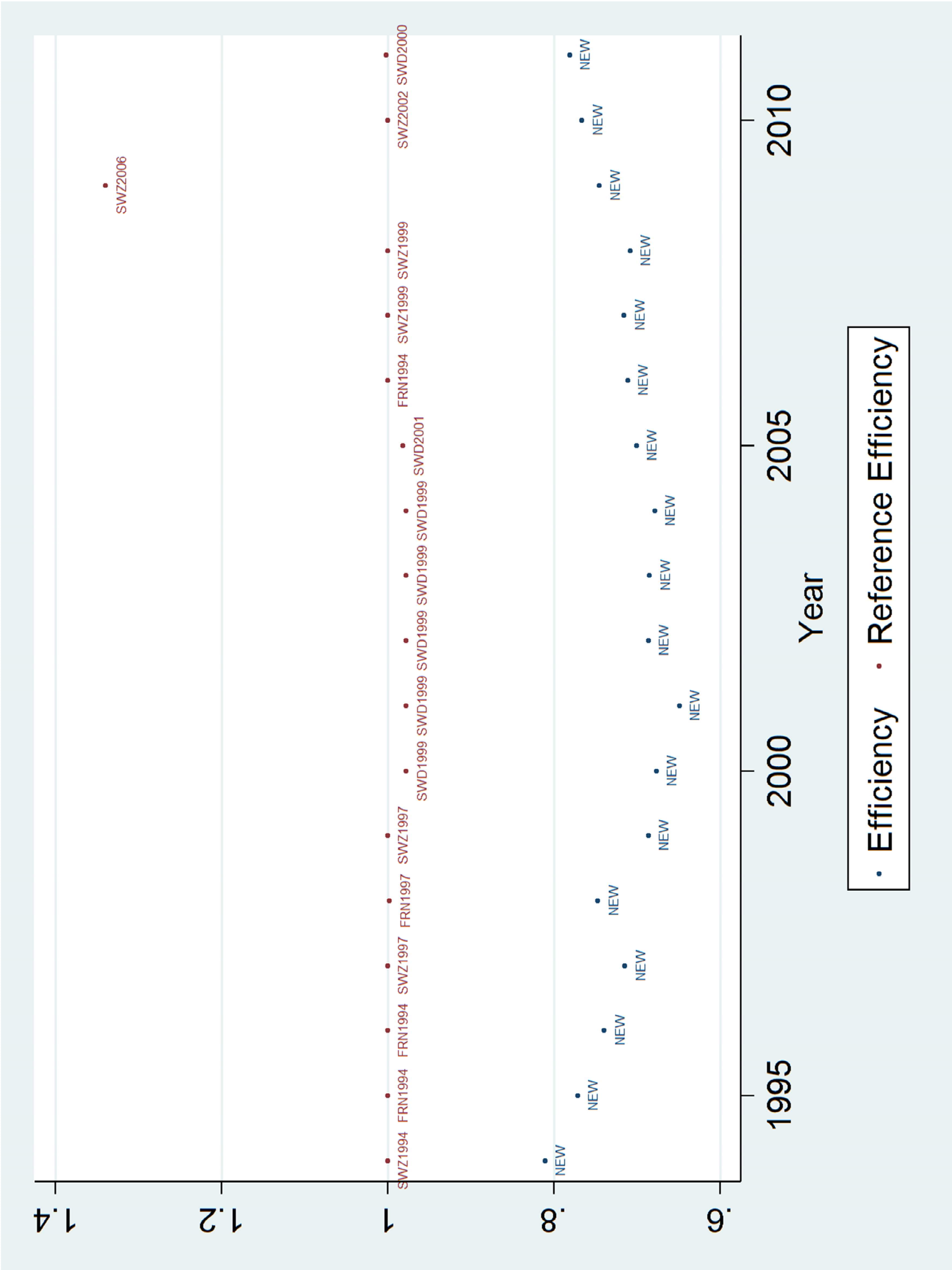
Efficiency of India over time



Efficiency of Australia over time



Efficiency of New Zealand over time



References for supplementary materials

Aidt T. (2005) The Rise of Environmentalism, Pollution Taxes, and Intra-Industry Trade. *Economics of Governance* 6(1): 1-12.

Bechtel M. and Leuffen D. (2010) Forecasting European Union Politics: Real-Time Forecasts in Political Time Series Analysis. *European Union Politics* 11(2): 309-327.

Beck N. (2001) Time-Series Cross-Section Data: What Have We Learned in the Past Few Years? *Annual Review of Political Science* 4(1): 271-293.

Beck N. and Katz J. (1995) What to do (and not to do) with Time-Series Cross-Section Data. *American Political Science Review* 89(3): 634-647.

Beck N. and Katz J. (1996) Nuisance vs. Substance: Specifying and Estimating Time-Series Cross-Section Models. *Political Analysis* 6(1): 1-36.

Beck T., Clarke G., Groff A., Keefer P. and Walsh P. (2001) New Tools in Comparative Political Economy: The Database of Political Institutions. *World Bank Economic Review* 15(1): 165-176.

Bernauer T., Böhmelt T. and Koubi V. (2013) Is There a Democracy-Civil Society Paradox in Global Environmental Governance? *Global Environmental Politics* 13(1): 88-107.

Bernauer T. and Koubi V. (2009) Effects of Political Institutions on Air Quality. *Ecological Economics* 68(4): 1355-1365.

Betsill M. (2002) Environmental NGOs Meet the Sovereign State: The Kyoto Protocol Negotiations on Global Climate Change. *Colorado Journal of International Environmental Law and Policy* 13(1): 49-64.

Betsill M. (2006) Transnational Actors in International Environmental Politics. In Betsill M., Hochstetler K. and Stevis D. (eds.), *Palgrave Advances in International Environmental Politics*. Houndsmill and New York: Palgrave Macmillan, 172-202.

Betsill M. and Corell E. (2001) NGO Influence in International Environmental Negotiations: A Framework for Analysis. *Global Environmental Politics* 1(4): 65-85.

Betsill M. and Corell E. (eds.) (2008) *NGO Diplomacy: The Influence of Nongovernmental Organizations in International Environmental Negotiations*. Cambridge, MA: MIT Press.

Binder S. and Neumayer E. (2005) Environmental Pressure Group Strength and Air Pollution: An Empirical Analysis. *Ecological Economics* 55(4): 527-538.

Böhmelt T. (2013) Civil Society Lobbying and Countries' Climate Change Policies – A Matching Approach. *Climate Policy* 13(5): 698-717.

Böhmelt T., Bernauer T. and Koubi V. (2015) The Marginal Impact of ENGOs in Different Types of Democratic Systems. *European Political Science Review* 7(1): 93-118.

Böhmelt T. and Betzold C. (2013) The Impact of Environmental Interest Groups in International Environmental Negotiations: Do ENGOs Induce Stronger Environmental Commitments? *International Environmental Agreements* 13(2): 127-151.

Budge I., Klingemann H., Volkens A., Bara J. and Tanenbaum E. (2001) *Mapping Policy Preferences: Estimates for Parties, Electors, and Governments 1945-1998*. Oxford: Oxford University Press.

Bueno de Mesquita B., Smith A., Silverson R. and Morrow J. (2003) *The Logic of Political Survival*, Cambridge, MA: MIT Press.

Cao X. and Prakash A. (2012) Trade Competition and Environmental Regulations: Domestic Political Constraints and Issue Visibility. *Journal of Politics* 74(1): 66-82.

Conconi P. (2003) Green Lobbies and Transboundary Pollution in Large Open Economies. *Journal of International Economics* 59(3): 399-422.

Engle R. and Granger C. (1987) Cointegration and Error Correction: Representation, Estimation, and Testing. *Econometrica* 55(2): 661-692.

Fredriksson P. and Ujhelyi G. (2006) *Political Institutions, Interest Groups, and the Ratification of International Environmental Agreements*. University of Louisville, KY: Typescript.

Gerring, J., Thacker S. and Moreno C. (2009) Are Parliamentary Systems Better? *Comparative Political Studies* 42(3): 327-359.

Guan W. et al. (2003) From the Help Desk: Bootstrapped Standard Errors. *Stata Journal* 3(1):71-80.

Gulbrandsen L. and Andresen S. (2004) NGO Influence in the Implementation of the Kyoto Protocol: Compliance, Flexibility Mechanisms, and Sinks. *Global Environmental Politics* 4(4): 54-75.

Henisz W. (2002) The Institutional Environment for Infrastructure Investment. *Industrial and Corporate Change* 11(2): 355-389.

International Union for Conservation of Nature (IUCN). (2006) *IUCN Membership Relations and Governance – Membership List*. Gland: IUCN.

Johansen S. (1988) Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control* 12(2-3): 231-254.

Keele L. and Kelly N. (2006) Dynamic Models for Dynamic Theories: The Ins and Outs of Lagged Dependent Variables. *Political Analysis* 14(2): 186-205.

Klingemann H., Volkens A., Bara J., Budge I. and McDonald M. (2006) *Mapping Policy Preferences II: Estimates for Parties, Electors, and Governments in Central and Eastern Europe, European Union, and OECD 1990-2003*. Oxford: Oxford University Press.

Kugler J. and Tammen R. (2012) *Performance of Nations*. Lanham, MD: Rowman and Littlefield.

Milesi-Ferretti G., Perotti R. and Rostagno M. (2002) Electoral Systems and Public Spending. *Quarterly Journal of Economics* 117(2): 609-657.

Newell P. (2000) Climate for Change: Non-State Actors and the Global Politics of the Greenhouse. Cambridge: Cambridge University Press.

Perkins R. and Neumayer E. (2007) Implementing Multilateral Environmental Agreements: An Analysis of EU Directives. *Global Environmental Politics* 7(3): 13-41.

Persson T. and Tabellini G. (2004) Constitutional Rules and Fiscal Policy Outcomes. *American Economic Review* 94(1): 25-45.

Persson T. and Tabellini G. (2005) *The Economic Effects of Constitutions*, Cambridge, MA: MIT Press.

Persson T., Roland G. and Tabellini G. (2007) Electoral Rules and Government Spending in Parliamentary Democracies. *Quarterly Journal of Political Science* 2(2): 155-188.

Plümper T., Troeger V. and Manow P. (2005) Panel Data Analysis in Comparative Politics: Linking Method to Theory. *European Journal of Political Research* 44(2): 327-354.

Raustiala K. (1997) States, NGOs, and Environmental Institutions. *International Studies Quarterly* 41(4): 719-740.

Scruggs L. (2003) *Sustaining Abundance: Environmental Performance in Industrial Democracies*. Cambridge: Cambridge University Press.

Tol R. (2012) Climate change will not precipitate peace (A response from Tol to Gartzke). *Journal of Peace Research* 49(1): 1-10.

Volkens A., Lehmann P., Merz N., Regel S. and Werner A. (2013) *The Manifesto Data Collection. Manifesto Project (MRG/CMP/MARPOR). Version 2013a*. Berlin: Wissenschaftszentrum Berlin für Sozialforschung (WZB).

Ward, H. and Cao X. (2012) Domestic and International Influences on Green Taxation. *Comparative Political Studies* 45(9): 1075-1103.

Ward M., Greenhill B. and Bakke K. (2010) The Perils of Policy by *p*-value: Predicting Civil Conflicts. *Journal of Peace Research* 47(4): 363-375.