UNIVERSIDAD DEL CEMA
Buenos Aires
Argentina

Serie
DOCUMENTOS DE TRABAJO

Área: Economía

A REASSESSMENT OF ARGENTINA´S GHG PROPOSED TARGET

Mariana Conte Grand y Vanesa D´Elia

Marzo 2011
Nro. 444

www.cema.edu.ar/publicaciones/doc_trabajo.html
UCEMA: Av. Córdoba 374, C1054AAP Buenos Aires, Argentina
ISSN 1668-4575 (impreso), ISSN 1668-4583 (en línea)
Editor: Jorge M. Streb; asistente editorial: Valeria Dowding <jae@cema.edu.ar>

A Reassessment of Argentina´s GHG Proposed Target

MARIANA CONTE GRAND
Universidad del CEMA

and

VANESA V. D´ELIA*
Universidad del CEMA

Abstract

At the time of Argentina´s greenhouse gases emissions reduction voluntary commitment, most of the articles on intensity targets had not been published. The aim of this paper is to (re)discuss briefly the proposal made by Argentina taking into account that literature. To justify the adopted target form and stringency, we compare fixed and dynamic targets in terms of the likelihood of "hot air", the relationship between allowed emissions and GDP, the link between abatement and GDP, and outcomes´ dispersion. But, the assumptions implicit in the design of the target may change those properties. We show how the BAU scenario taken as reference and the level of emissions reduction affects targets´ design and characteristics. Finally, considering different emissions projections, we perform a comparison between allowed emissions and projected ones during the first half commitment period (2008-2010), concluding that compliance with the commitment depends on the data source used in the calculations.

Keywords: climate change, intensity targets, uncertainty, Argentina

JEL: Q28, Q54

* Both authors: UCEMA, Department of Economics, Av. Córdoba 374, Buenos Aires (C1054AAP), Argentina. Phone: 54-11-6314-3000. Fax: 54-11-4314-1654. E-mail: **mcg@cema.edu.ar** and **vvd04@cema.edu.ar**. The opinions conveyed in this paper are attributable to the authors only, and are not necessarily endorsed by UCEMA.

I. Introduction

There is no doubt that anthropogenic greenhouse gases (GHG) emissions increase is one of the greatest challenges of this century. Both developed and developing countries contribute to it. In fact, the biggest emitter (including land use and forestry) is China (17%), in the second place are the United States (16.1%), and both were followed by Brazil, Indonesia, Russia, India and Japan (data for 2005, from WRI 2011). However, this ranking changes when historical emissions are considered. According to Baumert et al. (2005), United States leads with a 29.3% of measurable historical emissions (1850-2002), and is followed by Russia (8.1%) and China (7.6%). In both orderings, Argentina contributes less than 1% of total emissions, but this low percentage should be interpreted carefully as Argentina *is* included among the 25 largest emitters in WRI (2011).

In 1999, at the Fifth Conference of Parties (COP 5), Argentina announced an emissions reduction target (SAyDS, 1999). At that moment, this was an innovative event because it was the first time that a developing country had agreed to meet a voluntary quantified GHG limitation target. Argentina´s proposal pursued mainly two objectives (Barros and Conte Grand, 2002): trying to contribute to the ratification of the Kyoto Protocol in a context of a very difficult international negotiation process, and gain access to all the market mechanisms under the Protocol (and not only to the Clean Development Mechanism). In addition to being the first developing country to announce a GHG reduction, Argentina´s target originality was that it was linked to GDP. This means that it did not lock to a fixed emission level as the commitments adopted by developed countries under the Kyoto Protocol, but rather, allowed emissions to depend on economic development. Back in 1999, only a few publications had begun to discuss that kind of alternatives (see Baumert et al., 1999).[1]

The economic crisis in Argentina in 2002 and the subsequent change in the local government removed the proposal from the debate. The target was resisted by the new national authorities that were elected just before COP5. Part of that resistance derived from the opposite political sign of the new government, which was less willing to contribute to the United States claim that there should be “meaningful participation” of developing countries to abate carbon emissions. Another reason for abandoning the initiative came from the pressure of other developing countries which argumented that the target would be in conflict with development objectives. Nevertheless, the analysis of Argentina´s proposal remains a valuable exercise that can contribute to enrich academic discussions on emissions dynamic targets.

[1] Since 1999 the literature on intensity targets has flourished (Frankel 1999, Lutter 2000, Philibert and Pershing 2001, Kim and Baumert 2002, Ellerman and Sue Wing 2003, Kolstad 2005, Pizer 2005, Marschinski and Edenhofer 2010, to name a few).

When reading the more recent literature, there is a great emphasis on whether or not dynamic targets are superior to fixed ones. Formal assessments of those particularities have being studied in Ellerman and Sue Wing (2003), Kolstad (2005), Sue Wing et al. (2009) and Marschinski and Edenhofer (2010), for example. However, as several authors have already made clear, the superiority of intensity caps over absolute limits depends on "parameter values" (as explicitly noted in Marschinski and Edenhofer, 2010), on certain "conditions" (as pointed out in Sue Wing et al., 2009) or on "model assumptions" (as emphasized clearly by Tian and Whalley, 2009). This paper wants to contribute to that assertion by showing how the properties of Argentina´s intensity target do depend on its design. This refers to another dimension of uncertainty, the one related to the design of the target. As a secondary result, this article makes a preliminary assessment on what would be Argentina´s situation if the proposed target had been binding, and how would that state of affairs if certain key assumption had been different.

This paper is organized as follows. Section II discusses Argentina's proposal design. It compares allowed emissions and abatement resulting from fixed and alternative dynamic targets. This same section also deals with the targets´ characteristics in terms of the likelihood of "hot air", [2] the shape of the relationship between allowed emissions/emissions reductions and GDP, as well as the resulting dispersion between the levels of effort needed to comply with the commitment. Section III shows how targets´ properties change when the design implies different projections over emissions in the future, or when the stringency of the target varies. Finally, Section IV compares actual emissions with what would have been the allowed one if the target had been binding in the period 2008 to 2010 and Section V concludes.

II. Argentina´s GHG target design back in 1999

In 1997 Argentina presented its First National Communication (FNC) to UNFCCC, which included GHG inventories for 1990 and 1994 (SAyDS, 1997). During the years 1998 and 1999, the Secretariat of Environment and Sustainable Development of Argentina coordinated a technical team that defined a GHG target, which was announced during COP 5 in Germany.

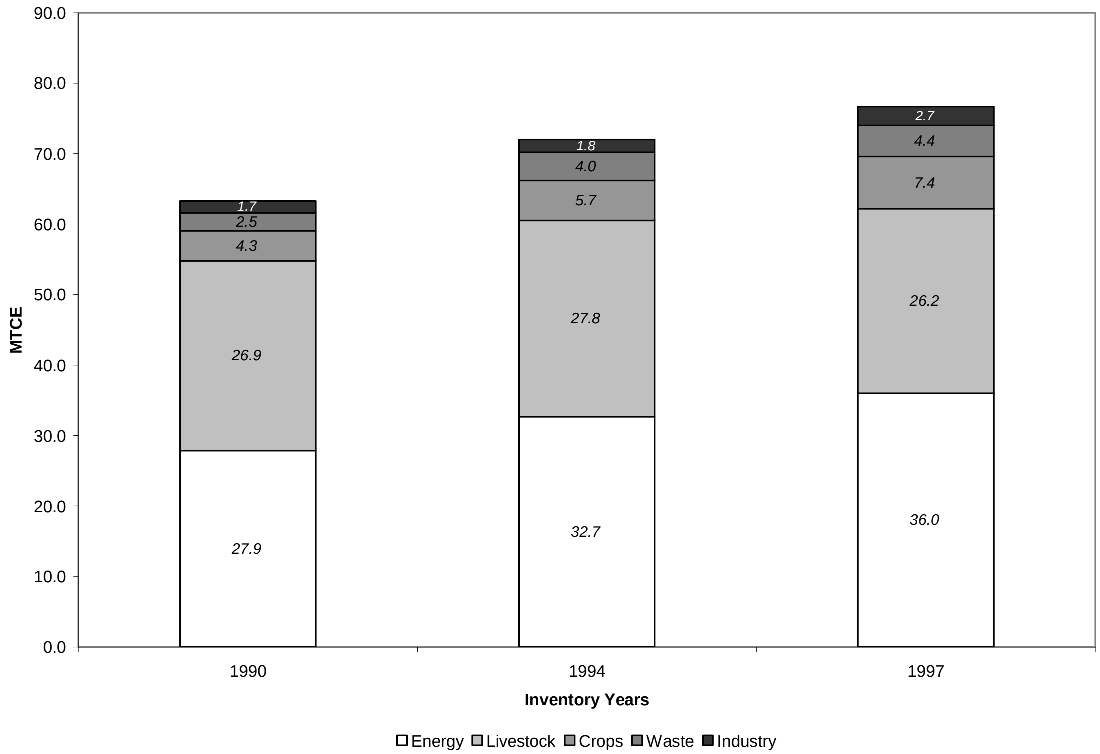
II. 1. Argentina´s GHG emissions

At the time of the target´s design, the most updated GHG inventory was the one included in the revised FNC (submitted to UNCCC in 1999), with a revision of the 1990 and 1994 inventories and

[2] The so-called "hot air" occurs when actual emissions turn out to be lower than the allowed ones (i.e., $A < 0$).

with a new inventory for the year 1997 (SAyDS, 1999). As is documented in SAyDS (1999) and Barros and Conte Grand (2002), Argentina´s 1997 GHG emissions were 76.8 Metric Tons of Carbon Equivalent (MTCE). The energy sector and agriculture sector represented jointly 91% of GHG emissions, while the rest of the emissions came from industry (3%) and waste generation (6%). Total emissions had increased 14% between 1990 and 1994, and 7% between 1994 and 1997 (see Figure 1).

Figure 1: Evolution of Argentina´s sectoral GHG emissions based on inventories



Source: Own elaboration based on SAyDS (1999).
Notes: The Energy sector does not include Energy emissions from the Agriculture sector, which are included under Crops. Industry includes HFCs, PFCs and SF6 in 1997.

GHG in Argentina are strongly linked to the activities that emit those gases. These activity levels, in turn, maintain a close relation with the country's macroeconomic evolution as measured by the GDP. However, the agricultural sector is not as strongly "coupled" to GDP as are the rest of the sectors (energy, industry and waste management). As stated in Barros and Conte Grand (2002, p.559), "This is in great part because Argentina is a country that is a price-taker (and "conditions-taker") in international markets of crops and livestock products, so the prosperity of this sector depends more on the ups and downs of those markets that on own domestic conditions." This means that it is possible to have years of expansion in the economy with a difficult situation in agriculture, as was the case between 1994 and 1997.[3]

II. 2. Target stringency and alternatives

The adoption of a target implies reducing (abating) emissions. This reduction can be written as:

$$A(t) = E_{BAU}(t) - E_P(t) \quad (1)$$

Where $A(t)$ is the reduction of emissions (or abatement), $E_{BAU}(t)$ are the projected "Business as Usual" (*BAU*) average 2008-2012 emissions and $E_P(t)$ are the permitted (or allowed) emissions to comply with the commitment.[4]

Adopting a target requires defining its *stringency* and its *form* (Herzog et al., 2006). In terms of its stringency, Argentina´s decision, based on its estimation of possible mitigation options, was to reduce 10% GHG levels with respect to the average 2008-2012 "more likely" *BAU* scenario. For the definition of the target, *BAU* emissions were estimated for nine alternative scenarios: three scenarios (high, middle and low growth) of the agriculture sector were combined with the three resulting scenarios of the economic sectors highly sensitive to *GDP* (energy, industry and waste management). The latter were based on projections of 2.3, 3.6 and 5.1 % average GDP growth rates from 1997 to 2012. Then, the scenario chosen as the reference ("more likely" scenario) was the middle GDP growth and high agricultural sector growth. Under that scenario, a reduction of 10% implies an annual average target of 11.165 MTCE for the period 2008-2012.

In terms of the target´s *metric (form)*, Argentina´s technical team considered several options: 1) a fixed target, 2) a linear emission intensity target and 3) a "square root" GDP related target.[5] In the first case, the target is expressed in term of absolute (or percentage) reductions. For the latter options, the target is "dynamic", since allowed emissions are indexed to *GDP*. As stated above, what was done in the case of Argentina was to define a $\lambda\%$ abatement with respect to the most likely (reference) *BAU* scenario for 2008-2012. Table 1 reports the formulae and conditions needed for all target alternatives to be equivalent to the same percentage reduction target. Note that

---

[3] From 1994 to 1997, GDP increased from 250,308 to 277,441 million 1993 Argentine pesos, while emissions from agriculture remained almost constant over that period (31.2, 33.5 and 33.6 MTCE for 1990, 1994 and 1997 respectively).

[4] Note that $E_P(t)$ is what the Kyoto Protocol calls "initial assigned amounts" while $E_{BAU}(t)$ are emissions in the Protocol (1990) base year. Hence "initial assigned amounts" are base year emissions minus the reduction target.

[5] There are other metrics that are now discussed in the literature. For example, the "indexed target" in Kim and Baumert (2002) or the "growth-indexed emission limit" in Ellerman and Sue Wing (2003). Nevertheless, as stated above in the text, at the time of the design of Argentina´s target, most of the articles dealing with intensity targets had not been published.

under dynamic targets, allowed emissions are positively linked to GDP (in general, it always hold that $\frac{\partial E_P}{\partial GDP} \geq 0$: the derivative is equal to zero for fixed targets and greater than zero for the intensity (I > 0) and the "square root" target $\left(\frac{K}{2 \cdot \sqrt{GDP}} > 0 \right)$.

Table 1. Allowed emissions formulae for each type of target

Target	E_P	***Conditions for equivalence with the percentage target****
Percentage	$(1-\lambda) \cdot E^R_{BAU}$	
Absolute	$E^R_{BAU} - \theta$	$\theta = \lambda \cdot E^R_{BAU}$
Intensity (basic formula)	$I \cdot GDP$	$I = \frac{(1-\lambda) \cdot E^R_{BAU}}{GDP^R}$
Square root	$K \cdot \sqrt{GDP}$	$K = \frac{(1-\lambda) \cdot E^R_{BAU}}{\sqrt{GDP^R}}$

*Notes: $0<\lambda<1$ is the percentage of reduction and θ is a fixed amount of emission reduction. * These conditions were determined by the combination of each target with the percentage reduction formula.*

Table 2 summarizes allowed emissions and emissions reductions for each type of target under the nine 2008-2012 *BAU* alternatives, calculated by combining equation (1) and the formulae in Table 1. The equivalence among targets is guaranteed only when there is certainty on what would be the *BAU* scenario. However, at the moment the target is designed, emissions in the future are uncertain. Hence, abatement levels required by each type of target would be different and so would be their properties.

As can be seen in Table 2, under a fixed target, there would be no effective commitment (i.e., $A < 0$) in the case of pessimistic scenarios (low growth of emissions linked to GDP and low or middle growth of agriculture sector emissions). In contrast, if the scenario were the most optimistic (high growth of emissions linked to GDP and of the agriculture sector), given E_P fixed at the level that meets the commitment of 10% reduction (11.165 MTCE), the required A would represent 18% of E_{BAU}. Therefore, on one hand, this alternative would have the disadvantages of risking "hot air" (achieving a fixed level of emissions might be extremely easy under low economic growth). On the other hand, achieving the fixed target might be extremely difficult under high economic growth (this occurs because A increases with increases in GDP). As a result, fixed allowed emission entail widely varying levels of emission reductions (a high dispersion) among the nine scenarios projections.

Table 2. Allowed emissions and Abatement under alternative scenarios

λ	10%	Fixed target	θ	11,165	Intensity	I	0.23	SquareRoot	K	151.5
Scenarios	E_{BAU} avg 2008 to 2012 MTCE*1000	E_P	A	*Eff.* λ	E_P	A	*Eff.* λ	E_P	A	*Eff.* λ
LowGDP-LowAgr	95,550	100,485	-4,935	-5%	85,210	10,340	11%	92,533	3,017	3%
MiddleGDP-MiddleAgr	105,200	100,485	4,715	4%	100,485	4,715	4%	100,485	4,715	4%
HighGDP-HighAgr	122,300	100,485	21,815	18%	121,280	1,020	1%	110,394	11,906	10%
LowGDP-MiddleAgr	95,950	100,485	-4,535	-5%	85,210	10,740	11%	92,533	3,417	4%
LowGDP-HighAgr	102,400	100,485	1,915	2%	85,210	17,190	17%	92,533	9,867	10%
MiddleGDP-LowAgr	104,800	100,485	4,315	4%	100,485	4,315	4%	100,485	4,315	4%
MiddleGDP-HighAgr	**111,650**	**100,485**	**11,165**	**10%**	**100,485**	**11,165**	**10%**	**100,485**	**11,165**	**10%**
HighGDP-LowAgr	115,450	100,485	14,965	13%	121,280	-5,830	-5%	110,394	5,056	4%
HighGDP-MiddleAgr	115,850	100,485	15,365	13%	121,280	-5,430	-5%	110,394	5,456	5%
Mean				6.1%			5.4%			6.0%
Standard Deviation				0.081			0.075			0.029

Notes: Effective λ denotes $A*100/E_{BAU}$*. Mean refers to the average of effective λ and Standard Deviation refers to the standard deviation of effective λ.*

These drawbacks of a fixed target led Argentina´s authorities to consider a second option: an emission intensity target. In this case, the target is dynamic instead of being fixed. The idea was that a target of this type would have the advantage -very valuable for a developing country like Argentina - that the greater the GDP, the greater would be the allowed emissions E_P, (since it allows more emissions to fast-growing economies and fewer emissions to contracting ones). Nevertheless, one of the disadvantages of this option is that it does not contemplate the fact that, as in the case in Argentina, the agriculture sector does not depend strictly on the GDP. As a consequence, adopting a target based on this index implied that *A* becomes greater when there is less growth (less GDP) and less strict the greater the GDP (i.e., *A* varies negatively with respect to GDP). As the target would be more severe in low economic growth situations and less strict in high economic growth scenarios, there could also be circumstances in which there would be no commitment (or "hot air"). As can be seen in Table 2, on one hand, effective commitments would involve effective reductions of between 11 and 17% of the BAU emissions in the low GDP scenarios but there would be "hot air" up to approximately 5% of the BAU emissions in the high GDP scenarios. This happens while the dispersion among scenarios remains almost constant (standard deviation among scenarios only changes from 0.081 to 0.075 when an intensity target –instead of a fixed target- is adopted).

All those characteristics of fixed and linear GDP targets (the presence of "hot air", the negative relationship between *A* and *GDP*, and the high dispersion) lead Argentina´s technical team to propose an alternative: a “square root target”. That type of target was a way to consider the fact that emissions in Argentina did not vary linearly with the GDP. Under the square root rule, as shown in Table 2, it remains valid that the greater the GDP, the greater would be allowed emissions. In addition, there would no be generation of “hot air” in any case, the target becomes more stringent in high growth scenarios (effective reductions of 10% or 11.9 thousand of MTCE in the high GDP-high agriculture Sector scenario) and less stringent in low growth scenarios (effective reductions of approximately 3% or 3 thousand MTCE in low GDP – low or middle agriculture sector-), and the dispersion would be considerably lower (standard deviation drops from 0.075 to 0.029).

II. 3. More on Argentina´s “square root” target metric

The “square root” formula caused some surprise back in 1999 since at that time the main discussion was around a directly proportional indexation between emissions and GDP (see Baumert et al., 1999). Alternatives target options in the last decade consider a less than proportionate indexation to GDP. More precisely, the general formula for an intensity target is now (see Kim and Baumert 2002 and Herzog et al., 2005):

$$E_p = Z \cdot GDP^{\beta} \tag{2}$$

where β determines the extent to which allowed emissions increase in response to GDP changes. If β = 1, as GDP increases, allowed emissions increase to the same extent. If β < 1, when GDP increases, allowed emissions increase at a lower rate.

The value of the indexation parameter (β) can be determined by econometric models. For example, Lutter (2000) modeling emissions with data for CO_2 in 86 countries as of function of 5-years lagged emissions, lagged GDP and lagged GDP per capita (all expressed in logarithms) and a constant, established a “universal” indexation parameter of 0.6. This means that a 1 % increase in *GDP* of a 5 years period is associated with a 0.6% increase in emissions over the subsequent 5 years period. Similarly, Jotzo and Pezzey (2007) using a 18-regions and countries simulation model derived an optimal degree of indexation less than one for most developing countries. Jotzo and Pezzey (2007) derive an indexation of 0.6 for the particular case of Argentina. Both studies are in line with the “square root” approach chosen by Argentina at the time its target was defined: a special case of the general emission intensity target with an indexation to *GDP* of 0.5.

Hence, nowadays, by simply using GHG emission data from 1990 to 2005, it is possible to reconfirm that result for Argentina by estimating the following simple logarithmic transformation of (1) by ordinary least squares:

$$\ln(E)_t = \alpha + \beta \cdot \ln(GDP)_t + \mu_t \qquad (3)$$

where $\beta = \dfrac{\partial \ln(E)_t}{\partial \ln(GDP)_t}$ is the GDP elasticity of emissions, α is a constant and μ_t is the error term that reflects all those factors (different from GDP) that affect GHG emissions.

Table 3. Regression analysis to reconfirm the validity of the square root rule

	Without LULUCF			With LULUCF		
	Coef.		Std. Error	Coef.		Std. Error
ln(GDP)	0.589	***	0.105	0.420	***	0.158
Cons	5.141	***	1.310	7.159	***	1.970
Adj R-squared		0.6688			0.2869	
N		16			16	

*Note: *** represents 1% statistical significance.*

As can be seen in Table 3, the elasticity coefficients go from about 0.4 to 0.6 in the model with and without LULUCF respectively. These results suggest that a parameter of 0.5 for GDP indexation (square root target) can still be considered adequate to adjust the evolution of emissions in Argentina.[6]

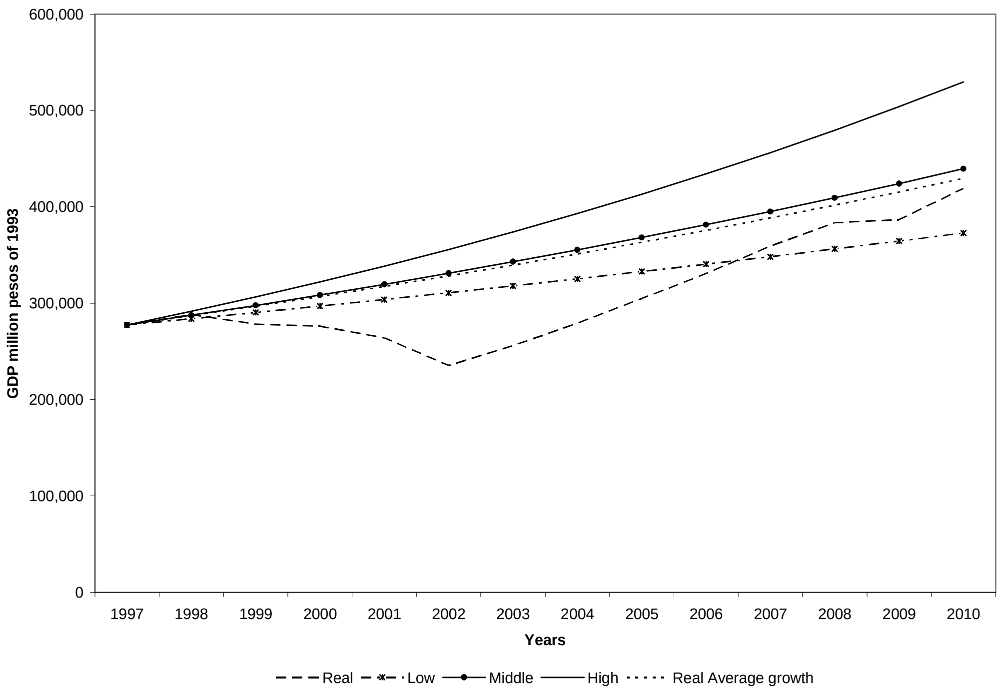
III. Consequences of changing key assumptions of the target design

In terms of GDP, Argentina projections from 1997 to 2012 are not so far from the observed evolution over the period 1997-2010. Figure 2 shows the Argentina's GDP in 1993 million of pesos together with the low (2.3%), middle (3.6%) and high (5.1%) growth scenarios projections. The 1997-2010 average annual growth is 3.4%, which lies between the low and middle scenarios (INDEC, 2011). This result supports the middle GDP reference scenario chosen for the target. Note that if Argentina´s institutional problems in 2001 and the world economic crisis in 2009 (both unexpected events in 1999) were excluded, the average growth over the period would have been considerably higher. Hence, it is possible to say that the target designer was relatively accurate with

[6] This result is confirmed by the nonparametric Spearman correlation coefficient with a ρ=0.80 (p-value=0.002) in the model without the LULUCF sector and a ρ=0.66 (p-value=0.002) in the other model.

respect to Argentina´s expected economic evolution, but not necessarily for the right reasons. Experts in charge of the target construction could have never forecasted the major 2009 economic crisis. It was almost by coincidence that the average GDP growth rate felt within the range of forecasted growth.

Figure 2. Argentina´s GDP: projections 1997 to 2010



Source: Own elaboration based on GDP projections (UCEMA, FIEL and FLACSO) and realized GDP (INDEC).

A question that derives from observing reality and forecast is what would have happened if another reference scenario had been taken as the "most likely". It may be the case that some of the target properties (regarding the possibility or not of "hot air" and eventually the dispersion among scenarios) may change.[7] If that was the case, the preference of one form of target over another metric may change. The importance of this analysis is that it refers to another dimension of uncertainty, not the ex-post dispersion, but the ex-ante lack of knowledge of economic development and emission path. The former refers to the fact that once the target is defined (based on the most likely growth scenario), economic development in the future is uncertain, hence under dynamic targets, the reduction effort is variable and unknown. The latter uncertainty refers to how the change

[7] The relationship between *A* and *GDP* does not change when other scenarios are taken as reference.

in the planner forecast of the most likely scenario affects the possible range of emissions reductions. The target functioning depends on actual outcomes *relative* to expectations at the time the target is set. More precisely, as it was shown in Table 1, the target functioning depends on both actual GDP and on the reference scenario chosen to set the target. So, different choices regarding the BAU scenario (and as detailed below, of the stringency parameter λ) affect the target design. To develop a sense of how important this issue could be, we simulate this dimension of uncertainty by varying the reference BAU scenario and λ.

IV.1. Reference scenarios

As it was shown above, with λ =10% and considering the middle GDP growth and high agriculture scenario as the reference (more likely) BAU scenario, Argentina's target takes the following form: $E_p = K \cdot \sqrt{GDP}$, with *K*= 151.5. But, it could have been the case that the scenario was not forecasted in this way by the technical team because they simply made a mistake in their "best guessing" procedure.

Table 4 shows, with the same stringency parameter (λ =10%) but changing the scenario taken as the reference, the number of situation for which "hot air" arises and the standard deviation of the effective effort (Appendix A shows these results in the same format as Table 2). This is useful to compare how those two main characteristics (of each type of target) change when the other scenarios (different from middle GDP and high agriculture) are projected as the most probable in the future.

It is clear from Table 4 that, if the target planner chooses a different scenario, "hot air" still appear (but for different rules). In particular, there would be "hot air" under the fixed target rule if a high GDP had been forecasted and "hot air" would appear only under a linear intensity target if low GDP scenarios had been taken as the reference. Under the "square root" rule "hot air" would have not occurred in any case even if the planner had been mistaken in terms of what was the most likely scenario.

Seconly, we find that the ranking of dispersion in reduction efforts among the three targets is robust to changes of the reference scenario from middle GDP to high GDP. But, that is not the case when low GDP scenarios are taken as the most likely. In effect, as can be seen in Table 4, intensity target standard deviation is higher than under the fixed target when low GDP growth is projected as the most likely situation. This result is in line with those who argue that intensity targets *do not always* reduce uncertainty (Sue Wing et al. 2009 and Marschinski and Edenhofer

2010, for example). More precisely, in some circumstances (if emissions and GDP are weakly positively correlated or the uncertainty about future GDP is much larger than the uncertainty about future emissions), fixed targets could produce less variance in outcomes than intensity caps. This is what can be occurring in the case of Argentina, because as stated above the agriculture sector plays a strong role in emissions, but its evolution depends more on weather and other conditions than on the country´s own economic development.

Table 4. Summary indicators of sensitivity of targets to the reference scenario

Reference Scenario/Target	Fixed		Intensity		Sq.Root	
	"Hot air" Cases	*StdDev Effort*	*"Hot air" Cases*	*StdDev Effort*	*"Hot air" Cases*	*StdDev Effort*
LowGDP-LowAgr		0.0690	3	0.0755		0.0270
LowGDP-MiddleAgr		0.0693	3	0.0758		0.0271
LowGDP-HighAgr		0.0739	5	0.0809		0.0289
MiddleGDP-LowAgr		0.0757		0.0702		0.0272
MiddleGDP-MiddleAgr		0.0760		0.0705		0.0273
MiddleGDP-HighAgr	***2***	***0.0806***	***2***	***0.0748***		***0.0290***
HighGDP-LowAgr	3	0.0834		0.0641		0.0273
HighGDP-MiddleAgr	3	0.0836		0.0643		0.0274
HighGDP-HighAgr	5	0.0883		0.0679		0.0289

Nevertheless, it can be affirmed that while fixed and intensity targets´ properties (regarding the presence or lack of hot air and the dispersion of the effective reduction) change when different scenarios are taken as the most likely, this is not the case for the “square root” type target. Its properties (lack of hot air, lower effort dispersion among probable future scenarios, a positive relationship between allowed emissions and GDP and between emissions reduction and GDP) are maintained even if the target designer mistakenly chooses a different scenario than the one chosen by Argentina´s target team in 1999. Again, this is consistent with the literature since, as shown in Ellerman and Sue Wing (2003) and Sue Wing et al. (2009), generalized intensity targets (which link emissions to GDP with an elasticity less than 1, as is the case of the Argentinean “square root” target) always reduce uncertainty with respect to fixed targets provided there is a positive correlation between emissions and GDP.

Finally, these results confirm also the point raised by Marschinski and Edenhofer (2010) that the probability of “hot air” is larger for the target that exhibits higher variance. Here, when low GDP scenarios are taken as the reference ones, uncertainty is larger under intensity targets than under fixed targets, and it is possible to see that some “hot air” situations happens under the intensity target and not under the fixed target. Moreover, since in our particular case, to avoid "hot air", the following conditions have to hold for fixed, intensity and "square root" targets respectively:

$$\begin{aligned}
&\frac{E_{BAU}}{E^{R}_{BAU}} > (1-\lambda);\\
&\frac{E_{BAU}}{E^{R}_{BAU}} > (1-\lambda)\cdot\frac{GDP_{BAU}}{GDP^{R}_{BAU}};\\
&\frac{E_{BAU}}{E^{R}_{BAU}} > (1-\lambda)\cdot\sqrt{\frac{GDP_{BAU}}{GDP^{R}_{BAU}}},
\end{aligned} \tag{4}$$

We confirm that if the uncertainty about future GDP is much higher than uncertainty about future emissions (intuitively, this means that the deviation of GDP_{BAU} with respect to GDP^{R}_{BAU} is higher than that of E_{BAU} with respect to E^{R}_{BAU}), then a coupling of the target to GDP will introduce more new uncertainty than can be reduced. However, as stated in Sue Wing et al. (2009), we also find here that the (β=1/2) parameter contributes to avoid "hot air" since it reduces the likelihood of finding hot air by neutralizing the uncertainty with respect to future GDP (the right-hand side term of the above equation).

III.2. Level of the Target

Regarding the level of the target, as has been mentioned above, the decision of the Argentine government had been to adopt a reduction of 10% of GHG emissions with respect to the BAU scenario (middle GDP- high Agriculture growth). There are two main reasons for this decision: the first one had to do with the fact that the options for mitigation that were studied would enable the fulfillment of that commitment. The second motive is that this 10% reduction results in a positive relationship between *A(t)* and *GDP(t)* (and entails no possibility of "hot air"). As stated in Barros and Conte Grand (2002, p. 567-568) if, for example, a mitigation of only 5% were made with respect to the reference scenario, the target would not be valid since there would be no effective commitment (except in the most optimistic scenario) scenario.

To be here more precise, in order to fulfill the $A > 0$ condition, λ has to satisfy the following conditions for fixed, intensity and "square root" targets respectively:

$$\lambda > 1 - \frac{E_{BAU}}{E_{BAU}^{R}}$$
$$\lambda > 1 - \frac{E_{BAU}}{E_{BAU}^{R}} \cdot \frac{GDP^{R}}{GDP} \qquad (5)$$
$$\lambda > 1 - \frac{E_{BAU}}{E_{BAU}^{R}} \cdot \sqrt{\frac{GDP^{R}}{GDP}}$$

Hence, the required λ in order to avoid "hot air" changes according to $\frac{E_{BAU}}{E_{BAU}^{R}}$ and $\frac{GDP^{R}}{GDP}$, and so they will be different for different reference scenarios. But, it will also change depending on the metric used for the target, as is made clear by the different equations in (5). For example, for the most optimistic reference scenario, $\frac{E_{BAU}}{E_{BAU}^{R}}<1$ and $\frac{GDP^{R}}{GDP}>1$. When the square root is applied, the GDP relationship in the square root rule is lower than that of the intensity rule, so λ needs to be higher under the square root rule than under the intensity one.

Now, for the case of Argentina, for the fixed target condition (5) requires that λ > 14.42% under the reference scenario. For the most pessimist scenario, the condition is met for any λ > 0, while for the most optimistic, the condition is fulfilled for λ > 21.87%. For the intensity target, in order to avoid "hot air", the following inequalities have to hold: λ > 14.33% for the reference scenario, λ > 15.11%, for the most pessimist scenario, and λ > 5.60% for the most optimistic situation. Finally, for the "square root" rule, the no "hot air" condition requires that λ > 7.07% for the reference scenario, the condition is met for any λ > 0 for the most pessimist scenario, while for the most optimistic it holds for λ > 6.79%.

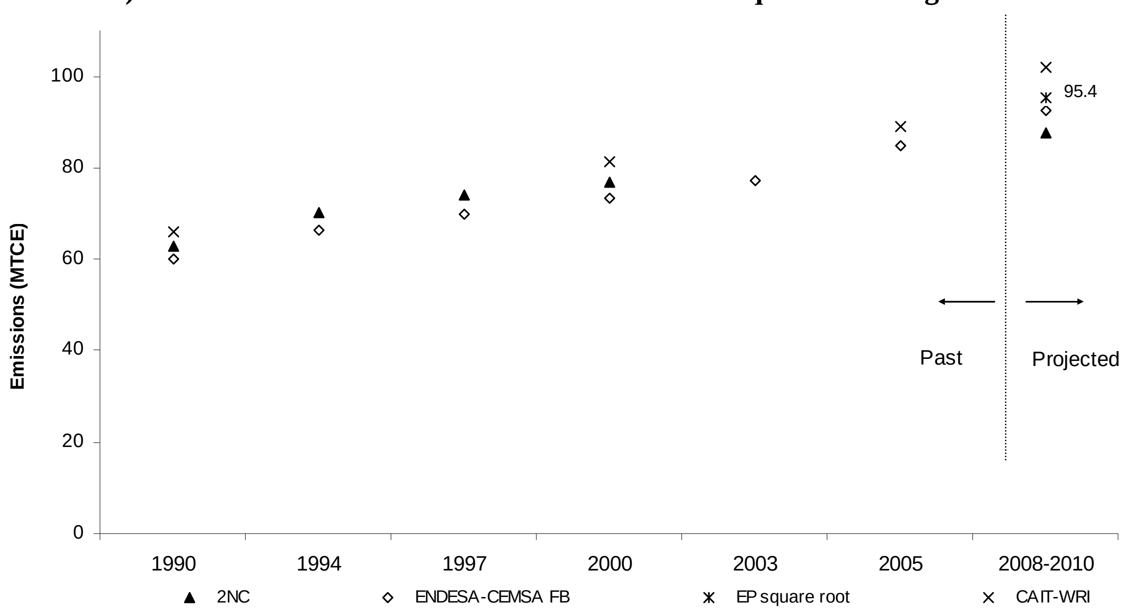
In summary, the characteristics of the "square root" target regarding "hot air" were sensible to the level of the stringency chosen, but this was again not the case for the condition that links positively emissions reductions and GDP. While more precisely stated here, this weakness of the Argentina´s target was known and already pointed out in Barros and Conte Grand (2002). This point also appears in the related literature. In effect, as Marschinski and Edenhofer (2010) make clear, target probabilities of generating "hot air" is smaller the more stringent is the reduction envisaged by that target.

IV. Argentina´s GHG emissions evolution and the proposed target

As stated above, Argentina ultimately abandoned its proposal for multiple reasons. However, an interesting question is to explore what would have happened if the target had been binding.

Regarding the evolution of emissions, Argentina´s authorities presented the Second National Communication (2NC) to the UNFCCC in March 2008 (SAyDS, 2008). This communication contains GHG inventory information for the year 2000, and small readjustments of the 1990, 1994 and 1997 emissions.[8] There is more than a 5 years lag in GHG emissions inventories. Although there are no official figures for current emissions, there are estimations from a private study over the period 1990-2005 (see Proyecto Endesa-Cemsa/Fundación Bariloche, 2008). Reported emissions from the two alternative sources are in line with those in CAIT-WRI (Climate Analysis Indicator Tool, Version 8.0). For example, emissions reported in the 2NC, in the the study of Fundación Bariloche (FB), and the CAIT-WRI database for the year 2000 are 76.9, 73.2 and 81.4 MTCE respectively. Figure 3 shows the differences in past emissions among the alternative sources.

Figure 3. Alternative calculations for Argentina´s GHG emissions (all gases without LUCLUFs) and allowed emissions for 2008-2010 under the square root target



Note: Own elaboration based on data of 2NC (2008), ENDESA-CEMSA, FB(2008) and CAIT-WRI (version 8.0).

[8] In accordance with UNFCCC recommendations and with IPCC guidelines, emissions in the Second National Communication were measured in Gg of CO_2 equivalent instead of MTCE as was the case in the previous inventories. Here, to maintain homogeneity in units, we express emissions in terms of MTCE, where 1 Gg CO_2 equivalent=1000*MTCE*44/12.

However, it is possible to show in the same graph how much would have been the average annual allowed emissions for 2008-2012 if the target had been binding. Knowing the GDP for 2008, 2009 and 2010, it is possible to calculate average allowed emissions for those three years: 95.4 MTCE. As can be seen in Figure 3, if over the period 2008-2010 Argentina´s GHG emissions follow the trend given CAIT-WRI, there could be a strong risk of not fulfilling the target when the commitment period arrives (projected emissions are 101.9 MTCE, greater than the allowed emissions under the square root target). However, if the average annual emissions are forecasted using inventories built with local data (as the 2NC and FB), the commitment (if binding) could be met (projected emissions are 87.5 MTCE and 92.4 MTCE respectively).[9]

Finally, if the technical team in charge of planning the target had taken a different scenario as the most likely, emissions projected based on the 2NC would always be below the allowed ones, emissions predicted based on CAIT-WRI would always be above the GDP related emissions by under the square root rule, while FB estimated emissions will be above or below the allowed ones depending on which was the scenario taken as the most likely one.

V. Conclusions

Argentina is among the 25 largest contributors to climate change, despite its participation of less than 1% in overall GHG emissions. In part because of that, Argentina proposed a voluntary GHG reduction target to the Conference of the Parties of the United Nations Climate Change Convention in 1999. Argentina´s target was an innovation at the time it was formulated, since it was the first time a developing country proposed to commit to a quantifiable GHG reduction. But also because its target was linked to GDP and as a result the higher/lower the GDP, the greater/smaller would be allowable emissions. It was pointed out that Argentina´s target had two additional characteristics: its metric would not represent a restriction for the country's development (required abatement would be lower in low economic growth situations and more stringent in high economic growth scenarios) and it would eliminate the possibility of "hot air".

However, when reconsidering the target after some time, it is now clear that all the supposedly attractive properties of Argentina´s target vis a vis a fixed and a linear intensity target are robust to changes in its main parameter values or model assumptions. However, what *do* vary (when some parameters are modified) are the relative properties of fixed and linear intensity rules. More specifically, for the case of Argentina, it was shown that the possibility of having hot air

[9] It is important to mention that the forecast based on the FB trend is more robust than the others since, due to information availability, this projection considers more observations (16 observations of GHG emissions against 4 observations for 2NC and 3 for CAIT-WRI).

under fixed and intensity targets *do* depend on the choice of a particular baseline scenario. In particular, negative abatement occur under low GDP scenarios for the fixed target while hot air arise under high GDP reference scenarios for the simple intensity format. Related to this issue, depending on the scenario taken as the most likely, the dispersion of effective reduction resulting from fixed and intensity targets can be lower or higher. In other words, if low GDP scenarios were taken as reference, an intensity target would result in higher dispersion in effective efforts than under a fixed target. While this happens, "square root" target properties (lack of hot air, a lower effort dispersion among probable future scenarios with respect to fixed and intensity targets, a positive relationship between allowed emissions and GDP and between emissions reduction and GDP) are maintained even if the target designer mistakenly chooses a different scenario than the one chosen in 1999. Finally, as was already acknowledged in Barros and Conte Grand (2002), the properties of the square root target (in particular, the appearance of hot air) *are* sensitive to the level of stringency chosen (i.e, the proposed annual average emissions reduction for 2008-2012). What we document here with more detail is the extent of that sensitivity.

Despite those allegedly positive aspects, Argentina never pursued the intention to adopt a GHG target beyond the COP 5 meeting. Hence, it cannot be discussed how it actually worked in reality. The country's exact amount of what would have been allowable emissions under the target will only be known several years past the end of the period 2008-2012, since there is a 5 year lag in Argentina´s GHG inventories. Notwithstanding, taking "middle commitment period year" projections (2010), it has been shown that there would be a risk of not fulfilled the commitment (if binding) when using national data (Argentina´s National Communication and a study from a local institution -Fundación Bariloche-), but this is not the case when the trend is calculated using international data (WRI-CAIT). Maintaining the square root rule, but changing the reference scenario, this results is not as robust since emissions projections using local data in some cases are higher than the limit imposed by the square root target calculated for the average 2008-2010 GDP. Once again, it is possible to assess that targets do depend on design assumptions.

There is no doubt that revisiting Argentina´s proposal after a decade has passed since it was designed, and after the literature on intensity targets has evolved, represents a concrete and valuable exercise that contributes to the study of emissions targets.

References

Barros V. and M. Conte Grand (2002), "Implications of a Dynamic Target of GHG emissions reduction: the case of Argentina", *Environment and Development Economics* 7: 547-569.

Baumert K. R. Bhandari, and N. Kete (1999), “What might a developing country climate commitment look like?, World Resources Institute, Washington D.C.

Baumert, K., T. Herzog, and J. Pershing (2005),“Navigating the Numbers: Greenhouse Gas Data and International Climate Policy”. Washington, D.C.: World Resources Institute.

Elleman A.D. and, I. Sue Wing (2003), “Absolute versus intensity-based emission caps”, *Climate Policy* 3 (Supplement 2): S7-S20.

Frankel J. (1999), "Greenhouse Gas Emissions", Policy Brief no. 52, The Brookings Institution, Washington, DC, June 1999.

Fundación Bariloche (2008), *Argentina: Diagnóstico, Prospectivas y lineamientos para definir Estrategias posibles ante el Cambio Climático*, Proyecto Endesa-Cemsa, Buenos Aires, Argentina.

Herzog T., K. Baumert, and J. Pershing (2006), *“Target: Intensity. An analysis of Greenhouse Gas Intensity Targets”*, World Resources Institute, Washington D.C.

INDEC (2011), Series of Gross Domestic Product. Available at http://www.indec.gov.ar (last accessed January 2011).

Jotzo F. and, C.V. Pezzey (2005), “Optimal intensity targets for emissions trading under uncertainty”, Economics and Environment Network Working Paper N° 41, Australian National University.

Kim, Y-G, y K. Baumert. (2002), “Reducing Uncertainty through Dual Intensity Targets. In Building on the Kyoto Protocol: Options for Protecting the Climate”, edited by K. Baumert et al. Washington, D.C.: World Resources Institute.

Kolstad C. (2005), “The Simple Analytics of Greenhouse Gas Intensity Reduction Targets,” *Energy Policy*, 33:2231-36.

Lutter R. (2000), “Developing countries´ greenhouse emissions: uncertainty and implications for participation in the Kyoto Protocol”. *Energy Journal* 21 (4): 93-120.

Marschinski R. and, O. Edenhofer (2010), “Revisiting the case for intensity targets: Better incentives and less uncertainty for developing countries”, *Energy Policy* 38 (9): 5048-5058.

Philibert and Pershing (2001), “Considering the Options: Climate Targets for All Countries”, Climate Policy 1: 211-227.

Pizer, W. (2005), “The Case for Intensity Targets”, RFF Discussion Paper 05-02. Washington, D.C.

SAyDS (1997), Primera Comunicación Nacional de la República Argentina, Secretaría de Ambiente y Desarrollo Sustentable. Available at http://www.ambiente.gov.ar/?idarticulo=5340 (last accessed January 2011).

SAyDS (1999), Revision of the First National Communication. Available at http://unfccc.int/resource/docs/natc/argnc1e.pdf (last accessed January 2011).

SAyDS (2008), Segunda Comunicación Nacional del Gobierno de la República Argentina, Secretaría de Ambiente y Desarrollo Sustentable. Available at http://www.ambiente.gov.ar/?idarticulo=1124 (last accessed March 2011).

Sue Wing, I., A.D. Ellerman and J.M. Song (2009), "Absolute vs. Intensity Limits for CO2 Emission Control: Performance Under Uncertainty", in H. Tulkens and R. Guesnerie (eds.), The Design of Climate Policy, MIT Press, 221-252.

Tian, H. and, J. Whalley (2009), "Level versus equivalent intensity carbon mitigation commitments". NBER Working Paper N° 15370, September.

WRI (2011), Climate Analysis Indicators Tool (CAIT). Version 8.0. Word Resources Institute, Washington D.C. Available at http://cait.wri.org (last access: January 2011).

Annex

Table A.1. Sensitivity of targets to the reference scenario

λ	*10%*	*Fixed target*	*θ*	*9,555*	*Intensity*	*I*	*0.23*	*SquareRoot*	*K*	*140.8*
Scenarios	E_{BAU} avg 2008 to 2012 MTCE*1000	*E_P*	*A*	*Eff. λ*	*E_P*	*A*	*Eff. λ*	*E_P*	*A*	*Eff. λ*
LowGDP-LowAgr	***95,550***	***85,995***	***9,555***	***10%***	***85,995***	***9,555***	***10%***	***85,995***	***9,555***	***10%***
MiddleGDP-MiddleAgr	105,200	85,995	19,205	18%	101,411	3,789	4%	93,385	11,815	11%
HighGDP-HighAgr	122,300	85,995	36,305	30%	122,398	-98	0%	102,594	19,706	16%
LowGDP-MiddleAgr	95,950	85,995	9,955	10%	85,995	9,955	10%	85,995	9,955	10%
LowGDP-HighAgr	102,400	85,995	16,405	16%	85,995	16,405	16%	85,995	16,405	16%
MiddleGDP-LowAgr	104,800	85,995	18,805	18%	101,411	3,389	3%	93,385	11,415	11%
MiddleGDP-HighAgr	111,650	85,995	25,655	23%	101,411	10,239	9%	93,385	18,265	16%
HighGDP-LowAgr	115,450	85,995	29,455	26%	122,398	-6,948	-6%	102,594	12,856	11%
HighGDP-MiddleAgr	115,850	85,995	29,855	26%	122,398	-6,548	-6%	102,594	13,256	11%
λ	*10%*	*Fixed target*	*θ*	*12,230*	*Intensity*	*I*	*0.21*	*SquareRoot*	*K*	*151.1*
Scenarios	E_{BAU} avg 2008 to 2012 MTCE*1000	*E_P*	*A*	*Eff. λ*	*E_P*	*A*	*Eff. λ*	*E_P*	*A*	*Eff. λ*
LowGDP-LowAgr	95,550	110,070	-14,520	-15%	77,333	18,217	19%	92,261	3,289	3%
MiddleGDP-MiddleAgr	105,200	110,070	-4,870	-5%	91,197	14,003	13%	100,190	5,010	5%
HighGDP-HighAgr	***122,300***	***110,070***	***12,230***	***10%***	***110,070***	***12,230***	***10%***	***110,070***	***12,230***	***10%***
LowGDP-MiddleAgr	95,950	110,070	-14,120	-15%	77,333	18,617	19%	92,261	3,689	4%
LowGDP-HighAgr	102,400	110,070	-7,670	-7%	77,333	25,067	24%	92,261	10,139	10%
MiddleGDP-LowAgr	104,800	110,070	-5,270	-5%	91,197	13,603	13%	100,190	4,610	4%
MiddleGDP-HighAgr	111,650	110,070	1,580	1%	91,197	20,453	18%	100,190	11,460	10%
HighGDP-LowAgr	115,450	110,070	5,380	5%	110,070	5,380	5%	110,070	5,380	5%
HighGDP-MiddleAgr	115,850	110,070	5,780	5%	110,070	5,780	5%	110,070	5,780	5%

Note: E_{BAU}, E_P and A are expressed in MTCEx1000.

λ	10%	Fixed target	θ	10,520	Intensity	I	0.22	SquareRoot	K	142.7
Scenarios	E_{BAU} avg 2008 to 2012 MTCE*1000	E_P	A	Eff. λ	E_P	A	Eff. λ	E_P	A	Eff. λ
LowGDP-LowAgr	*95,550*	*94,680*	*870*	*1%*	*80,287*	*15,263*	*16%*	*87,187*	*8,363*	*9%*
MiddleGDP-MiddleAgr	**105,200**	**94,680**	**10,520**	**10%**	**94,680**	**10,520**	**10%**	**94,680**	**10,520**	**10%**
HighGDP-HighAgr	122,300	94,680	27,620	23%	114,274	8,026	7%	104,017	18,283	15%
LowGDP-MiddleAgr	95,950	94,680	1,270	1%	80,287	15,663	16%	87,187	8,763	9%
LowGDP-HighAgr	102,400	94,680	7,720	8%	80,287	22,113	22%	87,187	15,213	15%
MiddleGDP-LowAgr	104,800	94,680	10,120	10%	94,680	10,120	10%	94,680	10,120	10%
MiddleGDP-HighAgr	111,650	94,680	16,970	15%	94,680	16,970	15%	94,680	16,970	15%
HighGDP-LowAgr	115,450	94,680	20,770	18%	114,274	1,176	1%	104,017	11,433	10%
HighGDP-MiddleAgr	115,850	94,680	21,170	18%	114,274	1,576	1%	104,017	11,833	10%

λ	10%	Fixed target	θ	9,595	Intensity	I	0.23	SquareRoot	K	141.4
Scenarios	E_{BAU} avg 2008 to 2012 MTCE*1000	E_P	A	Eff. λ	E_P	A	Eff. λ	E_P	A	Eff. λ
LowGDP-LowAgr	95,550	86,355	9,195	10%	86,355	9,195	10%	86,355	9,195	10%
MiddleGDP-MiddleAgr	105,200	86,355	18,845	18%	101,836	3,364	3%	93,776	11,424	11%
HighGDP-HighAgr	122,300	86,355	35,945	29%	122,911	-611	0%	103,024	19,276	16%
LowGDP-MiddleAgr	***95,950***	***86,355***	***9,595***	***10%***	***86,355***	***9,595***	***10%***	***86,355***	***9,595***	***10%***
LowGDP-HighAgr	102,400	86,355	16,045	16%	86,355	16,045	16%	86,355	16,045	16%
MiddleGDP-LowAgr	104,800	86,355	18,445	18%	101,836	2,964	3%	93,776	11,024	11%
MiddleGDP-HighAgr	111,650	86,355	25,295	23%	101,836	9,814	9%	93,776	17,874	16%
HighGDP-LowAgr	115,450	86,355	29,095	25%	122,911	-7,461	-6%	103,024	12,426	11%
HighGDP-MiddleAgr	115,850	86,355	29,495	25%	122,911	-7,061	-6%	103,024	12,826	11%

λ	10%	Fixed target	θ	10,240	Intensity	I	0.25	SquareRoot	K	150.9
Scenarios	E_{BAU} avg 2008 to 2012 MTCE*1000	E_P	A	Eff. λ	E_P	A	Eff. λ	E_P	A	Eff. λ
LowGDP-LowAgr	95,550	92,160	3,390	4%	92,160	3,390	4%	92,160	3,390	4%
MiddleGDP-MiddleAgr	105,200	92,160	13,040	12%	108,681	-3,481	-3%	100,080	5,120	5%
HighGDP-HighAgr	122,300	92,160	30,140	25%	131,173	-8,873	-7%	109,949	12,351	10%
LowGDP-MiddleAgr	95,950	92,160	3,790	4%	92,160	3,790	4%	92,160	3,790	4%
LowGDP-HighAgr	***102,400***	***92,160***	***10,240***	***10%***	***92,160***	***10,240***	***10%***	***92,160***	***10,240***	***10%***
MiddleGDP-LowAgr	104,800	92,160	12,640	12%	108,681	-3,881	-4%	100,080	4,720	5%
MiddleGDP-HighAgr	111,650	92,160	19,490	17%	108,681	2,969	3%	100,080	11,570	10%
HighGDP-LowAgr	115,450	92,160	23,290	20%	131,173	-15,723	-14%	109,949	5,501	5%
HighGDP-MiddleAgr	115,850	92,160	23,690	20%	131,173	-15,323	-13%	109,949	5,901	5%

λ	10%	Fixed target	θ	10,480	Intensity	I	0.21	SquareRoot	K	142.2
Scenarios	E_{BAU} avg 2008 to 2012 MTCE*1000	E_P	A	Eff. λ	E_P	A	Eff. λ	E_P	A	Eff. λ
LowGDP-LowAgr	95,550	94,320	1,230	1%	79,982	15,568	16%	86,856	8,694	9%
MiddleGDP-MiddleAgr	105,200	94,320	10,880	10%	94,320	10,880	10%	94,320	10,880	10%
HighGDP-HighAgr	122,300	94,320	27,980	23%	113,840	8,460	7%	103,621	18,679	15%
LowGDP-MiddleAgr	95,950	94,320	1,630	2%	79,982	15,968	17%	86,856	9,094	9%
LowGDP-HighAgr	102,400	94,320	8,080	8%	79,982	22,418	22%	86,856	15,544	15%
MiddleGDP-LowAgr	***104,800***	***94,320***	***10,480***	***10%***	***94,320***	***10,480***	***10%***	***94,320***	***10,480***	***10%***
MiddleGDP-HighAgr	111,650	94,320	17,330	16%	94,320	17,330	16%	94,320	17,330	16%
HighGDP-LowAgr	115,450	94,320	21,130	18%	113,840	1,610	1%	103,621	11,829	10%
HighGDP-MiddleAgr	115,850	94,320	21,530	19%	113,840	2,010	2%	103,621	12,229	11%

λ	10%	Fixed target	θ	11,545	Intensity	I	0.20	SquareRoot	K	142.6
Scenarios	E_{BAU} avg 2008 to 2012 MTCE*1000	E_P	A	Eff. λ	E_P	A	Eff. λ	E_P	A	Eff. λ
LowGDP-LowAgr	95,550	103,905	-8,355	-9%	73,002	22,548	24%	87,093	8,457	9%
MiddleGDP-MiddleAgr	105,200	103,905	1,295	1%	86,089	19,111	18%	94,578	10,622	10%
HighGDP-HighAgr	122,300	103,905	18,395	15%	103,905	18,395	15%	103,905	18,395	15%
LowGDP-MiddleAgr	95,950	103,905	-7,955	-8%	73,002	22,948	24%	87,093	8,857	9%
LowGDP-HighAgr	102,400	103,905	-1,505	-1%	73,002	29,398	29%	87,093	15,307	15%
MiddleGDP-LowAgr	104,800	103,905	895	1%	86,089	18,711	18%	94,578	10,222	10%
MiddleGDP-HighAgr	111,650	103,905	7,745	7%	86,089	25,561	23%	94,578	17,072	15%
HighGDP-LowAgr	***115,450***	***103,905***	***11,545***	***10%***	***103,905***	***11,545***	***10%***	***103,905***	***11,545***	***10%***
HighGDP-MiddleAgr	115,850	103,905	11,945	10%	103,905	11,945	10%	103,905	11,945	10%

λ	10%	Fixed target	θ	11,585	Intensity	I	0.20	SquareRoot	K	143.1
Scenarios	E_{BAU} avg 2008 to 2012 MTCE*1000	E_P	A	Eff. λ	E_P	A	Eff. λ	E_P	A	Eff. λ
LowGDP-LowAgr	95,550	104,265	-8,715	-9%	73,255	22,295	23%	87,395	8,155	9%
MiddleGDP-MiddleAgr	105,200	104,265	935	1%	86,387	18,813	18%	94,906	10,294	10%
HighGDP-HighAgr	122,300	104,265	18,035	15%	104,265	18,035	15%	104,265	18,035	15%
LowGDP-MiddleAgr	95,950	104,265	-8,315	-9%	73,255	22,695	24%	87,395	8,555	9%
LowGDP-HighAgr	102,400	104,265	-1,865	-2%	73,255	29,145	28%	87,395	15,005	15%
MiddleGDP-LowAgr	104,800	104,265	535	1%	86,387	18,413	18%	94,906	9,894	9%
MiddleGDP-HighAgr	111,650	104,265	7,385	7%	86,387	25,263	23%	94,906	16,744	15%
HighGDP-LowAgr	115,450	104,265	11,185	10%	104,265	11,185	10%	104,265	11,185	10%
HighGDP-MiddleAgr	***115,850***	***104,265***	***11,585***	***10%***	***104,265***	***11,585***	***10%***	***104,265***	***11,585***	***10%***

Note: E_{BAU}, E_P and A are expressed in MTCEx1000.