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"REDUCING EMISSIONS FROM DEFORESTATION AND FOREST DEGRADATION (REDD): HARNESSING THE FINANCING POTENTIAL OF CARBON MARKETS"

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INFORME DEL DIRECTOR

Pablo Martínez de Anguita, profesor titular de Departamento de Tecnología Química y Ambiental, en calidad de director

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Que según lo dispuesto en la Ley Orgánica de Universidades de 21 de Diciembre de 2001, el Real Decreto 56/2005, de 21 de enero, los Estatutos de la Universidad y normativa reguladora de los estudios de Tercer Ciclo para la obtención del Grado de Doctor por la Universidad Rey Juan Carlos, el presente trabajo de investigación titulado "REDUCING EMISSIONS FROM DEFORESTATION AND FOREST DEGRADATION (REDD): HARNESSING THE FINANCING POTENTIAL OF CARBON MARKETS" constituye un trabajo original de Investigación, así como la Memoria que presenta Don Pedro Piris Cabezas para aspirar al grado de doctor por la Universidad Rey Juan Carlos, gozando de la aprobación y el aplauso de su director.

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Fdo: Pablo Martínez de Anguita

Abstract

The destruction of forests – principally in the tropics – emits massive amounts of carbon dioxide. Reducing emissions from deforestation and forest degradation (REDD) – a prime source of low-cost reductions of greenhouse gas emissions – in tropical forest nations could make a substantial contribution to addressing climate change. To date, large-scale forest protection efforts have been financed primarily by official development assistance, which are in most cases orders of magnitude lower than required. A better way — both in terms of economic efficiency and political plausibility — is to draw capital flows from the carbon market. Using the market as a source of funds can free billions in financial flows. However there is no place for these tons in existing carbon market policy frameworks. The goal of this dissertation is to shed light on the issues preventing 'market-based REDD' from taking off, as well as to illustrate some potential solutions and paths forward.

'Market-based REDD' would enable developing nations themselves to earn carbon credits for verified emissions reductions against an agreed national baseline and sell them in existing carbon markets. This would encourage emissions reductions in tropical forest nations while helping to manage the costs of compliance in countries that take on economy-wide caps. However, a prominent concern with market-based REDD has been that emissions reductions from forests will be so abundant as to 'flood the carbon market'. We use a multi-period partial equilibrium modeling approach to assess the impact of REDD tons in frameworks with long time horizons. We conclude that the long-term horizon, the progressive tightening of emission caps, and the possibility of banking enable a direct market-based funding mechanism to deliver financing at significant scale and absorb the maximum quantity of REDD credit tons, even in the near-term.

Absent an overarching international agreement, a bilateral agreement between the EU and Brazil would make great strides towards halting the destruction of the Amazon Rainforest. The Brazilian plan to reduce deforestation by 80% in 2020 sets the stage for a win-win situation for Brazil and the EU. If a portion of Brazil's reductions, above a pre-determined reference level, were sold as carbon market credits, the EU would gain by reducing its compliance costs and could potentially increase its emissions reductions at no additional cost over the case without REDD. The EU would just need to create further certainty over future EU climate policy in order to enable greater emissions reductions over the near term for the purpose of banking credits for future use.

A Brazilian economy-wide cap-and-trade system has the potential to tap on a broader mitigation potential in a cost-efficient fashion and to bolster the eligibility of REDD credits in the EU by linking the Brazilian cap-and-trade with the EU carbon markets. The Brazilian REDD crediting system could be easily integrated into the Brazilian cap and trade program through a point of regulation at the level of the Brazilian states, which could then establish so-called 'nested' programs for crediting reductions within their jurisdiction in order to tap on private funding.

Bilaterally linking the proposed climate protection efforts of the EU and Brazil through a future carbon market could not only multiply the effectiveness of each nation's program and achieve greater combined climatic benefits, but also generate intangible and countless ancillary benefits associated with the conservation of the Amazon Rainforest.

To my mother and father

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RESUMEN EN CASTELLANO

ANTECEDENTES

La destrucción de los bosques, principalmente en los trópicos, emite cantidades ingentes de dióxido de carbono (CO_2), entre el 15 y el 20 por cierto de las emisiones globales de gases de efecto invernadero (GEI). La reducción de las emisiones procedentes de la deforestación y de la degradación de los bosques (REDD por sus siglas en inglés) representa una de las opciones de mitigación relativamente más asequible, por lo que REDD está destinado a realizar una contribución substancial en la lucha contra el cambio climático. Hasta la fecha, la gran mayoría de las acciones encaminadas a preservar los bosques han sido en gran medida financiadas a través de programas de ayuda oficial al desarrollo, cuya cuantía se encuentra generalmente uno o más órdenes de magnitud por debajo de las necesidades de financiación. Una alternativa de financiación – tanto en términos de eficiencia económica como de factibilidad política – consiste en canalizar flujos financieros a través de los mercados de derechos de emisión, también llamados mercados de carbono. Esta alternativa podría generar flujos de capital anuales en el orden de los miles de millones de dólares, en línea con las necesidades estimadas.

La implementación de mecanismos de financiación de REDD a través del mercado de carbono permitiría a los países en desarrollo generar créditos de carbono – créditos REDD – asociados con las reducciones de emisiones logradas por debajo de los niveles de referencia acordados, con el fin de venderlos en los mercados de carbono de los países industrializados. De esta manera los países tropicales tendrían incentivos económicos para reducir la deforestación y la degradación de los bosques, y los países industrializados una herramienta para limitar los costes de cumplimiento de sus metas de reducción de emisiones de GEI, o incluso profundizar en la cuantía de sus compromisos, lo que redundaría en la factibilidad política de dichas políticas públicas. Sin embargo, el principal argumento en contra de la implementación de dicho mecanismo es el recelo a que los créditos REDD sean tan abundantes a corto plazo como para inundar el mercado de carbono, hundiendo los precios de los derechos de emisión y consecuentemente destruyendo los incentivos de inversión en tecnologías limpias.

OBJETIVOS

La primera parte de esta disertación tiene como objetivo valorar cuantitativamente si la financiación de REDD a través de los mercados de carbono es una solución viable o si bien sus detractores tienen razón y los créditos generados pondrían en peligro la esencia misma de los mercados de carbono, en especial en un contexto como el actual de ausencia de acuerdo internacional, que a priori generaría una demanda inadecuada para los créditos REDD. La hipótesis sostenida es que los créditos REDD no inundarían el mercado de carbono de los países industrializados si estos tuvieran un horizonte temporal de largo plazo, véase el año 2050 o en su defecto 2030, y sólido. Dicha configuración proporcionaría la necesaria estabilidad regulatoria que incentivaría la optimización intertemporal de las inversiones.

El resto de la disertación tiene como objeto la valoración de un posible acuerdo bilateral entre la Unión Europea (UE) y Brasil, los únicos actores a nivel internacional con capacidad de hacer una contribución significativa en ausencia de un acuerdo global bajo el paraguas de la Convención Marco de Naciones Unidas sobre Cambio Climático.

La metodología de valoración de políticas públicas de financiación para REDD se desarrolla en la primera parte de la disertación y se utiliza para analizar los diferentes elementos de la propuesta de acuerdo bilateral entre Brasil y la UE.

METODOLOGÍA

Para probar la hipótesis enunciada anteriormente hemos desarrollado un modelo microeconómico simple de equilibrio parcial del mercado global de carbono que incorpora las expectativas racionales de los agentes. Dicho modelo nos permite valorar el impacto de los créditos REDD así como los flujos financieros asociados bajo diferentes configuraciones de políticas públicas de financiación. En este marco, se estudia en detalle el papel que el ahorro de derechos de emisión (denominado *banking* en inglés), pues es la clave que permite integrar las expectativas futuras de demanda de reducciones de los agentes con la oferta de créditos REDD en el corto plazo. La clave consiste en que dicha capacidad de ahorrar derechos de emisión permite que los agentes del mercado de carbono vayan más allá de sus necesidades de mitigación de emisiones de GEI en el corto plazo – cuando las metas de reducciones suelen ser menos exigentes – y sus necesidades en el futuro cuando los precios de carbono sean mucho mayores como consecuencia de metas de reducción mucho más exigentes que en el corto plazo. Por lo tanto, esta flexibilidad temporal tiene el potencial de crear una demanda adicional de reducción de emisiones de GEI en el corto plazo, dando así cabida a la oferta potencial de créditos REDD y creando una reserva de créditos que tendría un efecto positivo en la estabilidad de los mercados de carbono dada su potencial capacidad de moderación de la volatilidad de precios en el mercado de carbono.

CONCLUSIONES

Nuestro modelo del mercado global de carbono nos permite concluir que se pueden generar flujos financieros en el orden de magnitud necesarios para alcanzar el objetivo de preservación de los bosques tropicales con un impacto moderado en el precio de carbono de una magnitud que desincentivaría de manera significativa la inversión en tecnologías limpias; incluso en el improbable escenario en el que todos los países tropicales pudieran desarrollar las capacidades técnicas para participar en los próximos cinco años. Por lo tanto, en un escenario con expectativas razonables bajo un marco regulatorio estable con un horizonte temporal de largo plazo, el temor a que los créditos REDD hundan los precios del mercado de carbono no tiene sentido económico. De hecho, el problema sería más bien el contrario, es decir, que los países tropicales no estuvieran en función de generar suficientes créditos REDD debido a la falta de capacitación.

En resumen, la capacidad de ahorrar créditos REDD para su uso futuro proporciona una solución intertemporal eficiente que da sentido económico a una opción de mitigación relativamente más barata que de otra manera sería probablemente desaprovechada como consecuencia del desequilibrio de las metas de reducciones entre el corto y el largo plazo. Se crea por tanto una sinergia entre la necesidad de evitar la deforestación y la degradación de los bosques – con todos los beneficios medioambientales y sociales asociados – y la de reducir las emisiones globales de GEI en línea con el objetivo de evitar un calentamiento global por encima de los 2º C.

En ausencia de un acuerdo internacional satisfactorio que creara un mercado global de carbono, un convenio bilateral EU-Brasil podría contribuir significativamente en la lucha contra la destrucción de la Amazonía brasileña y sentar las bases para un sistema global en el futuro. La combinación de la demanda generada por el mercado de carbono regional más grande del mundo con la oferta resultante de los planes del gobierno brasileño de reducir la deforestación en un 80 por ciento en la Amazonía en relación a la deforestación media del periodo 1996-2005, permitiría alcanzar una solución satisfactoria para ambas partes. Si una porción de las reducciones alcanzadas en Brasil por debajo de un nivel de referencia a acordar por las partes se vendiera a agentes de la UE como créditos REDD, la UE podría reducir los costes de implementación de su política de cambio climático o asumir reducciones de mayor calado con el mismo coste agregado. Para crear demanda, aparte de regular la elegibilidad de los créditos REDD, la UE simplemente tendría que crear certidumbre sobre el marco regulatorio de su mercado de carbono a largo plazo asumiendo metas con un horizonte temporal mayor.

Por otro lado Brasil podría ir más allá de un simple programa REDD e implementar un mercado de emisiones similar al de la UE pero que comprendiera todos los sectores económicos bajo el mismo techo de emisiones, incluyendo naturalmente las emisiones por deforestación y degradación, que representaron en torno al 60 por ciento de las emisiones de GEI en el año 2005. De esta manera conseguiría ampliar la cuantía del potencial de mitigación a bajo coste y aumentar la elegibilidad de los créditos REDD, que en este marco serían simplemente derechos de emisión. Teniendo en cuenta el principio de subsidiaridad, REDD se podría integrar fácilmente en el mercado de emisiones brasileño a través de un punto de regulación al nivel de los estados que conforman la republica federal. Así mismo, los estados podrían establecer programas que permitieran la existencia de proyectos del estilo de los del mecanismo de desarrollo limpio (MDL) establecidos en el protocolo de Kioto, a nivel de su jurisdicción con el fin de aprovechar el poder catalizador del capital privado. En este caso, a diferencia de los proyectos MDL, los proyectos REDD estarían supeditados al logro de los objetivos tanto a nivel de la jurisdicción estatal como a nivel federal.

En resumen, un convenio bilateral EU-Brasil es factible y puede lograr beneficios en la lucha contra el cambio climático superiores a la suma de los esfuerzos individuales de las partes, a los que habría que sumar los beneficios ecológicos y sociales asociados con la preservación de la Amazonía brasileña.

Preface

> Avoiding global average warming in excess of 2ºC requires reduction commitments from both industrialized and developing countries. The industrialized world cannot solve the problem by itself, yet it does have an obligation to bear a significant portion of the cost. This will entail large financial flows from industrialized to developing countries. Official development assistance or other bilateral or multi-lateral means cannot fill that need. They are often orders of magnitude lower than required. A better way — both in terms of economic efficiency and political plausibility — is to draw capital flows from the carbon market. Using the market as a source of funds can free billions in financial flows for mitigation in developing countries.

The destruction of forests – principally in the tropics – emits massive amounts of carbon dioxide (CO_2): approximately 15-20 per cent of global greenhouse gas (GHG) emissions, or roughly as much each year as all the CO2 emitted by all the fossil energy consumed in the United States. When forest carbon emissions are included, the third and fourth largest emitters of GHGs in the world are Indonesia and Brazil, respectively. Avoiding deforestation should be part of the solution for averting 2ºC of warming.

To date, large-scale forest protection efforts have been financed primarily by official development assistance (ODA); even with generous ODA financing from many industrialized nations, the scale of economic incentives historically available has not been sufficient to serve as a counterweight to the economic pressures that favor deforestation in many nations. If the world waits a decade or two to create powerful incentives for compensating those who protect tropical forests, potentially a large share of the forests – and the approximately 300 billion tons of carbon they hold – will already be gone.

Alternatively to ODA financing, bringing emission reductions achieved by protecting forests at large scale into future carbon markets has the potential to be transformative. Carbon markets have the potential to marshal forest protection resources commensurate with the problem of deforestation globally. Failure to achieve significant progress in stemming the tide of global deforestation risks losing most of the world's remaining forests and all of the ecosystem and social services they provide. The current decade and the next are crucial.

On the other hand, forestry activities in the developing world represent a prime source of low-cost reductions of greenhouse gas emissions, especially over the next ten or twenty years. A range of estimates indicate that the cost of forest protection in some parts of the world is far less than the cost per ton of more expensive means of reducing CO_2 emissions given today's technologies. In particular, **reducing emissions from deforestation and forest degradation (REDD)** in tropical forest nations could make a substantial contribution to addressing climate change. Afforestation and changes in forest management also offer considerable potential for carbon sequestration, reducing net emissions of carbon into the atmosphere.

However, while forest conservation represents a prime source of low-cost reductions of greenhouse gas emissions, especially over the next ten or twenty years, there is no place for these tons in existing carbon market policy frameworks (the Kyoto Protocol, the current EU Emissions Trading Scheme). Previous negotiations on these policy frameworks excluded these tons, primarily because of concerns about difficulties in measuring deforestation, and because of concerns about leakage. Substantial progress has been made in each of these areas. The world's remote sensing scientists are now in agreement that the tools are in hand to measure tropical forests with a high degree of accuracy. And a promising approach, namely to enable developing nations themselves to earn carbon credits for verified emissions reductions against an agreed national baseline, has made substantial progress in addressing leakage. Such credits could then be used for compliance in cap-and-trade programs in the European Union (and eventually, perhaps, the United States).

This promising approach, known as *REDD crediting or direct market-based REDD*, would encourage emissions reductions in tropical forest nations while helping to manage the costs of compliance in countries that take on economy-wide caps. In other words, it would leverage the carbon market to create a powerful incentive for the protection of tropical forests.

Allowing REDD credits to be used for compliance in cap-and-trade programs could accomplish several goals at once: it would create a powerful incentive for the protection of tropical forests, transform the dynamics for forest protection world-wide, encourage large emissions reductions in tropical forest developing nations, and help preserve the world's options to avert global warming of more than two degrees above preindustrial levels. In addition, REDD credits could help to manage the costs of compliance in countries that take on economy-wide caps – helping to create and maintain the political will to achieve deep reductions in emissions. Besides REDD offers the potential for achieving multiple benefits in areas other than climate change mitigation such as biodiversity protection, and poverty alleviation.

Although the argument for this policy mechanism is compelling, the scope of emissions reduction and sequestration opportunities in developing countries – and the potential for forest carbon credits to lower compliance costs in cap-and-trade programs – have not been well estimated. At the same time a prominent concern with REDD crediting mechanism, however, has been that emissions reductions from forests will be so abundant as to 'flood the carbon market', driving down the price of GHG allowances and dampening incentives for emissions reductions in capped countries or for investment in clean technologies.

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Over the last few years the international debate on the role of REDD has been gaining political momentum. The comparatively large role of global emissions from deforestation combined with the sequestration potential stemming from the enhancement of carbon forest stock has made of REDD+[1] a prominent element of the international negotiations aiming at developing a post-2012 global climate treaty under the United Nations Framework Convention on Climate Change (UNFCCC). REDD is poised to become an important international GHG emissions reduction mechanism.

In December 2007, UNFCCC Decision 1/CP.13 (the Bali Action Plan) launched a comprehensive process to enable the full, effective and sustained implementation of long-term cooperative action with the objective of reaching an agreed outcome and adopt a decision at its fifteenth session in Copenhagen, which eventually did not take place. The Bali Action Plan decided that the process had to be conducted under a subsidiary body under the Convention, the Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA), which had to consider policy approaches and positive incentives on issues relating to REDD+ in developing countries. Under that mandate, the AWG-LCA has made sizable progress on the REDD+ draft decision text, which was considered to be in the latest stages of negotiation, giving way to speculation about the likelihood of a REDD+ decision – either as a stand alone one or as part of a set of decisions in Copenhagen.

One of the results of the conference in Copenhagen was *The Copenhagen Accord*, which recognizes the crucial role of REDD and the need to enhance removals of greenhouse gas (GHG) emissions by forests. It also agrees on the need to provide positive incentives to such actions through the immediate establishment of a mechanism including REDD+, to enable the mobilization of financial resources from developed countries.

In addition to the UNFCCC process, the Convention has encouraged the Parties to coordinate their efforts to reduce emissions from deforestation and forest degradation. As

[1] As the negotiations evolved the REDD concept became REDD+, which – in addition to reducing emissions from deforestation and degradation – expands the scope of REDD to also compensate developing nations that succeed in conservation of forest carbon stock, sustainable management of forest, and the enhancement of forest carbon stocks.

a result, around 70 countries have organized their action on REDD+ within a global platform called the *REDD+ Partnership*. The core objective of the Partnership is to contribute by serving as an interim platform for the Partners to scale up REDD+ actions and finance.[2] Currently the REDD+ debate has cleared many technical aspects of the international negotiations process and had already attracted $4 billion in interim 'fast start' financial commitments through 2012 from developed nations under the *REDD+ Partnership*.

In addition to the UNFCCC track there have been numerous initiatives to channel bilateral and multilateral REDD funds for enhancing developing countries readiness – investing for instance in capacity building and pilot REDD projects – such as the prominent Government of Norway's International Climate and Forest Initiative, the UN-REDD program and the Forest Carbon Partnership Facility (FCPF) housed at the World Bank. In parallel the role of civil society has been paramount: (1) scrutinizing the international negotiations; (2) carrying out pilot projects, (3) getting indigenous peoples representatives involved and acquainted to the intricacies of the international negotiations; and (4) making substantial contributions to the policy debate in conjunction with the academia.

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REDD has attracted an outstanding amount of attention, particularly over the last four years, reframing the debate over tropical forest conservation around the fifteen to twenty per cent of global GHG emissions that are caused by deforestation and forest degradation. The issues related to REDD spread over a wide-ranging spectrum. Among these issues we can highlight for illustration purposes: the assorted drivers of deforestation and forest

[2] The *REDD+ partnership* is a positive step that could deliver fast-start capacity building and readiness funding to REDD countries. The REDD+ Partnership document from 2010 is downloadable at http://www.oslocfc2010.no/pop.cfm?FuseAction=Doc&pAction=View&pDocumentId=25019 [last accessed November 2011]

degradation; ecosystem conservation; poverty alleviation; indigenous peoples and forest-dependent people rights; REDD financing; payments for environmental services programs; and, of course, sustainable development. The purpose of this dissertation is to make an academic contribution on one of those topics, namely REDD financing, with the goal to shed light on the issues preventing 'market-based REDD' from taking off, as well as to illustrate some potential solutions and paths forward.

This dissertation consists of four parts. *Part I*, the core of the dissertation, aims at addressing the 'flooding the market' concerns. The *hypothesis* is that REDD credits do not necessary 'flood the market' and make the price of carbon to collapse if two conditions are met, namely, that the REDD program is properly designed to safeguard its environmental integrity and the cap-and-trade systems have credible long-term time horizons. The latter condition is the main focus of the dissertation. In order to test the hypothesis we have developed a forward-looking partial equilibrium model to analyze carbon market conditions under various policy scenarios. In this framework, the concept of *banking*[3] is explored in detail and modeled explicitly since it is a crucial feature for REDD credits – given that forest carbon tons in particular represent a reservoir of low-cost abatement that could allow entities to build up an allowance bank in the early years of a cap-and-trade program. *Chapter 1* surveys the literature and provides a theoretical introduction to the concept of banking. Direct market-based mechanisms for financing mechanisms not directly linked to the market include voluntary allocations by governments or dedicated taxes, and more importantly, proceeds from the auctioning of

[3] Banking allows market actors to overcomply in the present by reducing emissions beyond their near-term requirements and bank the surplus emissions allowances for compliance in the future when carbon prices are generally expected to be higher as a result of progressively tightening targets. This flexibility over the timing of abatement potentially creates an added source of abatement demand in the present, driven by the anticipated needs to undertake more expensive emissions cuts in the future. Also, banking is often characterized as a price-volatility containment measure that would potentially provide a reserve of credits that could serve as a short-term buffer against volatility in the carbon markets.

GHG emissions allowances. *Chapter 2* explores the practical consequences of banking in the carbon markets by means of the partial equilibrium model noted above.

Part II and III analyze the potential supply and demand of REDD credits in the near-term from the two players, namely the European Union (EU) and Brazil, respectively. These players are in a position to make a determinant contribution in the near-term that could shape the design and scope of REDD for the years to come.

Part II explores in detail the position of the European Union (EU) – with its reluctance to apply direct market-based REDD financing approaches in the near-term. Among the key developed countries, the EU emerges as the leading region in the climate debate and house of the largest carbon market established to date – the EU Emissions Trading System (ETS) – that is, the only carbon market to which REDD crediting programs could dock into at the present, thus its relevance. The United States (US) have also significantly shaped the REDD policy debate, with significant contributions coming from the in-depth legislative/regulatory debates at the federal and state level.[4] However the legislative process to adopt an economy-wide cap-and-trade legislation at the federal level in the US was stalled in the US Senate after a legislative milestone in 2009 when the House of Representatives passed a bill that incorporated an economy-wide cap-and-trade program including a major contribution to halt deforestation in developing countries. Nowadays the political prospects of enacting legislation establishing a cap-and-trade system in the US are slim. Thus rather than dedicating a whole section to cover the US position (or the lack of position) in detail, we have opted to highlight its key

[4] In addition to the federal legislative process – unfortunately stalled at the moment – there are efforts to construct sub-national GHG compliance regimes in the US. In that sense, REDD+ is evolving as an important element in the implementation of the GHG emissions offsets program now being designed in California as part of the overall implementation of the state's Global Warming Solutions Act (AB-32) that created a statewide program to reduce GHG emissions. AB-32 would probably adopt two pathways to REDD crediting: (1) "nested" projects, within sectoral or state-level carbon accounting, and (2) for jurisdictional, sectoral or state-level reductions. Therefore, state (and eventually probably national) – level REDD will be eligible for compliance credit. The specific criteria for accepting REDD credits still have to be elaborated.

elements and analyze their role along the three parts of the dissertation instead.

Chapter 3 provides an overview of the EU's evolving position on REDD financing. *Chapter 4* explores the role REDD credits could play in the European carbon markets established by the EU climate and energy package using the methodology developed in Part I; and makes policy recommendations to address the main concerns about REDD.

Part III focuses on the supply of REDD credits from Brazil and provides an illustration of the potential financial flows generated by a market-based REDD system. For that purpose we analyze the role a national market-based REDD mechanism would play in Brazil. This part also aims at providing a vivid illustration of how a REDD program could turn into a reality in Brazil, where almost 60 per cent of greenhouse has emissions were from deforestation and other forestry and land-use change activities in 2005.

Brazil is in a unique position to deliver emissions reductions from avoiding deforestation and forest degradation (see Appendix 4 for a detail overview). Among the key tropical nations, Brazil is the only country in a position to successfully implement and MRV[5] a national market-based REDD program in the near-term. The advanced capacities on remote sensing developed over the years make of Brazil the leading power in the field. Besides, the Brazilian government has emerged as a leading international actor in the effort to address the threat of global climate change. For instance, the government adopted legislation establishing a national target of reducing emissions across all of the economy by 36.1% to 38.9% below projected levels in 2020, which includes Brazil's target of reducing Amazon deforestation 80%, below the 1996 – 2005 average by 2020, and reducing deforestation in the Cerrado biome by 40%. Government actions have already been instrumental in reducing Brazil's deforestation rates to the lowest rates in recent history and in line with these targets, but significant challenges

[5] MRV stands for monitoring, reporting and verifying.

remain to sustain and deepen these accomplishments. Addressing the multiple drivers of deforestation and forest degradation requires implementing a myriad of public policies – that go beyond standard payments for environmental services – encompassing, for example policies aiming at alleviating poverty of forest-dependent communities or at creating the conditions for sustainable economic growth patterns.

The case of Brazil is also particularly interesting because there has been a great deal of debate on REDD financing within the country itself, between the federal government – supporting traditional public funding mechanism for financing REDD – and the eight Amazon state governments – advocating for national direct market-based REDD.

Chapter 5 explores the possible configurations of a national direct market-based REDD program that achieves Brazilian National Plan[6] target of reducing Amazon deforestation 80 per cent below the 1996–2005 average by 2020, and finance its REDD program by docking to the international carbon markets – and the US in particular, a possibility that gained significant momentum in 2009 when the House of Representatives passed legislation consistent with that assumption. *Chapter 6* focuses on the potential opportunities for the integration of Brazilian market-based REDD into a domestic economy-wide cap-and-trade system that might eventually be linked to the international carbon markets. *Chapter 7* lays down the principal design elements for a Brazilian economy-wide cap-and-trade program with a focus on REDD's ideal state-level jurisdiction and the role of nested approaches.

Part IV concludes and closes the dissertation.

[6] Government of brazil (2008), *National plan on climate change*, Decree No. 6263 of November 21, 2007 Available at http://www.mma.gov.br/estruturas/imprensa/_arquivos/96_11122008040728.pdf

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1. REDD and the Global Carbon Market: The Role of Banking

1.1 INTRODUCTION

Since December 2007 at the UN climate conference in Bali, when Parties to the Convention affirmed the urgent need to reduce emissions from deforestation and forest degradation (REDD) and agreed to take action, a central point of debate has been how to finance REDD efforts at national, regional, and global levels. Governments and non-government organizations have proposed numerous financing approaches.[1] Direct market mechanisms involve making credits for REDD activities (resulting from reductions in deforestation below a national baseline, for example) directly tradable with emissions allowances in a GHG compliance market. This approach is a central feature of the most prominent US climate bills. On the other hand, mechanisms not directly linked to the market include voluntary allocations by governments or dedicated taxes, and more importantly, proceeds from the auctioning of GHG emissions allowances. Non-market or indirect market-based mechanism have received endorsements from the EU and are also contemplated in some degree in the key US climate bills. There is growing consensus that a combination of market and fund-based approaches is needed to finance different REDD activities.

The advantage of indirect over direct market-funding mechanisms is often argued on grounds that introducing REDD credits into the carbon market would potentially flood the market and drive down the allowance price, reducing incentives for investments and innovations in clean energy and other low-carbon technologies. Early on in the debate, such concerns were motivated with comparisons of the size of the potential supply of

[1] See Parker et al. (2008) for a comprehensive overview of the most recent proposals.

credits for reducing deforestation emissions – in the order of 20 per cent of global greenhouse gas emissions – with the size of the existing carbon markets. According to this reasoning, potential REDD credits would outnumber the annual allowance allocation under the current EU emissions trading system by a factor of 3 or 4. Nevertheless, this comparison ignores the fact that the carbon market will presumably increase substantially in the coming years. In addition, only a fraction of theoretical potential for REDD tons may be credited in the near term due to lack of readiness at the global scale and/or the establishment of ambitious reference levels for the forest sector below which REDD tons would be credited. Concerns over market flooding could also be addressed by constraining the fungibility of REDD credits through trading ratios or quantitative limits on the quantity of REDD credits that can be used for compliance.

An indirect market-based mechanism would address flooding concerns as the REDD tons credits would not be fungible with the allowances traded in the carbon markets. However, the sustainability of this funding mechanism would be precarious if the allocation of funds is voluntary – as it is the case in the EU Energy and Climate package of 2008 – and therefore subject to shifting political will. REDD efforts would compete for scarce resources with other public policies such as adaptation to climate change, which contrary to REDD has no alternative funding mechanism that has been proposed. Furthermore, linking REDD credits to the market directly provides potentially important flexibility and resulting cost savings for the market participants, increasing the political acceptability of more stringent emission reduction targets. Hence we should take a careful look at the arguments that justify indirect funding mechanisms on the grounds of protecting the market from flooding.

1.1.1 The role of banking

As the debate has progressed, new analytical work has directly examined the implications of linking REDD to the carbon market. The predominant modeling approach has been to use a partial equilibrium model of the carbon market built upon region- or sector-specific marginal abatement cost curves and national or regional demands for emissions reductions. In spite of using similar modeling approaches and even the very same REDD marginal abatement cost (MAC) curves, results have diverged, with alternative implications for policy. While assumptions over the availability of project-based offsets produce some of the differences, another key assumption is the possibility of banking.

Banking allows market participants to overcomply in the present by reducing emissions beyond their near-term requirements and bank the surplus emissions allowances for compliance in the future when carbon prices are generally expected to be higher as a result of progressively tightening targets (Dinan and Orszag, 2008; Murray et al., 2008). This flexibility over the timing of abatement potentially creates an added source of abatement demand in the present, driven by the anticipated needs to undertake more expensive emissions cuts in the future. Banking is often characterized as a price-volatility containment measure that together with borrowing – the ability to bring forward emissions allowances allocated to future periods – would potentially provide a reserve of credits that could serve as a short-term buffer against volatility in the carbon markets (Piris-Cabezas and Keohane, 2008; Murray et al., 2009). While most legislative proposals constrain the amount of borrowing so as to avoid postponing all environmental benefits, there is no environmental or economic rationale for limiting the amount of allowances that could be banked. Banking accelerates the scheduled emission reductions while providing market participants with the flexibility to take advantage of lower cost mitigation options that may available in the near term. Without banking, these opportunities would be postponed or perhaps even permanently lost, as in the case of reduced emissions from deforestation. Once a tropical forest area is deforested, the forest may eventually regrow but the option to prevent the emissions from the loss of that forest is irreversibly lost over the most relevant planning horizons.

The potential importance of banking depends on the extent to which climate policies provide a credible, long-term price signal that enables market participants to anticipate future compliance obligations. Modeling the banking provisions has been integral to the assessment of recent cap and trade proposals in the U.S., which provide for emissions caps extending from 2012 through 2050 and beyond.[2] This time frame contrasts with the 2013-2020 policy time frame considered under the EU's Energy and Climate package. As a direct consequence, and given the undefined regulatory framework after that date, the European modeling community has had fewer incentives to model the impacts of banking in the carbon market.

Ignoring the role of banking could be appropriate given a short-term regulatory framework. However, the potential enactment of cap and trade legislation in the US changes the policy landscape, introducing a major player that could become the dominant buyer of REDD credits.[3] In this case, the incentives for banking created by the long-term commitments in the US would impact the global carbon market.[4] The incentives for banking excess credits apply not only to REDD efforts but to all available mitigation options. Absent the perspective based on that additional modeling effort, the gap between the US and Europe positions on REDD could broaden further. This chapter attempts to bridge this divide by exploring some of the key elements of the additional layer of complexity brought in with banking.

[2] See, for example, the U.S. Environmental Protection Agency's economic analyses of the major legislative proposals for U.S. climate legislation, available at: http://www.epa.gov/climatechange/economics/economicanalyses.html

[3] The current version of H.R. 2454 considers a mix of funding mechanisms for REDD efforts. On the one hand, the bill sets aside 5 per cent of the emissions allowances to finance REDD activities including readiness efforts, leakage prevention, and purchases of 6 $GtCO_2$ of REDD tons through 2025 in order to meet the complimentary reductions required beyond the main cap. On the other hand, subject to quantitative limitations, REDD credits could be used for compliance purposes through a direct market based mechanism.

[4] Most assessments of the impact of REDD in the carbon markets relax constrains to trading among regions with emissions reductions commitments, such that a global carbon market emerges with a unique carbon price.

The rest of the chapter is organized as follows. First we discuss the theoretical underpinnings for banking, focusing on the economic rationale. Second, we review how banking has been modeled so far and compare the forecasted impacts of REDD in the market under different modeling assumptions. Finally, based on a model that accounts for banking, we run an hypothetical exercise in order to illustrate the scale of REDD that would be necessary to depress the price of carbon by the orders of magnitude estimated by analyses that do not account for banking. The last section is carried out with the modeling framework described in detail in chapter 2.

1.2 ECONOMIC THEORY OF BANKING

The intuition behind banking is intertemporal arbitrage based on expectations about the future by market participants. Rational behavior implies that allowance prices will increase at the expected rate of interest reflecting the prevailing rate of return in the market. If prices were expected to rise at any rate other than the prevailing market rate of return, investors could make a pure profit by buying or selling allowances relative to other assets. For example, if prices rose at a faster rate, it would pay investors to buy and hold allowances in order to sell them later at a profit. The resulting current increase in demand would raise prices today, forcing them to rise more slowly in the future and eventually bringing the market back into intertemporal equilibrium. Chapter 2 further explains the underpinnings of banking in the context of the modeling framework developed for this dissertation.

The rationale supporting banking is common to that applying to any other commodity. There are, though, relevant differences when it comes to the cost of carry, as banked allowances or credits have no storage costs. The nature of the risks associated with “bankable” allowances is twofold. First there are the regulatory risks over the long run. For example, the rules could be changed or a relevant country could opt out of the policy. Second there are the risks associated with economic conditions including technological expectations, for instance the uncertainty about the marginal cost of the technologies that will set the market price over the next decades. At the same time, there might be a risk-hedging benefit to holding excess allowances as a buffer against unexpected price rises in the future. This means that the expected cost of holding banked allowances could require either an upwards or downwards adjustment to the risk-free interest rate to reflect the risk premium from holding allowances as well as the potential added "convenience yield" to directly holding this asset. The real interest rates applied to model banking in climate policy studies the US range between 4 and 5 per cent constant. The lower the interest rates, the higher the amount of expected banking.

In reality, allowance prices will tend to vary over time as shocks and unexpected events unfold and lead market participants to readjust their expectations of the future. However, without explicit modeling of the sources of this volatility, a smooth price path is consistent with market equilibrium and profit-maximizing behavior by rational market agents.

Allowance price expectations will depend, on the one hand, on the design and political sustainability of the policy and, on the other hand, on the technological breakthroughs that occur over time, which are themselves a function of the design and stringency of the policy. According to the latest IPCC recommendations, avoiding dangerous climate change requires ambitious and rapid global reductions in GHG emissions. A quick survey of modeling results for a global carbon market consistent with climate stabilization (see for instance latest IPCC AR4 or EMF22) shows marginal abatement costs that increase at annual rates much higher than the prevailing interest rates. This suggests that banking could play an important role.

In the most widespread approach to modeling banking in the US, the models solve for an allowance price that grows steadily at a constant interest rate and clears the market intertemporally through 2050, the time horizon of the US climate bills.[5] As a result of banking, in the first two decades of the policy, the net aggregate demand for carbon allowances or credits exceeds the required abatement deriving from the caps, meaning there is overcompliance. The inverse takes place in the last two decades where the net demand decreases and the banked allowances are used for compliance. Thus, according to these analyses, the market participants' banking accounts increase in the aggregate over the first two decades of the policy, peak in the late 2020s or early 2030s, and gradually decrease until its depletion in 2050. There is no doubt that the design of the policy after 2050 would have an additional impact on how the banking accounts are optimized and would be internalized by market participant as expectations over the future policy unfold.

1.2.1 Empirical evidence

The most compelling evidence of banking comes from the US sulfur dioxide (SO2) program, which was the first large scale, long-term program to rely on tradable emissions allowances to cut pollution (Schmalensee and Joskow, 1998). In terms of recent climate policy experiences, banking was not allowed between Phase I and II of the EU ETS program but when Phase I allowance prices collapsed due to overallocation, the forward-sale prices of Phase II allowances remained high, suggesting that there would have been a demand for banking Phase I allowances which could have stabilized prices. Banking is now allowed between the current Phase II and the future Phase III. While definitive data are not yet available, banking under Phase II might also be limited as a result of uncertainty over the future targets and regulatory regime.

[5] In an assessment of US climate bills, Babiker et al. (2008) use a forward looking version of the MIT emissions prediction and policy analysis (EPPA) model and find similar results to those obtained by forcing the mainstream recursive version of model to rise at a constant interest rate.

The sulfur dioxide (SO2) emissions trading system, established by Title IV of the 1990 Clean Air Amendments, brought the allowance banking issue to the debate in the US. The scale and scope of this program is small compared to the GHG allowance markets under consideration, but it has been instrumental in the design of cap-and-trade systems. A cap on SO2 from power generation plants was implemented in two phases. During Phase I, 1995 through 1999, only the largest power generating units were covered under the cap. Since Phase II, starting in 2000, virtually all the power sector in the continental US has been under a cap, much tighter than that of Phase I. In the early 1990s, analysts predicted far higher prices in Phase II than in Phase I. However, there was no sudden jump in allowance prices at the start of Phase II due principally to the ability to hold allowances over time – banking was explicitly allowed between the two phases and widely discussed at the time (Schmalensee and Joskow, 1998).

During the early stages of Phase I emissions dropped sharply beyond the required abatement. Schamelensee et al. provide two explanations for the dramatic overcompliance observed in those years. First and foremost there was banking, based on the rational expectations of more stringent future policies. The second explanation is that in the aggregate the market overestimated the future compliance costs and therefore overreacted in the near term.

1.3 REVIEW OF LITERATURE RESULTS

Early attempts to capture the potential role of forest and other land-based mitigation options can be found in a range of analyses from the Stanford University Energy Modeling Forum 21. The results indicate that land use, land-use change and forestry related mitigation options can be cost-effective in the global portfolio of mitigation strategies for long-term climate stabilization (Rose et al., 2007). In addition, Tavoni et al. (2007) estimate the impacts of a broad array of forest related mitigation, namely, REDD, afforestation/reforestation and changes in the management of timber plantations by dynamically coupling the WITCH model with the Global Timber Model (GTM). These analyses were based on integrated assessment models that usually incorporate sophisticated economic and environmental dynamics, but did not examine the dynamics spurring from banking as they did not attempt to model a compliance market for GHG reductions. The focus of these analyses was to examine the role of forest- and land- based mitigation in reducing the costs of a global carbon policy, rather than to assess the impact on the price of carbon under a cap-and-trade framework in which participants face particular compliance obligations that evolve over time (for a review of these results, see Murray et al., 2009).

More recently, researchers have explicitly analyzed the impacts of REDD in global carbon markets. Such modeling efforts can be classified as dynamic or static, depending on whether or not banking is modeled. Modeling a carbon market, rather than an optimal portfolio of global emissions reductions, involves taking into account the global pattern of emission reduction commitments and how they evolve over time, as well as any restrictions on allowable trading. Furthermore, impacts on compliance costs and carbon price will differ as the gains from trade from REDD could accrue in differing proportions to either the buyers or sellers or credits depending on market arrangements.

1.3.1 Static models

A discussion paper by Anger and Sathaye (2008) provided an early static analysis of the impact of REDD on the carbon market, considering only a single period spanning the year 2020. This study was later updated in: (1) a report prepared for the New Zealand Ministry of Agriculture and Forestry (Dixon et al., 2008); (2) a report commissioned by Greenpeace (Livengood and Dixon, 2009); and (3) a recent discussion paper (Anger et al., 2009). This set of analyses is hereinafter referred to as Anger et al. In the scenarios where no “supplementary” requirements (constrains on trading) are applied, Anger et al. report that the impact of REDD credits on the carbon price ranges between 40 and 75 per cent, depending on the industrialized countries' commitments to reduce emissions by 2020. The benchmark scenarios against which the impact of REDD is assessed include an unlimited amount of project-based developing country credits from the Clean Development Mechanism (CDM) of the Kyoto Protocol. Introducing these credits lowers the carbon price by as much as 60 per cent relative to a carbon market without any CDM trading. Hence, the carbon prices are already relatively low in the absence of REDD as a result of allowing unlimited CDM. In addition, the analysis in Anger et al. (2009) does not include non-CO2 sources of abatement. Accounting for the full basket of mitigation opportunities across all greenhouse gases significantly lowers the policy costs, particularly in the near term (Rose et al., 2007). If a multigas mitigation portfolio had been considered in Anger et al., the forecasted prices before allowing REDD in the market would have been even lower. Consequently, the impact of introducing REDD after allowing CDM could have been proportionally reduced.

In another static assessment using the GLOCAF model from the UK Office of Climate Change, the Eliasch Review (2008) finds that linking REDD and afforestation/reforestation credits to the EU ETS without any supplementary limits would lower the EU carbon market price in 2020 by 4 to 40 per cent for 20 per cent and 30 per cent EU reductions targets compared to 1990 levels, respectively. In these scenarios, the benchmark against which the impact of REDD is estimated also allows for unlimited CDM, which means the EU carbon market prices is already reduced by 78 per cent and 67 per cent for the 20 per cent and 30 per cent EU reduction targets, respectively, relative to a case without any international credits.

Den Elzen et al. (2009) use the FAIR model to assess the impact of REDD and other forest sequestration options using the MAC curves available in the literature. The analysis examines a relatively more stringent 450 ppmv CO_2e stabilization scenario in line with the latest recommendation by the IPCC. As a result of limitations on CDM and the greater stringency of the caps, this study finds more moderate impacts of REDD credits on the carbon price, ranging between 10 and 32 per cent decreases in 2020. Although the FAIR model does not account for banking, the authors discuss the potential role that banking could play in theory.

The FAIR and GLOCAF models – which share the same structure – are multi-year models that partially capture some dynamics in their MAC curves that are absent in Anger et al.'s model. The MAC curves are path dependent, i.e., are a function of the policies from previous periods as a result of induced technological change and learning by doing. For instance, if the abatement demand in the early years of a climate policy is relatively low as a result of a weak international agreement, the MAC curves in 2020 will yield less abatement for the same carbon price than in scenario with the same cap in 2020 but with stronger earlier commitments. A shortcoming of most partial equilibrium models comes from the fact that such dynamics are lost. The FAIR and the GLOCAF models partially capture the path-dependent nature of emission reductions. This is a crucial feature that might lead to a large difference between scenarios across static models. If banking were implemented in such models, however, it would most probably reduce the importance of the near term caps, as market participants would have incentives to overcomply early on so as to reap the benefits of expected abatement efficiencies in the later years.

1.3.2 Models with banking

In general, models with banking indicate higher allowance prices in the near term and lower prices in the later years compare to the no banking case. They also indicate that introducing REDD credits has lower price impacts in any single period, as the price reductions are optimally spread out over the entire lifetime of the policy, compared to a situation without banking. Piris-Cabezas and Keohane (2008) provided the first assessment of the impact of REDD credits in the global carbon market using a model that incorporated banking (see chapter 2). The emissions reductions path considered in their analysis is consistent with a peaking target of 450 ppmv CO2e, which translates approximately into a stabilization target of about 550 ppmv CO2e by 2050. In a scenario with unlimited REDD trading, they find that a global REDD program would lower the global carbon price by 14 per cent in 2020 relative to a price of \$35/tCO_2e in 2020. In a rough sensitivity analysis, doubling and halving the supply of REDD in the original MAC curves reduces the price by an estimated 9 per cent and 23 per cent, respectively, compared to the case with no REDD. Furthermore, in an update incorporating the MAC curves reported in Kinderman et al. (2008), the resulting reduction of the carbon price in 2020 ranges between 14 per cent and 29 per cent. Based on the same carbon model but using the most recently updated cost curves for avoided deforestation from the Global Timber Model (GTM), Murray et al. (2009) report that a global REDD program reduces the carbon price by about 22 per cent if deforestation only is included, and by about 43 per cent if all international forest carbon is included.

Using similar policy assumptions consistent with a 550 ppmv CO2e stabilization scenario but a more integrated modeling framework that takes into account impacts on the climate as well as induced technological innovation in the energy sector, Bosetti et al. (2009) also find that banking has important implications for the carbon price trajectory and the associated impact of REDD. Modeling a carbon market that limits international trading before 2020 and that lasts through the end of the century, they find that banking raises the carbon price until 2035 and lowers it thereafter. In contrast to other studies where the carbon price is predicted to rise at a constant rate of interest, in this model, even with banking, the impact of introducing REDD credits varies over time as the interest rate varies endogenously over time and different world regions. Taking into account banking, Bosetti et al. (2009) estimate that credits for deforestation reductions worldwide lower the price about 22 to 23 per cent for the period 2015-19 as well as for

2045-49. Without banking, REDD lowers the price by an estimated 20 to 25 per cent in 2045-49. The price is already so low over 2015-19 ($3.5 versus $46-$47 with banking) that including REDD has a negligible effect during this period.

1.4 STRESS TEST

This section presents a new modeling exercise to further explore the potential impact of REDD on the carbon market. Instead of estimating the price impact resulting from the marginal abatement costs curves applied in the studies described above, we carry out the inverse exercise, calculating the required amount of REDD tons that would make the global price of carbon drop by a given percentage, namely, 25 per cent, 50 per cent and 75 per cent.[6] The scope is to provide an order of magnitude of the scale of REDD credits that would make the price of carbon drop to the levels forecasted by models that do not take into account banking.

1.4.1 Methodology

This analysis is based on the partial equilibrium model described in detail in chapter 2. We use the model to find the quantity of REDD credits that lowers the carbon price by each target percentage relative to a core scenario without REDD. For the sake of simplicity and to illustrate the potential impact of very low cost REDD opportunities, we make the extreme assumption that REDD credits actually come at zero cost to regulated entities and thus are all purchased as soon as they become available.

A global carbon market over the period from 2013-2050 is modeled by combining estimates of the costs of reducing emissions from all potential sources (for example, the supply of abatement) and the demand for these reductions based on a scenario of differentiated national commitments to reduce emissions over this period. For the US, the model has been updated with president Obama's proposal – as outlined November 2008 –

[6] As the forecasted carbon prices are supposed to increase at a constant real interest rate, the noted drops in the price of carbon apply indistinctly throughout the time frame of the policy.

to reduce US emissions to 1990 emission levels by 2020 and an additional 80 per cent by 2050.[7] The modeled policy scenario allows full-flexibility in terms of trading of allowances or offsets, whether domestic or international, as well as for banking excess emissions reductions above and beyond current obligations for use in complying with obligations in future periods.

Three REDD supply scenarios are considered in this analysis. First, the supply of REDD credits is assumed constant for the period analyzed. Second, we assume the supply of REDD credits gradually decreases at a constant rate such that the REDD tons available by 2050 are just 20 per cent of the supply in 2013 (i.e., the REDD supply decreases by 4.26 per cent per year). This order of magnitude is consistent with global business-as-usual forecasts of gradually decreasing global deforestation (e.g. Kindermann et al. 2008). Conversely, in the third set of scenarios, the supply of REDD ramps up over time, quintupling between 2013 and 2050, an increase of 4.26 per cent per year. The cumulative supply is thus the same in both the second and third set of scenarios but following the inverse time path. The second set of scenarios represents the impact of decreasing crediting baselines or business-as-usual deforestation while the third set reflects gradually increasing REDD capacity and availability. As a consequence of banking, all three scenarios result in the same cumulative quantity of REDD tons purchased over time for each of the three price scenarios considered.

1.4.2 Results

In the constant REDD supply -25 per cent scenario, the amount of REDD credits required for a 25 per cent drop in the carbon price relative to a scenario without REDD is 3.40

[7] We assume that this target is a truly national target and that the target between 2012 and 2019 follows the one proposed in the Boxer Lieberman-Warner Climate Security Act of 2008 (S.3036). For the European Union, Japan, Canada, Australia, and New Zealand, reductions in line with the current Kyoto protocol are assumed to continue, reaching 20 per cent below 1990 by 2050 and 60 per cent below 1990 levels by 2050. The rest of the world, including Brazil, is assumed to emit at business-as-usual levels until 2020 and then reduce emissions steadily to 1990 levels by 2050.

billion tCO2 (Table 1.1). For reference, this figure is in line with the average maximum available avoided deforestation across the three global models (GTM, GCOMAP and DIMA) discussed in Kinderman et al. (2008)[8] for 2010, 2020 and 2030 (3.53 billion tCO_2). However, the maximum quantity of reduced deforestation is only attained at a price of $100/$tCO_2$ over a long-term period and does not take into account, inter alia, the transaction costs. In the constant supply -25 per cent scenario, at the prevailing prices, the referred mean MAC curve would only yield 2.45, 2.65 and 2.90 billion tCO_2 in 2010, 2020 and 2030 respectively.

The constant amount of REDD quantity (Q) required to lower the carbon price (P) by 50 per cent and 75 per cent is 7.50 and 12.50 billion tCO2 per annum (Table 1.1) respectively. Such amounts are above the estimates of annual global deforestation emissions in the literature. Table 1.1 also depicts the results for REDD decreasing and REDD increasing scenarios. Except potentially for the -25 per cent scenarios, the quantities involved in the other cases exceed most current and future estimates of annual deforestation emissions.

1.5 CONCLUSIONS

The multi-period modeling approach to assess the impact of REDD credits under US climate bills provides a new perspective on REDD financing. The long-term horizon, the progressive tightening of ambitious emission caps, and the possibility of banking enable a direct market-based funding mechanism to deliver financing at significant scale and absorb the maximum quantity of REDD tons, even in the near term. Under such a scenario, not only do the flooding concerns appear unfounded but the opposite risks

[8] The REDD MAC curves in Kinderman et al. are relevant because such MAC curves have been used by at least four modeling teams in their assessment of the impact of REDD in the global carbon markets. Nevertheless, such MAC curves have been constructed with a set of constant carbon prices, which are not consistent with the forecasted rising price paths. In contrast to the constant REDD supply case, the models reviewed in Kinderman et al. also project a downward trend in the maximum available avoided deforestation.

become paramount of insufficient REDD credits being ready to deliver the desired cost savings. While ignoring the role of banking could be appropriate given a short-term regulatory framework, the potential enactment of cap and trade legislation in the US changes the policy landscape. As a result, modeling banking becomes important for examining the global carbon market. Absent the perspective based on this additional modeling effort, the gap between the US and Europe positions on REDD could broaden further.

A review of estimates of the price impact of REDD in the global carbon market illustrates the critical role of banking. On the one hand, models that take into account banking find moderate impacts on the price of carbon, as the price reductions are optimally spread out over the entire lifetime of the policy. On the other hand, static models indicate that allowing unconstrained trading of REDD credits lowers the price of carbon more dramatically. In order to put the latter results into context given banking and a global market over 2013-2050, we estimate the supply of completely free REDD tons that would depress the global price of carbon drop by percentages in line with the findings from the static models. We find the quantities required exceed most current and future estimates of annual deforestation emissions.

Banking provides an intertemporally cost-effective solution that harvests the relatively cheaper mitigation options that would otherwise be irreversibly neglected due to an unbalanced stringency of the short- and long-term targets that could result from the negotiations. It thus facilitates the synergies between efforts to curb deforestation and forest degradation – with all the associated ancillary benefits – and the required global abatement necessary for a 450 ppmv CO2e stabilization. Banking also accelerates global reduction targets and helps keep options open for meeting even more stringent stabilization targets in the future. Banking emissions allowances is a voluntary decision that results in a market solution that could yield significant economic and environmental benefits. The potential impact of banking highlights the importance of climate policies providing a credible, long-term price signal that enable market participants to anticipate future compliance obligations.

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TABLES

Table 1.1 Model Results for Constant, Decreasing and Increasing REDD Scenarios

	P	2013	2050
Constant Q (million tCO_2e)	-25%	3 400	3 400
	-50%	7 500	7 500
	-75%	12 500	12 500
Q declining by 4.26% per year	-25%	6 750	1 350
	-50%	15 000	3 000
	-75%	25 000	5 000
Q increasing by 4.26% per year	-25%	1 350	6 750
	-50%	3 000	15 000
	-75%	5 000	25 000

2. Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD): Implications for the Carbon Market*

2.1 INTRODUCTION

Forestry activities in the developing world represent a prime source of low-cost reductions of greenhouse gas emissions, especially over the next ten or twenty years. A range of estimates indicate that the cost of forest protection in some parts of the world is far less than the cost per ton of more expensive means of reducing CO2 emissions given today's technologies.[1] In particular, reducing deforestation in tropical forest nations could make a substantial contribution to addressing climate change. Afforestation and changes in forest management also offer considerable potential for carbon sequestration, reducing net emissions of carbon into the atmosphere.

Because tropical forest nations are unlikely to take on mandatory caps on emissions in the near term, a policy mechanism is needed to compensate them for emissions reductions achieved in the near term. A promising approach is to give credits for verified emissions reductions against a national baseline – credits that could then be used for compliance in cap-and-trade programs in the European Union (and eventually, perhaps, the United States). This proposal, known as Reducing Emissions from Deforestation and Forest Degradation (REDD) crediting or market-based REDD, would encourage emissions reductions in tropical forest nations while helping to manage the costs of compliance in countries that take on economy-wide caps.

At the same time, REDD crediting would leverage the carbon market to create a powerful incentive for the protection of tropical forests. Over time, this approach could

* This chapter is an adaptation of a paper written by Pedro Piris-Cabezas and Nathaniel Keohane.
[1] See IPCC (2007); Stern (2006); and Nepstad et al. (2007)

be supplemented with credits for rigorously verified and measured sequestration by afforestation and changes in forest management.

Although the argument for this policy mechanism is compelling, the scope of emissions reduction and sequestration opportunities in developing countries – and the potential for forest carbon credits to lower compliance costs in cap-and-trade programs – have not been well estimated. At the same time, several observers (particularly in Europe and in the environmental community) have expressed concerns that forest carbon credits might be so inexpensive and plentiful that they will be ‘flood the market’, and will drive down the price of allowances far enough to undermine incentives for the industrial and electric power sectors to invest in reducing their own emissions (see chapter 1 for a discussion). If forest carbon credits were ‘too cheap to meter’, these observers ask, will they end up hindering the development of the new clean technologies that will be needed to make deep emissions cuts in the long run?

As a first cut at exploring these issues, we have developed a spreadsheet-based partial equilibrium model to assess the supply of international forest carbon credits from the developing world. Using this model, we have conducted a simple modeling exercise to assess the potential impact of on GHG markets of allowing such credits to be used for compliance in the EU and United States. Our analysis takes into account the interplay of the supply of emissions reductions (through abatement and sequestration) and the demand for those reductions (driven by government policies). Banking is also modeled explicitly – a crucial feature, given that forest carbon tons in particular represent a reservoir of low-cost abatement that could allow entities to build up an allowance bank in the early years of a cap-and-trade program.

We model a global market for emissions credits, and consider a policy scenario in which the United States enacts the Lieberman-Warner legislation; the European Union, Japan, Canada, Australia, and New Zealand reduce emissions 60 per cent below 1990 level; and the rest of the world begins reducing emissions in 2020 and reaches 1990 levels by 2050. We assume that there are no quantitative restrictions on the number of forest carbon credits that can be used by regulated entities in the United States or European Union for compliance with their domestic cap-and-trade programs. This assumption does not reflect current reality. The European Union's Emissions Trading Scheme (ETS) does not allow forest carbon tons at all in its current phase; nor are such credits envisioned as part of the EU Climate Change Package as explored in detail in Part II of the dissertation. Nonetheless, we consider scenarios without quantitative restrictions in order to explore the potential impact of forest carbon credits on the global carbon market.

By the same token, the supply curves we use attempt to capture the economic potential for sequestration from reduced tropical deforestation, forest management, and afforestation. They do not take into account the needs for institutional capacity building, implementation, transactions costs, and so on. As a result, the results presented here should be viewed as a 'scoping exercise' to convey the potential magnitude of the opportunity from forest carbon credits.

The next section discusses our methodology and assumptions in more detail. Section 3 presents our key results, and Section 4 concludes.

2.2 METHODOLOGY

Our simple partial equilibrium model solves for an intertemporal equilibrium for the period 2012-2050 in which two conditions are met in every year: (1) the market clears (i.e. the quantity of credits demanded at the current price, including banked tons, equals the quantity supplied at that price); and (2) the present value of the international credit price is equal in every period (i.e., the price rises at the market rate of interest).

Throughout this paper, all monetary values are stated in real (inflation-adjusted) terms and in 2005 US dollars. Emissions and abatement are expressed in metric tons of carbon dioxide equivalent ($mtCO_2e$).

2.2.1 Supply of emissions reduction credits

The supply of credits comes from abatement and sequestration activities throughout the world. We use EPA's marginal abatement cost curves for energy-related and non-CO2 emissions reductions in industrialized and developing countries, and for non-CO2 abatement in the United States.[2] The estimates of U.S. energy-related abatement supply curves are taken from an analysis by researchers at the Massachusetts Institute of Technology, using the EPPA model.[3] Finally, for international forest carbon activities we draw on estimates by Brent Sohngen of Ohio State University.[4]

These marginal abatement cost curves shift over time, reflecting assumed changes in technology and underlying conditions (e.g. baseline rates of deforestation).

As discussed in more detail below, we also perform sensitivity analyses by running the model with more or less generous assumptions about the quantity of forest carbon credits available.

2.2.1 Demand for abatement

The demand for allowances is driven by the emissions caps imposed by government policy. Policy assumptions are as follows:

- The United States enacts the Lieberman-Warner legislation, reducing emissions to 70% below 2005 levels for the 85% of the economy covered by the bill.
- Group 1 (G1) countries (European Union, Japan, Canada, Australia, New Zealand) continue reducing emissions roughly in line with the current Kyoto

[2] These estimated marginal abatement cost curves are included in the technical materials provided by the Environmental Protection Agency (EPA) in its Data Annex to its report on S.2191, available at http://www.epa.gov/climatechange/downloads/DataAnnex-S.2191.zip.

[3] We derive energy-related marginal cost curves from the results of MIT's modeling of U.S. climate policy presented in Palsev et al. (2007).

[4] We use Sohngen's curves from the Energy Modeling Forum 21 based on rising carbon price scenarios, which are the most internally consistent with our model structure. These data are available at: http://www.stanford.edu/group/EMF/projects/group21/EMF21sinkspagenew.htm

Protocol, reaching 20% below 1990 by 2050 and 50% below 1990 levels by 2050.

- Group 2 (G2) countries (rest of the world – that is, developing countries plus Russia) emit at business- as-usual levels until 2020, and then reduce emissions steadily to 1990 levels by 2050.

Although our focus is on forest carbon credits from developing countries, we also take into account offsets from energy-related emissions in developing countries, as well as non-CO2 gases; in the Kyoto Protocol framework, these correspond to Certified Emissions Reductions under the Clean Development Mechanism. Throughout this paper, we refer to credits arising from these emissions reductions as "offsets," and refer to reductions and sequestration from forest activities exclusively as "forest carbon credits." We assume that G1 countries allow up to 10% of abatement to come from these offsets. On the other hand, we assume that the United States does not allow such offsets for compliance, until developing countries begin reducing their emissions. We do, however, assume that the United States allows the use of credits from other capped nations — meaning the G1 countries in the first eight years of the program, and the entire world from 2020 onward.

2.2.3 Policy scenarios for forest carbon

In order to assess the potential role played by forest carbon credits, and REDD credits in particular, we compare model results from several scenarios. In all scenarios, we use the overarching targets described above. All scenarios allow offsets for emissions reductions from forestry in the US, G1, and Russia.

1. Benchmark scenario. No forest carbon credits from developing countries allowed for compliance in the US or G1.
2. Core REDD scenario. Forest carbon credits from reduced deforestation in tropical forest nations only (i.e., South America, Asia Pacific, and Africa).
3. REDD sensitivity scenarios: (a) Twice as many REDD credits available at every

given price, relative to the baseline assumptions in Scenario 2; (b) Half as many REDD credits available at any given price.

4. Core All-Forestry scenario. Forest carbon credits allowed from all forestry activities in developing countries, including afforestation and forest management as well as reduced tropical deforestation.
5. All-Forestry sensitivity scenarios: (a) Twice as many forest carbon credits available at every given price, relative to Scenario 4; (b) Half as many forest carbon credits available at any given price.

2.2.4 Banking

A crucial feature of our approach is the assumption that agents optimize abatement decisions across time by "over-complying" in early years (or purchasing forest carbon credits on the market) and banking the resulting allowances for later. This assumption is common practice in current economic modeling of climate policy in the US by, for example, the US Environmental Protection Agency (EPA) and the Massachusetts Institute of Technology (MIT). Our modeling framework adds a layer of complexity by annually assigning the banked allowances or credits by country or regions proportional to their carbon budgets through 2050.

The ability to bank allowances is especially important in the context of international offsets from forestry. Since forest tons represent a large pool of relatively low-cost emissions reductions opportunities in the early years, they are a natural candidate for banking. This is true both for the U.S. and G1 countries (whose demand for forest carbon credits in early years increases when those credits can be banked for later) and for the developing countries where the emissions reductions occur (since they can now prepare for their eventual acceptance of mandatory emissions reductions).

Figure 2.1 demonstrates the importance of banking. The figure depicts the market for GHG allowances in the year 2020, with price (in dollars per ton) on the vertical axis and allowances (i.e., abatement, in millions of metric tons of CO2-equivalent, or $MtCO_2e$) on the horizontal axis. The upward- sloping red line represents the projected supply of offsets from developing countries; forest carbon credits, which are a subset of these offsets (and are included in the red line), are highlighted in green.

The dashed blue line represents current demand for allowances from the United States and G1 countries, given the policy assumptions described above. The solid blue line represents total demand, including demand for banked tons (effectively, demand for tons in 2020 that is driven by future compliance needs). In the early years, as in 2020, banking is positive (the bank is being built up), hence the solid line lies to the right of the dashed line. In effect, the demand for allowances increases because it now takes into account future demand. (In later years, banking is negative – the bank is being drawn down – hence the positions of the solid and dashed lines are reversed.)

As Figure 2.1 shows, banking raises allowance prices in the near term, as market participants build up the allowance bank. In our model, the projected price of allowances in the year 2020 is \$30/tCO_2e, under the REDD core scenario depicted in the figure. This price corresponds to the intersection of the solid red and blue lines. Without banking, the price would be driven only by current demand, and would correspond to the intersection of the solid red line and the dashed blue line, around \$11/tCO_2e.

To model banking, we treat agents as if they have rational expectations about the future, in line with standard economic theory.[5] As a result, allowance prices must increase at a constant rate of interest reflecting the real rate of return in the market. In our analysis, this interest rate is an exogenous parameter which must be chosen: here, we present results with a 5% interest rate. (A higher assumed interest rate would "tilt" the time profile of offset prices, so that they started out lower but increased more rapidly.)

[5] To implement banking, we use the macro program included in the Offset Market Tool program developed by the EPA and made available in the Data Annex to its analysis of the Lieberman-Warner legislation.

The intuition behind the steadily rising prices is a simple arbitrage argument. If prices were expected to rise at any rate other than the prevailing market rate of return, investors could make a pure profit by buying or selling allowances relative to other assets. For example, if prices rose at a faster rate, it would pay investors to buy and hold allowances in order to sell them later at a profit. The resulting current increase in demand would raise prices today, forcing them to rise more slowly in the future and bringing the market back into intertemporal equilibrium.

Of course, in reality prices will not rise as smoothly as this model would predict. Shocks and unexpected events constantly force the market to readjust its expectations of the future, and prices move as a result. However, such a smooth price path is the best single prediction of the future, since it is the only predicted path that is consistent with market equilibrium and profit- maximizing behavior by market agents.

2.2.5 Results

We now present the main results of our modeling exercise. What is the likely impact on GHG allowance prices of allowing international forest carbon credits? How many such credits are likely to be available at prevailing prices? And what is the profile of these credits over time?

2.2.5.1 Allowance prices

Figure 2.2 addresses the first question, showing the effect of forest carbon on projected allowance price paths. Under our baseline scenario, the allowance price is projected to be \$23/tCO_2e in the year 2012 (rising thereafter at 5 per cent in real terms). Under Scenario 2, with REDD credits allowed, the projected price falls by 13 per cent to \$21/tCO_2e.[6] Under Scenario 4, with credits from all forestry activities in developing countries, the

[6] The numerical values given are rounded to the nearest dollar. The percentage numbers reflect the more precise estimates, and thus may not match the apparent percentage changes from the figures given in the table.

projected price falls an additional \$5, to \$16/tCO_2e. Table 2.1 presents results for all scenarios.

2.2.5.2 Quantity of international forest carbon credits

We now turn to the quantity of international forest carbon credits under the two core scenarios (Scenarios 2 and 4). The next several figures offer a comprehensive look at the composition of abatement from all sources used for compliance in the United States and G1 markets.

Figures 2.3a and 2.3b show projected worldwide abatement by source under the two scenarios. The green areas in each chart correspond to forest carbon credits due to reduced deforestation, afforestation, and forest management in tropical nations; the orange and yellow layers correspond to emissions credits from forestry activities elsewhere in non-G1 countries (including countries in the former Soviet Union). The blue areas correspond to energy-related and non-CO2 offsets from the developing world; the gray areas at the bottom correspond to abatement within the G1 countries (light gray) and United States (dark gray). The upward-sloping line represents total demand for allowances.

Two conclusions emerge. First, total abatement exceeds demand in the first two decades of the program. In the figure, the colored areas rise above the line representing demand: The difference corresponds exactly to banking. (In later years, of course, the colored areas fall below demand, as the allowance bank is drawn down.) Moreover, the bank is comparable in magnitude to the quantity of forest carbon credits on the market.

The second conclusion to emerge from the figures is that forest carbon credits account for a significant portion of abatement, they are hardly “flooding the market.” This point is reinforced by the pie charts in Figure 2.4 (above). Each chart shows the breakdown of total abatement by source. The top two charts correspond to the REDD-only core scenario; the bottom two include all forestry activities. The left-hand charts depict the United States, while the right-hand charts show G1 countries.

In the REDD-only core scenario, REDD credits used for compliance in the US and G1 countries account for 27 Billion tons of abatement over the period modeled here (2012-2050), with roughly two- thirds of that going to the US. This amounts to about 10% of total abatement in the US and G1 markets combined. In the All Forestry core scenario, forest carbon credits altogether account for 51 Billion tons, or 18 per cent.

For both the US and G1 markets, however, the great majority of abatement over time – 60 to 75 per cent – comes from reduced energy-related CO2 emissions within those countries. (These are the gray-blue areas in the pie charts in Figure 2.4)

2.2.5.3 Reduced deforestation in comparison to other forestry activities

As Figures 2.3 and 2.4 illustrate, reduced deforestation in tropical nations accounts for the majority of credits from forest activities that are used for compliance in the US and G1 countries, even when other sources of forest credits are allowed. Figure 2.5 shows the breakdown of all forest abatement by source for the All Forestry core case. When developing countries are taken into account, as in Figure 2.5, avoided deforestation continues to account for a substantial share of abatement, although it plays a proportionally smaller role than afforestation in cumulative terms. As Figure 2.6 illustrates, we project that the U.S. would receive the lion's share of forest carbon credits for the first twelve years, until the developing countries take on mandatory caps of their own. Roughly 200 $MtCO_2e$ goes to the G1 countries in that early period, with similar amounts banked by G2 for their later use. Beginning in 2025, those figures fall dramatically, as most of the available emissions reductions are consumed by the tropical nations themselves to meet their own domestic targets. From 2035 on, the entire quantity of forest carbon credits are reserved for domestic use.

2.2.5.4 Robustness to alternative assumptions about availability of forest tons

Given the considerable uncertainty surrounding the availability and cost of emissions reductions from forestry, it is worth exploring how our results might change under alternative assumptions of the supply of forest carbon credits. Accordingly, we performed a simple sensitivity analysis (Scenarios 3a,b and 5a,b), first doubling and then halving the number of REDD and forest carbon credits available at any given price. (Recall the presentation of the results in Table 2.1.)

The striking conclusion from the sensitivity analysis is how little the qualitative conclusions are affected. In the REDD-only policy case, the initial allowance price ranges from \$18/tCO_2e (when the supply of REDD credits is doubled) to \$22/tCO_2e (when it is halved) – relative to \$21/scenario in our core scenario. Again, banking plays a crucial role. Even when the supply of REDD credits is doubled, the impact on near-term prices is still moderated by the opportunity to save the resulting tons for compliance in future years. A similar conclusion holds for the All Forestry scenarios, where the projected price in 2012 ranges from \$12/tCO_2e (if forest carbon credits are plentiful) to \$20/tCO_2e (if they are scarce).

2.4 CONCLUSIONS

The bottom line from our analysis is that there is a large reservoir of potential net emissions reductions from forests in the developing world – especially from reduced deforestation in tropical areas. These forest carbon tons can play a crucial role in keeping open options for averting 2ºC of warming, as they can serve as a bridge to the time when low-carbon energy technologies are more affordable and more widely deployed. At the same time, they can help moderate the long-term path of GHG allowance prices in the European Union and the United States, helping entities in those countries to manage their costs of compliance with a cap-and-trade program and bolstering political support for deep reductions in emissions.

We find that the short-run price impact of allowing forest carbon credits into the market will be mitigated by banking,[7] provided that banking is allowed in policy frameworks. Banking plays a crucial role in our results because it creates an economic link across years – so that the value of a ton of abatement in the early years of a program is driven in part by the cost of reducing emissions later, when caps are more stringent. Rather than flooding the market and driving down the price in the short run, only to have the price rise sharply again later, forest carbon credits will represent a deep reservoir of low-cost abatement that is available now but can be banked to help manage costs in the future.

The precise projections to come out of this analysis, of course, depend heavily on the underlying assumptions that must be made. The results are driven by assumptions about the timing and stringency of international policy, the availability and cost forest carbon credits, and the extent to which they are allowed into the market. Nonetheless, several conclusions emerge from this analysis that are likely to be robust to a range of alternative assumptions and scenarios.

1. Forest carbon credits from developing countries, including REDD credits, have considerable potential to help limit the costs of compliance with cap-and-trade programs in the EU and United States. In our model, allowing the use of REDD credits for compliance lowers the projected price of GHG allowances by roughly 13 per cent. A more expansive policy allowing credits from all forestry activities in developing countries would reduce prices by as much as one third.
2. Even if no regulatory limit were placed on the use of forest carbon credits for

[7] As described in chapter 1, by banking we refer to the ability of regulated entities, in any given year, to save surplus allowances and credits for use in future years.

compliance with cap-and-trade programs, and even if forest carbon credits throughout the developing world became available within the next five years, our model projects that the market price of GHG allowances would be \$16/tCO_2e in the year 2012, rising to \$24/tCO_2e by 2020 and \$40/tCO_2e by 2030. These levels are high enough to ensure that critical low-carbon technologies, such as renewable energy sources and carbon capture and sequestration, remain economically viable.

3. If REDD credits are allowed for compliance, but not credits from other forestry activities, the projected price of allowances in the US and EU markets is \$21/tCO_2e in the year 2012, rising to \$30/tCO_2e in 2020 and \$49/tCO_2e by 2030.
4. These key qualitative conclusions are robust to alternative assumptions about the availability and cost of forest carbon credits. For example, even if we increase the supply of REDD credits by a factor of two above our base case – assuming that turn out to be twice as plentiful as the best available estimates – we still project an allowance price of \$18/tCO_2e in 2012, rising to \$27/tCO_2e by 2020 and \$43/tCO_2e by 2030.
5. The crucial factor that sustains prices at a moderate level is the ability to bank allowances for the future. Forest carbon credits represent a promising reservoir of low-cost emissions reductions that are available in the short term. Their true economic value lies in their potential to be banked for the future – lowering costs over the course of decades, rather than being used all at once.

Importantly, we have focused solely on the potential for forest carbon credits in the abstract. By giving a sense of the magnitude of the opportunity available, this analysis provides the necessary starting point for a more detailed exploration of the policy mechanisms to help entities realize that potential.

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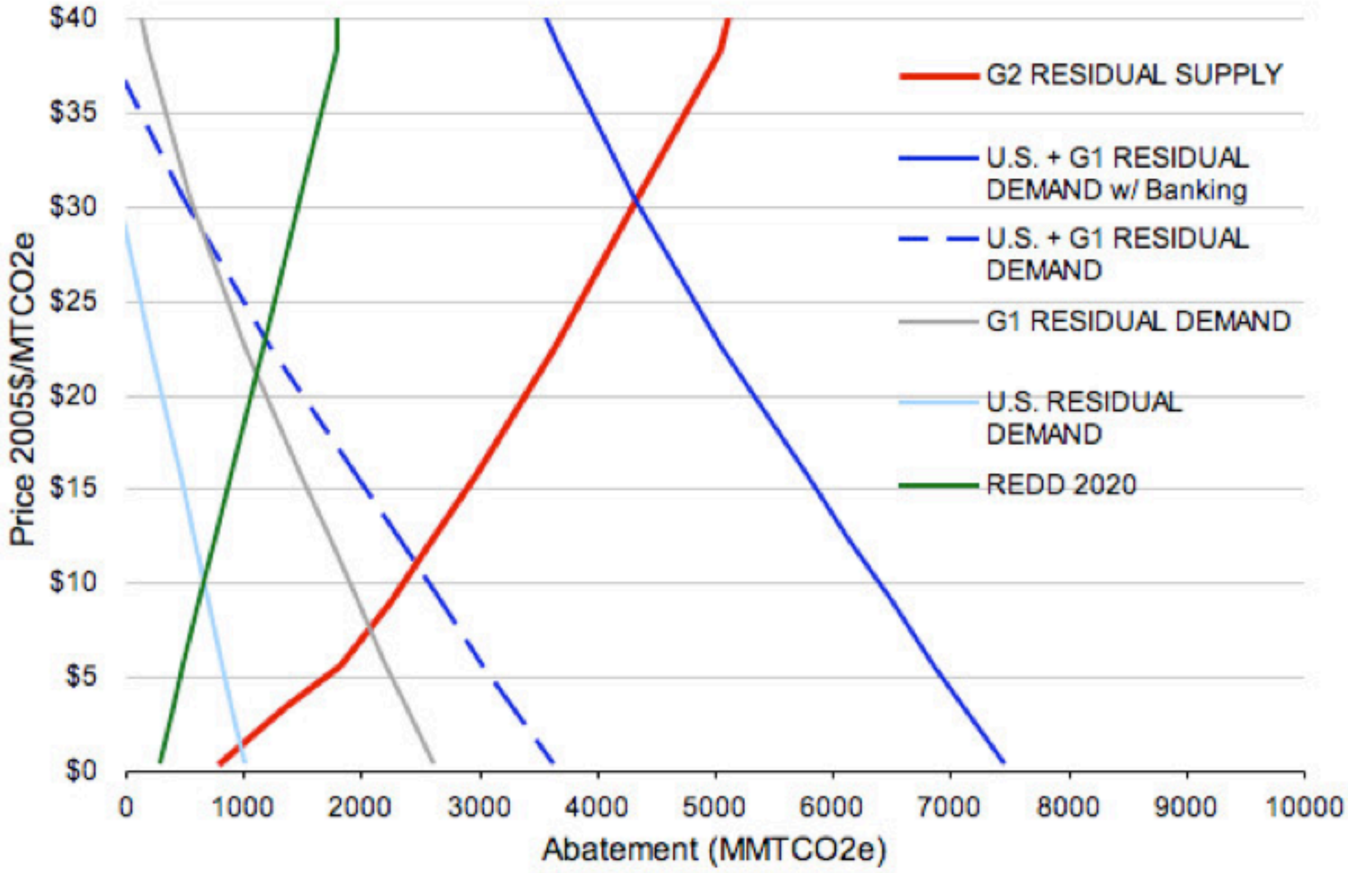
TABLES AND FIGURES

Table 2.1 Allowance Price Forecasts (core scenarios are shaded)

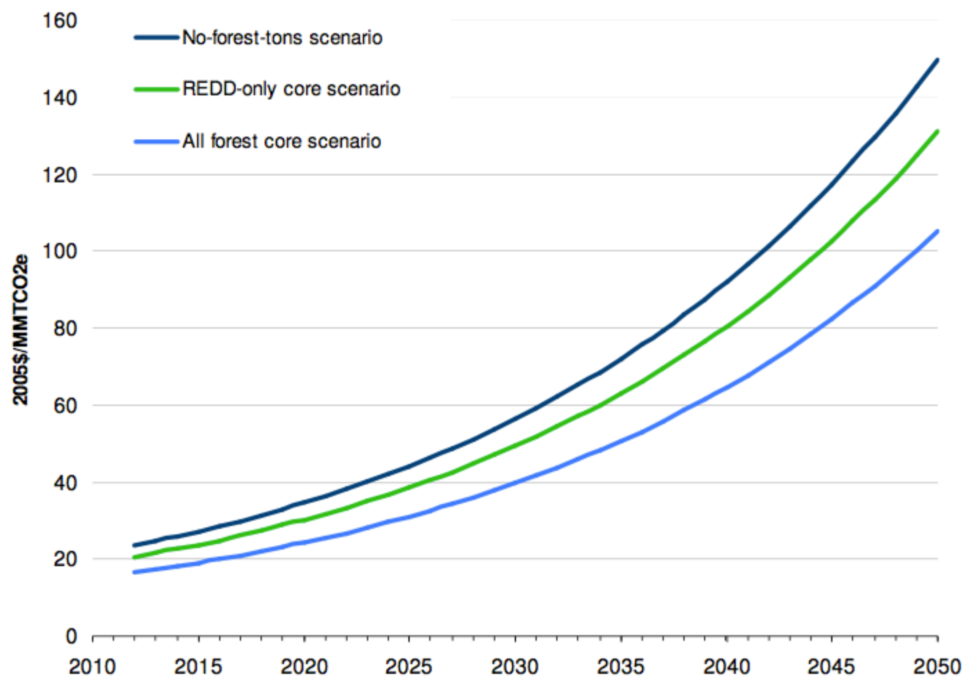
Scenario		(Prices $/tCO$_2$)	2012	2020	2030	2040	2050
1	Baseline (no forest credits)		$23	$35	$56	$92	$150
2	REDD-only core		$21	$30	$49	$80	$131
3a	REDD x2		$18	$27	$43	$70	$115
3b	REDD x1/2		$22	$32	$53	$86	$140
4	All Forest core		$16	$24	$40	$65	$105
5a	All Forest x2		$12	$18	$30	$49	$79
5b	All Forest x1/2		$20	$29	$48	$78	$127

Figure 2.1 Supply and Demand in 2020: the Importance of Banking



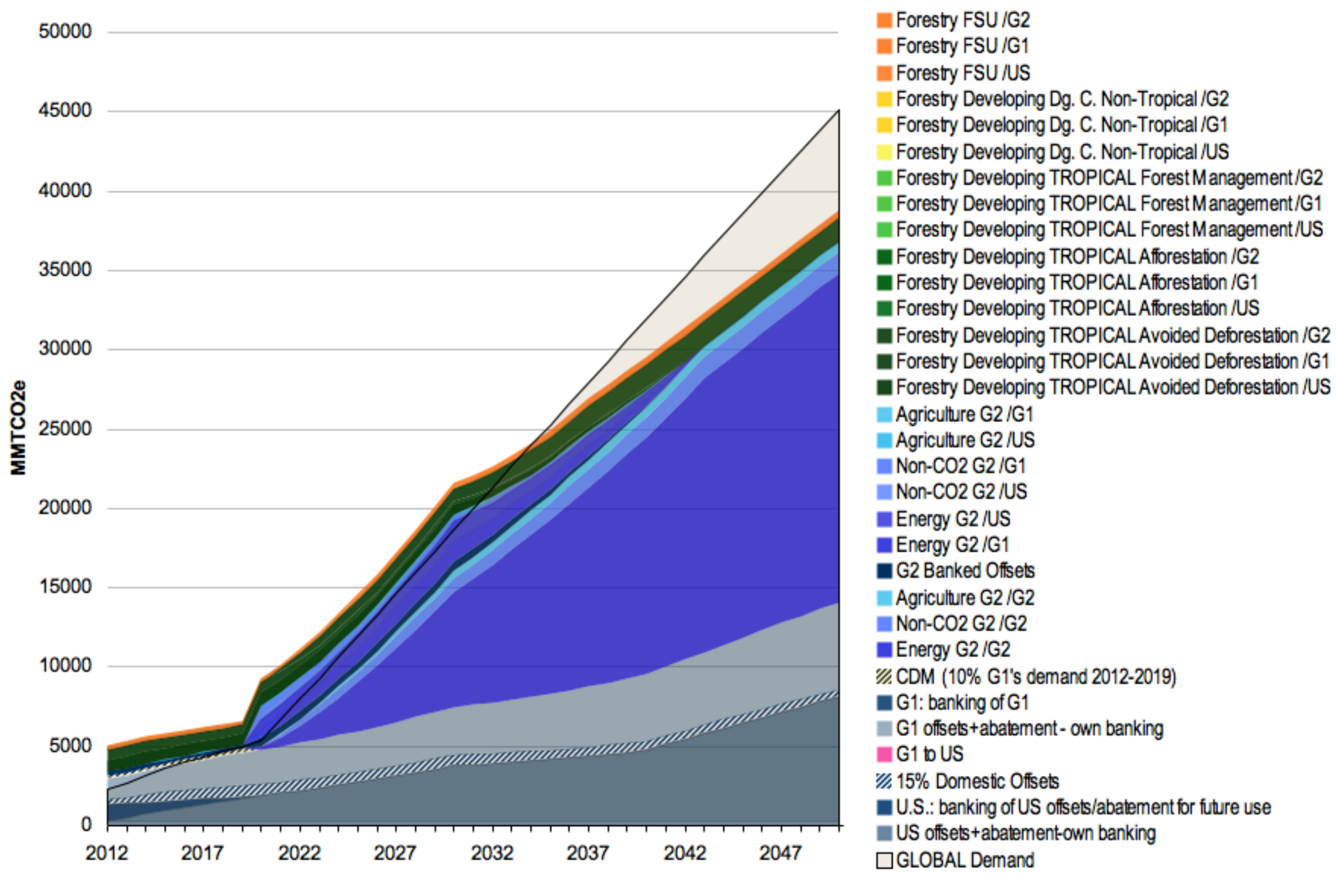
Banking raises allowance prices in the near term, as market participants build up the allowance bank. In our model, the projected price of allowances in the year 2020 is \$30/tCO_2e, under the REDD core scenario depicted in the figure. This price corresponds to the intersection of the solid red and blue lines. Without banking, the price would be driven only by current demand, and would correspond to the intersection of the solid red line and the dashed blue line, around \$11/tCO_2e.

Figure 2.2 Impact of International Forest Carbon Credits on Projected GHG Allowance Prices



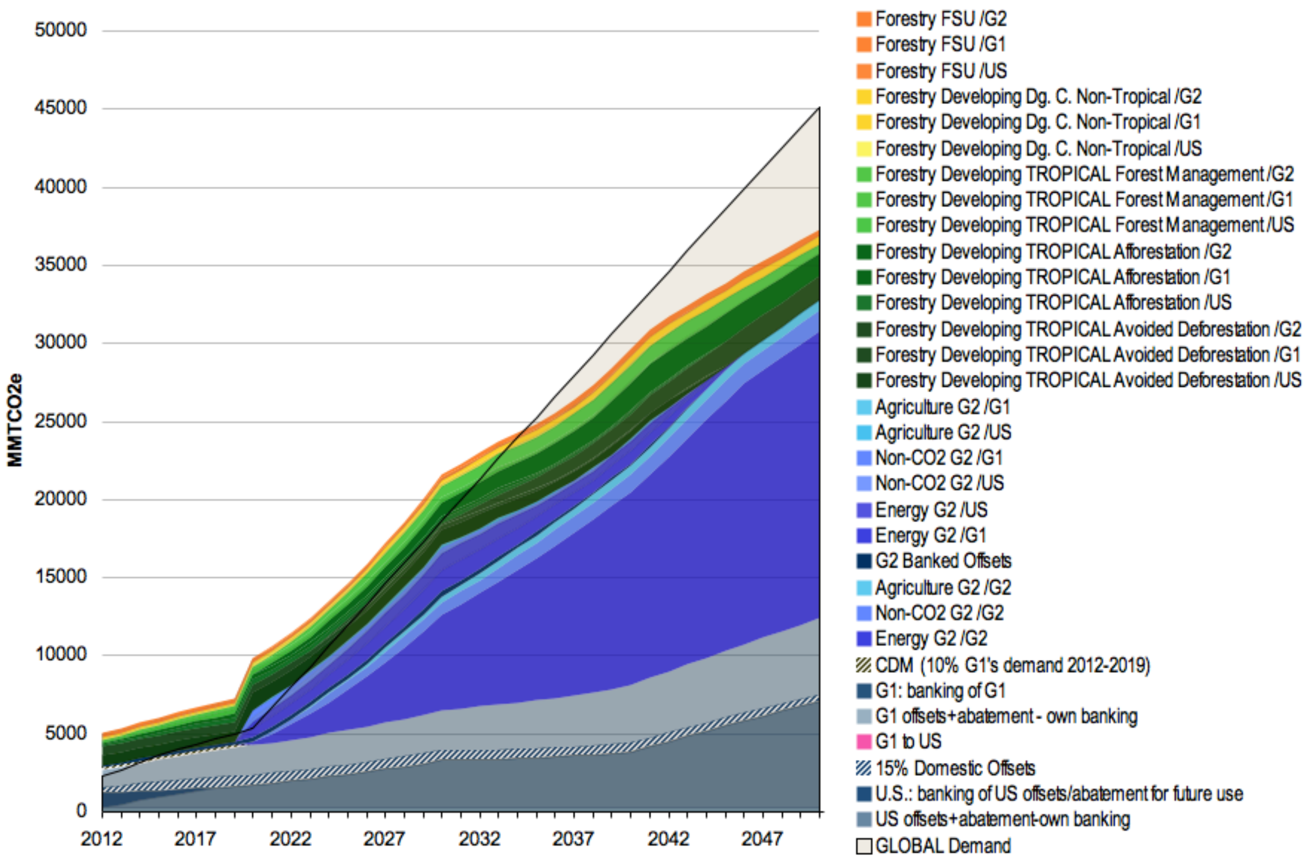
The top line shows projected prices in the baseline scenario without forest carbon credits; the middle line shows the scenario with REDD tons; and the bottom line shows prices with all forest activities. (As noted in the text, all price paths rise at an assumed rate of 5% per year in real terms.) According to these estimates, allowing REDD credits will reduce the initial price in 2012 by three dollars per tCO$_2$e, from \$23/tCO$_2$e to \$20/tCO$_2$e. Allowing credits from all forestry activities reduces the projected price by another \$4/tCO$_2$e.

Figure 2.3a Abatement by Source Activity



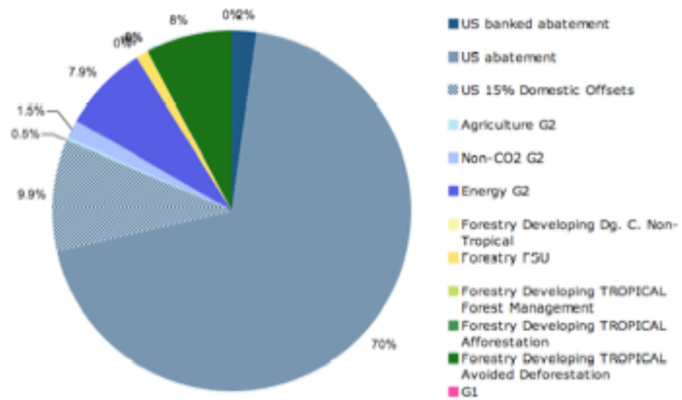
The charts depict worldwide abatement by source activity, for the REDD core scenario (top panel) and the All forestry core scenario (lower panel). In both scenarios, total abatement exceeds demand in the first two decades of the program, as the allowance bank is built up.

Figure 2.3b Abatement by Source Activity

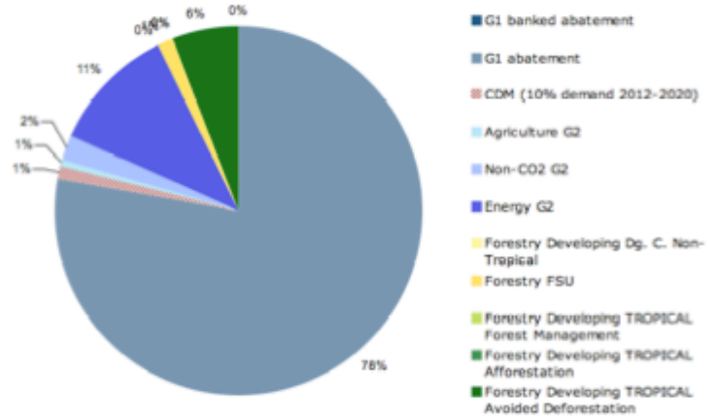


The charts depict worldwide abatement by source activity, for the REDD core scenario (top panel) and the All forestry core scenario (lower panel). In both scenarios, total abatement exceeds demand in the first two decades of the program, as the allowance bank is built up.

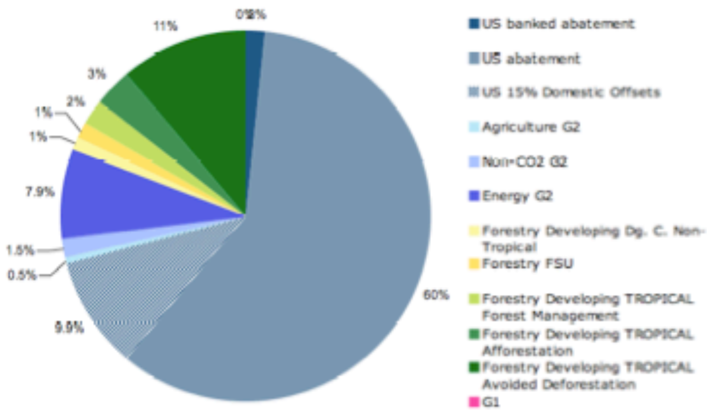
Figure 2.4 Composition of Total Abatement for the US and G1 Countries. *Each chart depicts the breakdown of abatement by source activity, for the US (panels (a) and (c)) and G1 countries (panels (b) and (d)). The top two panels depict the REDD core scenario, while the bottom two correspond to the All Forestry core scenario.*



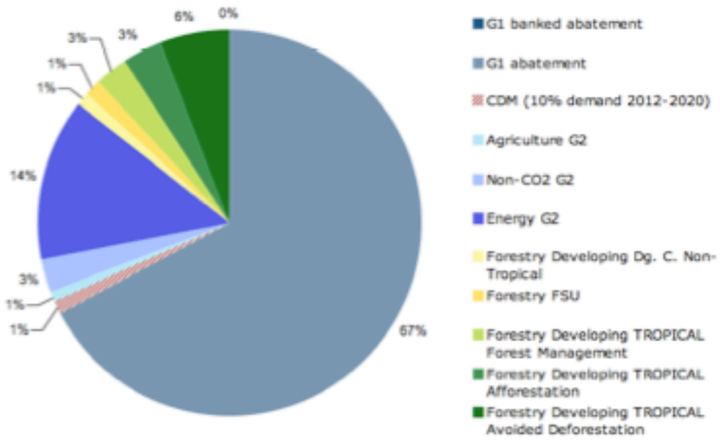
(a) REDD only; US. Total abatement: 213 GTCO2e.



(b) REDD only; G1 countries. Total abatement: 166 GTCO2e.

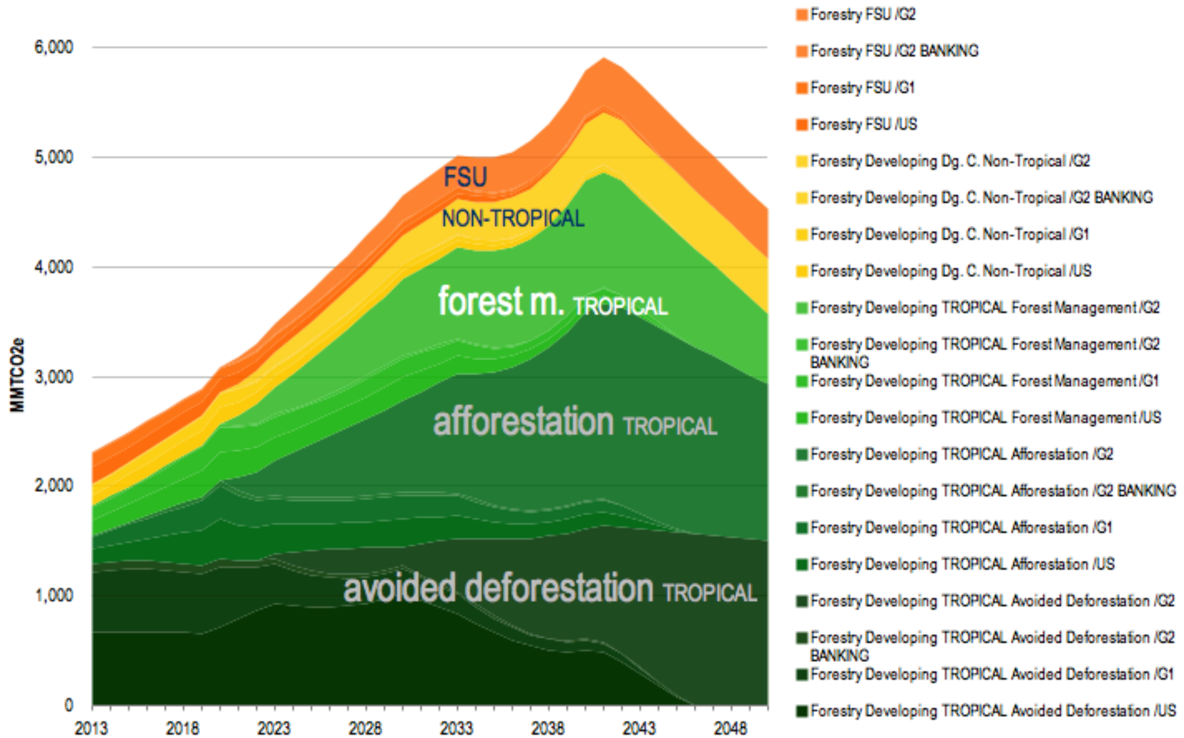


(c) All forestry; US.



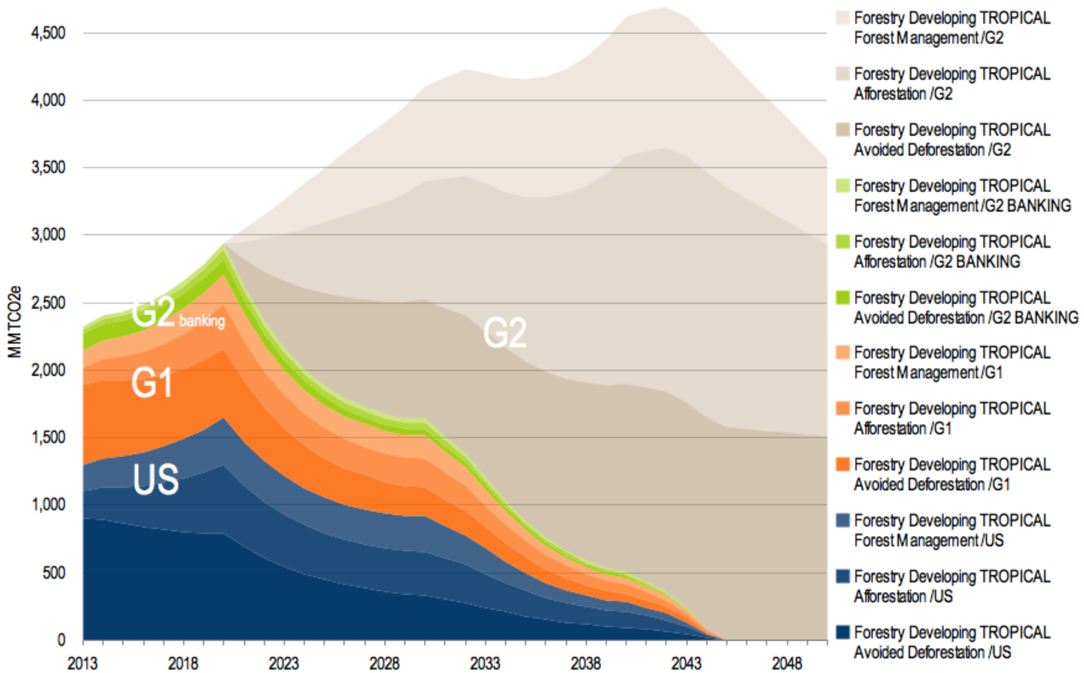
(d) All forestry; G1 countries.

Figure 2.5 Composition of Forest Carbon Credits



This chart depicts forest carbon credits only, for the All Forestry core scenario. Avoided tropical deforestation is represented by the dark green band at the bottom of the chart.

Figure 2.6 Composition of Tropical Forest Carbon Credits by Destination



The bottom (blue) three layers represent tropical forest carbon credits used for compliance in the United States. The jagged profile in the first two decades reflects assumptions about the timing of developing country participation in an international climate agreement. Note that the overall time trend is smooth: total emissions reductions and sequestration from tropical forests increase steadily, roughly doubling from 2013 to mid-century.

3. The European Union's Position on REDD Financing

3.1 INTRODUCTION

As a leader in global climate policy with the largest current compliance market for greenhouse gas (GHG) reductions, the European Union (EU) has been particularly important in shaping international debates on REDD and determining near-term opportunities for REDD financing. Since early in the REDD financing debate, the European Union (EU) has favored a fund-based funding mechanism over direct trading of REDD credits on GHG compliance markets. Such a fund-based approach was already reflected in the EU energy and climate package proposal as introduced by the European Commission (EC) in January 2008, which calls Member States to voluntarily earmark a share of the revenues from the auctioning of emissions allowances issued under the EU emission trading scheme (ETS) – the flagship of the European climate change policy (for a review see Annex 3.1 to this chapter) – to a set of priorities including deforestation and other forest activities in third countries. The package aims at setting the EU in the path to a low carbon economy by establishing, inter alia, unilateral economy-wide targets through 2020 for greenhouse gas emissions and therefore providing continuity and stability to the EU ETS.

This chapter provides an overview of the EU's evolving position on REDD financing. The EU position on REDD financing was conditioned by the need to craft legislation that accounted for a potential lack of emissions reductions on the part of the United States of America and/or the economically more advanced developing countries, and by the desire to safeguard the objectives of the EU ETS. The EU energy and climate package not only established a target for reducing the overall greenhouse gas emissions of the Community by at least 20 per cent below 1990 levels by 2020 in a unilateral fashion, but also opened the door to reducing the emissions by 30 per cent provided that other developed countries committed to comparable emission reductions and that economically more advanced developing countries contributed adequately – as a commitment by the European Council[1] of March 2007. In this way, the EU preserved options for alternative REDD financing approaches such a direct market link to the carbon markets.[2]

Even though the EU energy and climate package proposal already contained the essence of what the EC envisioned for financing REDD, the European Union's approach to REDD financing was officially described in detail and extended in a Communication[3] by the European Commission (EC) issued in October 2008 — before the vote on the EU energy and climate change package. The Communication, which was meant to inform the main European institutions involved in the legislative process, was essentially endorsed by the Council of Ministers[4] of the EU (hereinafter the Council) on December 4 2008 (see Environmental Council, 2008). Another Communication[5], known as the 'Copenhagen Communication', further delineated the EC position towards a comprehensive climate change agreement in Copenhagen.

The European legislative processes are complex and involve many European institutions with different roles depending on the matter in question. In the case of the EU climate and energy package, once it was launched by the EC, it had to be approved jointly by the Council and the European Parliament (EP) in what is called a co-decision

[1] The European Council gathers together the Heads of State or Government of the Member States of the European Union and the President of the EC, and should not be mistaken for the Council of the European Union – the main decision-making body of the EU – which is fully involved in the legislative process.
[2] The EU energy and climate change package involves three carbon markets, namely, the ETS, the government carbon market for the emission reductions non-covered by the ETS, and the international project-based market.
[3] COM/2008/645/3 addresses the challenges of deforestation and forest degradation and outlines the proposed EU position on the topic.
[4] The Council is the main decision-making body of the EU and gathers together the Member State ministers responsible for the issue on the agenda, in this case the Ministers of the Environment.
[5] COM/2009/39 of January 28th, 2009

procedure. On December 17 2008, the European Parliament and the Council finally agreed upon the EU energy and climate change package. The EC proposal was adopted with amendments on first reading. The scope of the legislation is large, focusing on, greenhouse gas emission cuts, energy efficiency and renewable sources of energy. It includes two key pieces of legislation with implications on REDD financing: (1) Directive 2009/29/EC, which amends Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community (EU ETS), which covers less than 50 per cent of the European emissions; and (2) Decision 406/2009/EC of the European Parliament on the effort of Member States to reduce the emissions non-covered by the EU ETS.[6] See Table 3.1 for a timeline and summary of EU policy positions on financing REDD.

The next sections aim at explaining: (1) The EC position on REDD financing as noted in the Communications mentioned above; (2) The provisions related to REDD in the Directive and Decision as passed by the Council and the EP; and (3) The rationale argued by the EC in favor of a fund based mechanism instead of a direct market based mechanism for REDD.

3.2 EC COMMUNICATIONS

In a communication from the Commission (European Commission, 2008) to the EP, the Council, the European Economic and Social Committee and the Committee of the Regions (the three institutions involved in the legislative process that resulted in the EU energy and climate change package), the EC addresses in a monographic fashion the

[6] The Community acts can be classified as binding and non-binding. The former consists of regulations, directives and decisions, and the latter of recommendations and opinions. The differences among the binding acts depend on the direct applicability, the addressees and the degree of involvement in the legislative procedure from the Council, Parliament and Commission. In this case, the decision is directly applicable in its entirety upon all Member States while the directive obliges Member States to take the national measures necessary to achieve the results set out in the directive without specifying how they are to implement it through national law.

challenges of deforestation and forest degradation and outlines the EC recommendations on REDD financing.

The EC proposes a two-track approach for funding REDD. The first track consists of establishing a performance-based funding mechanism named the 'Global Forest Carbon Mechanism' (GFCM) to cover the near term funding needs. The second track includes testing, within the frame of a long term perspective, the gradual inclusion of REDD credits in the carbon markets.

According to the EC, public funding is not only the most appropriate way to generate readiness funds but also the most realistic tool to provide incentives to avoid deforestation through at least 2020. The European contribution to the GFCM would come from the proceeds of allowances auctioned in the EU ETS, as outlined in the EU energy and climate package proposal. These funds would complement other sources such as development aid, the Global Climate Change Alliance, and EU contributions to bilateral and multilateral sources (European Commission, 2008). Before 2020, the EC would only favor funding REDD by means of a direct market link through a pilot phase pursued in the framework of the Global Forest Carbon Mechanism. This pilot phase would aim at testing the inclusion of deforestation credits for government compliance. Thus, it would only allow the use of REDD credits by Member States for government compliance, i.e., for meeting the targets established by Decision 406/2009/EC[7]. This step would provide the testing ground for the inclusion of REDD credits in the EU ETS after 2020 (European Commission, 2008).

In addition to the what was outlined in the previous Communication, the EC's 'Copenhagen Communication' notes the possibility of funding REDD in the early years

[7] As the EU ETS covers less than 50 per cent of the European emissions, Member State governments are responsible for implementing the policies necessary to reduce emissions from the uncovered sectors. Decision 406/2009/EC lays down the minimum contributions of Member States to meeting the emission reduction commitments of the Community as a whole for 2013 to 2020.

with a share of the funds raised for the Global Climate Financing Mechanism (GCFM) based on voluntary participation from Member States. The GCFM — not to be mistaken with the GFCM noted above — could also support mitigation activities, in particular, those that generate synergies between mitigation and adaptation such as reducing emissions from deforestation. The GCFM aims at raising around:

> €1 billion per year for the period 2010–2014, provided that Member States make appropriate pledges. (European Commission, 2009b)

The GCFM would be funded through the issuance of bonds and would allow early spending on priority climate-related actions. The EC notes that the GCFM would frontload finance through capital markets based on Member States' guarantees of repayments at a later stage.

> Repayment of such bonds would be secured by legally binding commitments from Member States, possibly using revenues linked to the carbon market, such as derived from the auctioning of carbon credits through the Emission Trading Scheme. (European Commission, 2009b)

The 'Copenhagen Communication' of January 2009 further develops the idea of the pilot phase for testing REDD by proposing that Member States be allowed to use REDD credits for government compliance as of 2013, and notes that the international targets would need to be increased in order to accommodate the additional supply. For illustration, the EC reports the results of an analytical analysis that shows that the 2020 target from developed countries would need to be increased from -30 per cent compared to 1990 to -38 per cent in order to ensure the assimilation of REDD credits by the carbon markets (European Commission, 2009b).

3.2 DIRECTIVE 2009/29/EC

Directive 2009/29/EC EC (see European Communities, 2009) amends Directive 2003/87/EC – the landmark directive that established the EU ETS – so as to improve and extend the EU ETS beyond 2012. For that purpose the covered installations under the

Directive – which account for around 42 per cent of the EU emissions – should be 21 per cent below reported 2005 emission levels or best proxy by 2020. Given the fact that the 2005 economy-wide emissions were already 8 per cent below 1990 levels, and that the emissions from non-covered sources need to be reduced, on the aggregate, around 7 per cent below 2005 levels by 2020, the bulk of the Community's economy-wide reductions relative to 2005 levels will be achieved by means of the extended EU ETS.

The Directive allows for the use of certified emission reductions (CERs) from clean development mechanism (CDM) projects and Emissions Reductions Units (ERUs) from Joint Implementation (JI) projects for compliance under the EU ETS. However – as was the case since its inception in 2005 – the use of forest activities related credits was rejected. The operators are entitled to use a limited amount of CERs and ERUs as to ensure 50 per cent supplementary through 2020, i.e., the overall use of such credits is not allowed to exceed 50 per cent of the required abatement relative to 2005. As a result the total amount of offsets allowed by the Directive is in the order of 1.5 $GtCO_2$ for the period from 2008 to 2020[8]. One of the objectives of this provision is to provide a legal framework beyond 2012 for CDM and JI projects already implemented or at least registered by that time. Consequently in the event that, for instance, REDD credits would have been allowed for compliance, there would have been very little room for such credits to be used as most of the supply might have been covered with the credits generated during Phase II of the EU ETS. Furthermore, even if REDD credits could capture a large share of the market, a parallel market to the EU ETS would have emerged for such credits, clearing at a lower carbon price than that of the EU ETS since the supply of REDD credits would most probably exceed the allowed demand under the 50 per cent

[8] This is rough estimate based on the aggregate allocation for the use of CERs and ERUs at the country level to existing operators and the minimum shares established in the Directive for the existing operators and the new entrants during Phase II of the EU ETS. The relatively smaller allocation to the aviation sector has not been included in this estimate.

supplementary limit at the prices determined under the EU ETS. Consequently, the funding potential stemming from the use of REDD credits in that context would have been by all means inadequate as noted in the *Eliasch Review* (Eliasch, 2008).

As of 2013, most of the emissions allowances will be auctioned. The proceeds of the auctions would then be distributed among Member States. This measure aims, *inter alia*, to get around the intra-Communitary distortions at the installation level created during the first two phases of the EU ETS, when free allocation and decentralization were the rule. The Directive establishes that at least 50 per cent of the proceeds of the allowances auctioned in the EU ETS have to be earmarked for a large set of priorities including international and domestic measures.[9] The Directive does not set up a hard number on the share of auctioning revenues to be allocated for international forest activities, in line with the EC original proposal. Hence, at this point it is up to Member States to transpose the European directive into national law and to allocate a voluntary share to international forest activities in accordance with their constitutional and budgetary provisions. On the contrary, the European Parliament (EP) reported the need to amend the original EC proposal with clear rules in that respect (European Parliament 2008). According to the EP, given the extent of the climate crisis, it appears appropriate to earmark 50 per cent of the auctioning proceeds to a dedicated international fund to reduce greenhouse gas emissions, to adapt to the impacts of climate change, and to fund research and development for reducing emissions and adaptation in developing countries. One quarter

[9] The original EC proposal recommended that at least 20 per cent of the revenues be used to address a fixed set of priorities including REDD. Meanwhile, the scope of the priorities was thoroughly expanded and the amount of allowances allocated for free increased considerably, as described later in the text. Furthermore, member States have a lot of flexibility as the earmarked revenues can be used for one or more of the following competing options: (1) international funds aiming at reducing GHG emissions, adaptation and demonstration projects; (2) European energy R&D with a focus on renewable energy; (3) international REDD and AR, technology transfer to third countries and facilitate international adaptation; (4) forestry sequestration in the EU; (5) domestic and international CCS; (6) public transportation policy; (7) finance R&D of EU ETS covered sectors; (8) other measures aiming at non covered sectors and to alleviate the transition to lower and middle income households; and (9) Administrative expenses of the European climate policy.

of that share would be allocated to funds to avoid deforestation and increase afforestation and reforestation in developing countries (European Parliament, 2008). The remaining revenues beyond the 50 per cent applied to international measures should be used to address climate change issues in the EU. The domestic measures outlined by the EP proposal were incorporated in the final version of the Directive under the list of options together with the international options.

The EC has suggested that 5 per cent of the total auctioning revenues would be the lion's share of the European contribution to dealing with international forest activities including REDD through 2020 (European Commission, 2008; European Commission, 2009). According to EC's calculations, such a share of auctioning revenues would raise €1.5–2.5 billion in 2020 for the GFCM. To put these figures into context we should bear in mind that the EC's original estimate to halve gross tropical deforestation by 2020 would require between € 15 and 25 billion per annum. In that line, the EC recommends the EU to fight for an international agreement on international forest activities that aims at halting global forest cover loss by 2030 at the latest and to reduce gross tropical deforestation by at least 50 per cent by 2020 compared to current levels (European Commission, 2008).

Such auctioning revenue estimates are calculated based on the original energy and climate change package as launched by the EC early in 2008. The Directive finally enacted by the European Parliament and the Council reduced the number of allowances to be auctioned and consequently its potential revenues. The original EC proposal established a transitional system to allocate emissions for free for sectors other than the power sector. In 2013, 80 per cent of a given reference value for such emissions would be allocated for free. Thereafter, the free allocation would decrease gradually resulting in zero free allocation in 2020. Instead, the Directive provides for the free allocation in 2013 to gradually decrease to 30 per cent free allocation in 2020, with a view to reaching no free allocation in 2027 instead of 2020. This change means that the potential auction revenues in 2020 decreased by 11 per cent compared to the original EC proposal. Additionally, another transitional system for the modernization of electricity generation was created to a great extent to further engage the least developed European economies. This transitional free allocation shall not exceed 70 per cent of the annual average verified emissions in 2005-2007 of the beneficiaries, and shall gradually decrease, resulting in no free allocation in 2020. Although it has no impact on the funds available in 2020, the auctioning revenues in 2013 are 19 per cent lower than in the original version proposed by the EC. In the aggregate through 2020, the amount of auctioning revenues is 15 per cent lower than in the original EC proposal. Hence, a slightly larger share – around 6 per cent – of auctioning revenues would be necessary to fund the GFCM with the same amounts noted by the EC, which would still be almost 60 per cent lower than in the EP's proposal.

3.3 DECISION 406/2009/EC

The Decision addresses the necessary effort of Member States to reduce the emissions from sources non-covered under Directive 2009/29/EC (see European Communities, 2009b). It lays down the minimum contribution of Member States to meeting the emission reduction commitment of the Community as a whole for 2013–2020. The Member State emission limits in 2020 relative to 2005 levels range between -20 per cent for Denmark, Ireland and Luxemburg and +20 per cent for Bulgaria. The established limits translate, on the aggregate, to emission reductions of around 7 per cent below 2005 levels by 2020.

Member States can make use of a considerable set of flexibility mechanism including a limited amount of borrowing, trade within the Community of up to 5 per cent of the annual emissions allocation, and the use of credits from CDM and JI. In contrast to the

Directive, in additional to the CERs and ERUs,[10] Member States can also use temporary CERs (tCERs) or long-term CERs (lCERs) from afforestation and reforestation projects. For the period 2008-2012 such credits are also recognized for government compliance but subject to strict quantitative limits.

The use of credits from project activities is limited so that it is supplemental to domestic action. However, the supplementary limit is not as stringent as in the case for the Directive – where no more of 50 per cent of the required abatement below 2005 levels is allowed. Instead, the annual use of allowed project-based credits is limited to 3 per cent of the Member States greenhouse gas emissions covered under this Decision in 2005. Under some circumstances, the Member States with more stringent commitments can use an additional 1 per cent from LDCs and Small Island Developing States (SIDS). As it is the case with the annual emissions allocation, Member States can also trade the right to use project-based credits among them. The amount of project-based credits allowed for compliance for the period 2013-2020 is estimated to be around 925 MtCO2e, which translates into around 84 per cent[11] of the required abatement relative to 2005 levels, that is most of the required abatement relative to 2005 could be met with project-based credits.

From 20 per cent below 1990 Levels to 30 per cent in Light of an International Agreement: Implications for International Forest Activities and Domestic Land Use, Land Use Change and Forestry

[10] As it was the case in the Directive, the CERs and ERUs allowed are the eligible credits generated (1) during the period 2008-2012, (2) from projects registered before 2013, and (3) generated in Least Develop Countries (LDCs) until those countries have ratified a relevant agreement with the Community or until 2020, whichever is the earlier.

[11] This is a conservative estimate that considers 2013 caps to be the same as the 2005 emissions. The Decision determines that for Member States with a negative limit in 2020, emissions in 2013 should not exceed its average annual emissions during 2008, 2009 and 2010. In the case of Member States with a positive limit, emissions in 2013 should not exceed a level defined by a linear trajectory, starting in 2009, of its average annual emissions during 2008, 2009 and 2010. In both cases Member States could make use of the flexibility mechanisms outlined in the Decision for complying with the 2013 emission cap. After 2013, Member States shall annually limit their emissions in a linear manner accordant with the respective limits established for 2020.

Both the Directive and the Decision lay down provisions for assessing and implementing stricter commitments leading to the 30 per cent commitment to be applied upon the approval by the EU of an international agreement on climate change. The role for international forest activities in order to enable the tightening of the caps appears to be prominent and leaves the door open for alternative financing mechanisms such as a direct market link.

The Directive establishes that upon the approval of a future international agreement on climate change, the EC shall assess, *inter alia*, (1) the role of additional measures including additional roles for REDD, afforestation and reforestation in third countries in the event of the establishment of any internationally recognized system; and (2) increase the amount of CERs, ERUs or other approved credits from third countries for compliance, including the use of additional types of project credits by operators. Hence, in the event of a successful international negotiation process the EU position on international forest activities could be thoroughly transformed. Interestingly, the EP proposal considered – additionally to the allocation of one quarter of the 50 per cent of the auctioning proceeds – a provision in this sense by allowing operators of installations covered under the EU ETS to comply with up to 5 per cent of their required abatement relative to 2005 levels for compliance with forest based credits upon ratification of the future international agreement on climate change, that is approximately 120 MtCO2e in aggregate for 2013-2020. Although the funding raising potential of such credits would have been rather small relative to the scale of the funds or tons needed to significantly avoid deforestation and forest degradation, it would have spurred expectations about a direct market based mechanism later on.

The Decision establishes similar provisions to those outlined in the Directive regarding: (1) the extended nature and amount of project-based credits allowed for compliance, which in this case would only need to be extended to REDD as afforestation and reforestation are already allowed; and (2) the need to assess the additional potential role for afforestation, reforestation, avoided deforestation and forest degradation in third countries in the event of a successful international agreement in that respect.

The Decision also notes that appropriate modalities for including domestic land use, land use change and forestry (LULUCF) should be proposed by the EC upon the approval by the Community of an international agreement on climate change on the basis of the rules established by it. In the event of no international agreement on climate change, Member States might specify their intentions about the inclusion of their LULUCF emission reductions to the EC.

The Rationale Behind the Decision not to Fund International Forest Mitigation Options through a Direct Market-Based Mechanism

According to the EC, the reluctance to fund REDD through a direct market-based mechanism in the near term is mostly based on the concern that unrestricted forest based credits would flood the market, as well as other issues which, it is argued, must be addressed and agreed upon in an international agreement. These issues include carbon leakage, uncertainties associated with methodological matters, and liability issues associated with the temporary nature that characterizes the CERs from afforestation and reforestation projects.[12]

Regarding market flooding, the EC notes that global emissions from deforestation are roughly three times higher than the amount of emissions regulated under the EU ETS (European Union, 2008b). The EC points out that, in the event of the EU reducing unilaterally its emissions by 20 per cent in 2020 compared to 1990, allowing companies to unrestrictedly buy avoided deforestation credits would cause a significant drop in the carbon price.

[12] This temporary nature of tCERs and lCERs involves that companies need to be replace such credits over time. The liability concern arises from the fact that companies could go out of business and therefore not replace the credits upon its expiration date.

To avoid this, the EC notes,

> It would be necessary to set strict limitations on the inflow of such credits, [which] would lead to a skewed demand/supply balance that would see a high price paid for only a limited amount of forestry credits that are generated at much lower cost, leading to significant windfall profits. (European Commission, 2008b)

3.4 SUMMARY AND CONCLUSIONS

According to the EC, public funding is the most realistic tool with which to provide incentives for combating deforestation at least through 2020. The EC envisions a two-track approach for funding international forest activities. The first track consists of establishing a performance-based global funding mechanism to cover the funding needs through at least 2020. The European contribution to such global fund would come from the proceeds of allowances auctioned in the EU ETS. The EC suggests that 5 per cent of the total auctioning revenues, which would gradually increase to amount between €1.5 to 2.5 billion in 2020, would be the lion's share of the European contribution to dealing with international forest activities in 2020. The second track includes testing, within the frame of a long-term perspective, the gradual inclusion of REDD+ credits in the carbon markets. Before 2020, the EC would only favor funding REDD by means of a direct market link through a pilot phase aiming at testing the inclusion of deforestation credits but only for government compliance. This pilot phase would only be feasible if an international agreement with ambitious mid-term emission reduction commitments and provisions addressing REDD is reached at Copenhagen or later. A key pre-condition would involve further tightening the -30 per cent target for developed countries by an amount that would allow the assimilation of REDD credits without significantly distorting the carbon market.

The EP and the Council of Ministers recently enacted the EU energy and climate change package, which establishes a fund-based mechanism to finance REDD and other forest activities in third countries in line with the EC's suggestions. The legislation was crafted for a scenario involving a lack of commitment to act on the part of the United States of America and the economically more advanced developing countries. However, such legislation lay down provisions relative to international forest activities if stricter commitments are to be applied upon the approval by the EU of an international agreement on climate change. Under such circumstances, the potential role for international forest activities appears to be prominent and leaves the door open for alternative funding mechanisms such as a direct market link. In such a case, the EC would be called to assess the role of additional measures including additional roles for REDD, afforestation and reforestation in third countries in the event of the establishment of any internationally recognized system. Hence, in spite of the EC vision, there is room for the EU to shift its approach to REDD financing towards a compliance market.

A scenario characterized by the absence of an ambitious international agreement and the unilateral -20 per cent target by the EU implies a limited potential to finance REDD via a direct market link to the carbon markets. Furthermore, the supplementary limits established under the European legislation would make it impossible to accommodate much of the potential supply of REDD credits. As a result, the REDD credits would be traded in a parallel market that might clear at just a fraction of the EU ETS marginal carbon price.

However, alternative funding mechanisms to a fund-based approach might be necessary to achieve the ambitious goal of halting gross tropical deforestation by 2020, as suggested by the EC. A direct market link for REDD credits could significantly reduce deforestation, without 'flooding' the market, in the case of serious and ambitious international commitments with long-term commitments through 2050 or at least 2030. This issue is further explored in chapter 4, which examines the potential intertemporal dynamics stemming from the rational expectations of the European market participants under a climate policy with such a long-term horizon.

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TABLES

Table 3.1 Evolution of EU Policy Positions on REDD Financing.

Date	Relevant document. Summary of provisions related to international forest activities.	REDD Funding approach
January 2008	*EC's Communication COM(2008)16, and associated documents.* Outlines the EC's EU energy and climate package proposal. Member States should voluntarily earmark 20% of the revenues from the auctioning of emissions allowances issued under the EU ETS to a set of priorities including reducing deforestation and other forest carbon activities in third countries.	*Fund-Based REDD*
October 2008	*EC's Communication COM(2008)645/3 on deforestation and forest degradation, and associated documents.* Proposes a two-track approach for funding REDD. The first track establishes a performance-based mechanism named the 'Global Forest Carbon Mechanism' (GFCM) to cover near-term funding needs. The second track includes testing, within the frame of a long term perspective, the gradual inclusion of REDD credits in the carbon markets.	*Fund-Based REDD and Market-Based REDD (after 2020 for EU ETS, earlier for non-covered emissions)*
October 2008	*EU energy and climate change package agreed upon by the European Parliament and the Council on December 17 (formally adopted on April 23*). • *Directive 2009/29/EC,* improves and extends the EU ETS through 2020. Although ETS-covered firms are entitled to use CERs and ERUs within limits to ensure 50% supplementary through 2020, the compliance use of credits from forest activities is not allowed. As of 2013, most of the emissions allowances will be auctioned and at least 50% of the proceeds will be earmarked for an expanded set of priorities including reducing deforestation and other forest carbon activities in third countries. • *Decision 406/2009/EC* on the effort of Member States to reduce emissions not covered by the EU ETS. In addition to the CERs and ERUs allowed for compliance under the EU ETS, Member States can also use temporary CERs or long-term CERs from afforestation and reforestation projects.	*Fund-Based REDD and Market-Based REDD (for EU ETS as of 2013)*

Table 3.1 Evolution of EU Policy Positions on REDD Financing (continued)

Date	Relevant document. Summary of provisions related to international forest activities.	REDD Funding approach
December 2008 (April 2009)	*EU energy and climate change package agreed upon by the European Parliament and the Council on December 17 (formally adopted on April 23*). • *Directive 2009/29/EC* improves and extends the EU ETS through 2020. Although ETS-covered firms are entitled to use CERs and ERUs within limits to ensure 50% supplementary through 2020, the compliance use of credits from forest activities is not allowed. As of 2013, most of the emissions allowances will be auctioned and at least 50% of the proceeds will be earmarked for an expanded set of priorities including reducing deforestation and other forest carbon activities in third countries. *Decision 406/2009/EC* on the effort of Member States to reduce emissions not covered by the EU ETS. In addition to the CERs and ERUs allowed for compliance under the EU ETS, Member States can also use temporary CERs or long-term CERs from afforestation and reforestation projects.	*Fund-Based REDD (Market-Based REDD could be considered under both acts in the event of an international agreement leading to stricter commitments)*
January 2009	*EC's Communication COM(2009)39 of January 28th, 2009.* • *In addition to the approach outlined in* COM(2008)645/3, *the commonly termed "Copenhagen Communication" notes the possibility of funding REDD in the early years with a share of the funds raised for the Global Climate Financing Mechanism (GCFM), based on voluntary participation from Member States. The GCFM could support mitigation activities and aims at issuing bonds to raise around € 1 billion per year for the period 2010-2014.* • *This further develops the idea of the pilot phase for testing REDD by proposing that Member States be allowed to use REDD credits for government compliance as of 2013, and notes that the international targets would need to be increased in order to accommodate the additional supply.*	*Fund-Based REDD and Market-Based REDD (Pilot phase for emissions non-covered under EU ETS as soon as 2013)*

4. The EU Climate and Energy Package and the Need for 2030 Emission Reduction Targets

4.1 INTRODUCTION

The European Union's emissions trading system (EU ETS) – the EU's climate change policy flagship – appears to be at a crossroad. The European Commission (EC) and many research groups have highlighted a potential misalignment[1] of the current stringency of the EU ETS cap through 2020 and the complementary policies[2] adopted in conjunction with the flagship policy under the EU Climate and Energy package agreed in December 2008 (see for instance European Commission, 2010; European Commission, 2011; Morris, 2011 –also known as the Sandbag report; Höhne, 2011). If fully enforced, the complementary policies might achieve more domestic reductions through 2020 than required by the EU cap. There is a concern that this supply of reductions would outstrip demand for abatement in at least 1,600 Million tCO_2 – that is equivalent to the amount of international credits that were created by the policy and heavily invested in by European market actors – leading to a collapse of prices in the EU ETS. Hence, the EU has very limited ability to absorb the international credits originally envisioned by the EU ETS Directive, not to mention additional credits from REDD programs.[3] This reduces the EU's leverage in the international negotiations and weakens the financing role of the EU

[1] This misalignment is – up to a certain degree – the consequence of the lack of international agreement on the post-2012 global climate change regime. The EU climate and energy package envisions a tightening of the EU economy-wide targets to -30 per cent in light of an international agreement that is proving hard to achieve. Such tightening might contribute to realign the stringency of the EU ETS with those of the complementary policies. However, as the European Commission notes (2010), even in such event, there would still be a surplus in 2020 that would need to be banked for future commitment periods.

[2] See Appendix 2 for a discussion on the role of complementary policies.

[3] This does not mean that such credits will not be surrendered before 2020. Under the current scenario, market actors have the incentive to surrender such credits and bank EUAs instead, which are perceived as more valuable assets.

ETS, which is called to enable the mobilization of financial resources from developed countries private sector. Furthermore, even in the case of tightening the cap to -30 per cent there would be no room for additional international credits or allowances such as REDD. According to Morris (2011), the EU should not only tighten the EU ETS cap but also address the international credits issue by setting additional constrains on its amount and nature, which would certainly not be very popular among market actors and the countries of origin of the CERs and ERUs that are in the pipeline.

The purpose of this chapter is to assess the role of the international credits under the EU climate and energy package in detail in order to make policy recommendations to address the concerns arisen under the circumstances noted above; and analyze the potential role additional international credits or allowances like REDD might have in the near-term if the EU climate policy is consider under forward-looking perspective instead. This chapter is organized as follows. Section 4.2 explores in more detail the supply and demand conditions of the European carbon markets through 2020. Section 4.3 contextualizes the potential surplus of international credits and/or allowances by evaluating the demand for international credits over the near- and longer-terms assuming that the EU carbon markets and economy-wide climate policies continue after 2020. Section 4.4 concludes.

4.2 THE SUPPLY AND DEMAND CONDITIONS THROUGH 2020

In a scenario of economic meltdown deriving in sharp emissions reductions in the EU, the EC resolved in 2010 that the EU 2020 target of -20 per cent had to be tighten in spite of the lack of a comprehensive and binding agreement under the auspices of the United Nations in 2009. Otherwise, the lack of stringency might jeopardize the existence of the EU ETS itself. The EC's economic assessments concluded that:

> With [the] existing policies, the EU will achieve the goal of a 20 per cent GHG reduction domestically by 2020. (European Commission, 2010)

> If the non-binding 20 per cent energy efficiency target by 2020 would be fully and effectively implemented as proposed by the EC, the EU could outperform the current 20 per cent emission reduction target and achieve 25 per cent reductions domestically. (European Commission, 2011)

In the same manner, Hölne et al. (2011) estimate that in order for the three targets[4] adopted in 2008 to be consistent, the EU ETS cap for 2020 should be 38 per cent relative to 2005 instead of 21 per cent as it is now. According to the EC (2011) Hölne et al.'s 38 per cent relative to 2005 might be slightly higher than the target that would correspond to the EU ETS under a -30% relative to 1990 if the same burden sharing mechanism between the EU ETS and ESD for assigning the -20 per cent target were applied for -30 per cent.

The combination of the current economic downturn and – to a lesser degree – the emission reductions achieved by the installations covered under the EU ETS will generate a surplus of EU allowances (EUAs) during Phase II.[5] Such surplus will be available to be banked for Phase III for the period 2013-2020, and in combination with the CERs and ERUs to which operators are entitled for Phases II and III would create a reserve of banked allowances and international credits/rights that might not be drawn down through 2020 (European Commission, 2010). If those permits were not banked for future use and instead were used by 2020, then the market price would collapse, as Morris (2011) and others have recently predicted. The situation would resemble 2007, when the oversupply in the pilot phase combined with the lack of banking provisions led to a crash in EU allowance prices (see Appendix 1 for an overview of the EU ETS). Further, as the EC (2010) notes, tightening the EU's 2020 target to -30 per cent would reduce but possibly not eliminate the surplus of credits remaining after Phase II. Thus,

[4] Renewable energy, energy efficiency and the EU ETS targets.
[5] For illustration, the Sandbag report recently released in July 2011 estimates that some 672 Million tCO2e will be banked from Phase II to Phase III.

tightening the cap might be a necessary solution but by no means sufficient to forestall a potential market collapse if the post-2020 regime is not credible.

However, the analyses raising these concerns focus on a time horizon of 2020 and do not take into account the temporal dynamics related to the fact that the EU ETS in particular is scheduled to continue afterwards.[6]

4.3 THE POTENTIAL ROLE OF EXTENDED POLICIES THROUGH AT LEAST 2030

Examining the issue with a different time horizon transforms what looks like an insurmountable deadlock into a major opportunity. As noted above, the common approach in EU market analyses is to consider the time horizon of 2020 without accounting for the temporal dynamics related to the fact that the EU ETS and related policies would continue afterwards. However, even if further regulation would be necessary for outlining what might be called Phase IV (2021-2030) of the EU ETS, the market actors should begin internalizing its existence in their investment strategies, notably those who would otherwise be locked into long-lived high-carbon-emitting-technologies. Expectations over stringent future climate policy would likely rule out scenarios with carbon prices collapsing before the end of Phase III of the EU ETS, in spite of the regulatory uncertainties. As a positive consequence of the expectations created by the longer time horizon considered, the price signal from the carbon price takes the leading role in driving future climate investments. Hence the EU should ensure that a forward-looking approach becomes mainstream among market actors by creating a climate of certitude for its climate change policy framework.

Under this perspective, the potential reserve of permits by 2020 should be evaluated relative to the future needs under a progressively tightening reduction target consistent

[6] According to the EU ETS directive, the EU ETS cap does not expire in 2020 but continues decreasing by a factor of 1.74 per cent per year afterwards. Further, the directive establishes the year 2027 as the year when free allocation will end definitely.

with the 2050 goals outlined in the EU 2050 Roadmap. The total amount of banked permits remaining by 2020 would not be a surplus caused by policy misalignment but instead be the efficient result of market participants' expectations about the current and future compliance markets that they will be involved in.

It is in this context that we evaluate the impact that additional REDD credits and other possible international allowances or credits in the EU carbon markets, as these could potentially contribute to the bank of allowances/credits built up through 2020 for future commitment periods. We should remind that such allowances would not pose a threat to the integrity of the carbon markets as currently designed before 2020. The supplementarity rule limits the amount of international credits both in the EU ETS and the market established by the ESD through 2020. Besides, most of the international credit demand from European market actors through 2020 should be covered with the CERs and ERUs from CDM and JI projects registered and approved before 2013, leaving little if any room for alternative sources of international credits or allowances before 2020.

Figure 4.1 illustrates the role a 2030 target could play in contextualizing the potential surplus of international credits through 2020. It depicts the additional required abatement and the potential room for international credits for a hypothetical scenario where the EU keeps the -20 per cent target in 2020 but sets a hard cap in 2030 of -47 per cent below 1990 levels consistent with the -80 per cent target in 2050 adopted in the EU 2050 Roadmap.[7,8] In the hypothetical case were a 50% supplementarity rule for Phase IV (2021-2030) applied relative to -20% in 2020, the potential use of int. credits would be

[7] 47 per cent is the target corresponding to 2030 as a result of linearly interpolating between the -30 per cent target in 2020 and -80 per cent in 2050. This figure is more stringent than that proposed by the EC for 2030 under the 2050 Roadmap, which originally only considers domestic abatement following a non-linear pathway.

[8] European Commission released "A Roadmap for moving to a competitive low carbon economy in 2050" in 2011, which is available at: http://ec.europa.eu/clima/documentation/roadmap/docs/com_2011_112_en.pdf

3,649 Million tons, or 1,139 Million tons above the probable surplus from Phases II and III. If the cap in 2020 were tightened to -30 per cent, an additional 4,724 Million tCO2e would need to be abated under this hypothetical case, half of which might potentially be achieved with international credits and allowances. However, the carbon market might probably not finish in 2030 either and the market actors would have economic incentives to go beyond that milestone.

4.4 ECONOMIC ANALYSIS

The purpose of this section is to evaluate the demand for credits over the near- and longer-terms from the perspective of market actors. We assume that the EU carbon markets and economy-wide climate policies continue after 2020. In particular, this analysis considers a longer-term time horizon for the EU climate policy based on hard caps through at least 2030.

Market actors would need to make assumptions about a series of uncertain factors including, inter alia, the gradual evolution of the EU climate policy in line with the EU roadmap to 2050 recently released by the EC, the global carbon budget available through 2050, the cost of carry of banked emission permits, the linkage of the EU cap-and-trade system to other potential carbon markets from the largest world economies, and the availability of international credits from, e.g., innovative mechanisms such as REDD+, EU LULUCF, or the potential role of surplus AAUs from the Kyoto protocol commitment period. Although the list is not comprehensive it provides a good sense of the potential supply of international credits and allowances.

4.4.1 Methodology

We model EU mitigation options and quantify the benefits and costs under various policy scenarios. We model a global carbon market where the price of permits is determined by the supply and demand for emission reductions and the possibility of generating excess emissions reductions and saving ('banking') them for use in future periods is explicitly taken into account. Hence we use a modeling framework with a 2050 time horizon and introduce rational expectations of future climate policy carbon constraints in order to quantify the role of banking (see chapter 2 for a detailed description).

When long-term targets are credible and anticipated, regulated entities have the incentive to overcomply with their current requirements and bank excess permits for use in later periods when the carbon prices could be higher, as is likely the case with a tightening cap (e.g. Dinan and Orszag 2008; Murray, Newell, and Pizer 2009). Our model allows market participants complete flexibility for banking. To model banking, we treat buyers and sellers as if they have rational expectations of the future, in line with standard economic theory. These assumptions are common practice in current economic modeling of climate policy by, for example, the US Environmental Protection Agency (EPA) and the Massachusetts Institute of Technology (MIT). When banking is allowed, rational expectations mean that allowance prices will increase at a constant rate of interest reflecting the real rate of return in the market. In our analysis, this interest rate is an exogenous parameter that must be chosen. We present results with a 5 per cent real (inflation adjusted) interest rate, as assumed in the most recent analyses of US cap-and-trade legislation by US Environmental Protection Agency (EPA). If prices were expected to rise at any rate other than the market rate of return, this would provide systematic opportunities for investors to profit from buying or selling carbon permits. These profit opportunities would be expected to induce buying or selling until the arbitrage opportunities were eliminated. The long-term target is thus estimated to generate the economic incentive for market actors to overcomply by investing in eligible international credits/allowances and domestic abatement in the near term. This would drive the price of carbon up in the near term, while lowering it over the long term.

The modeling is carried out with the partial equilibrium model described in chapter 2, supplemented with marginal abatement cost (MAC) curves and business as usual (BAU) estimates from IIASA's GAINS model[9] for the European Union.

Given the direct and indirect links between the two European carbon markets established by the EU climate and energy package[10] and their complementary policies, the modeling for this exercise considers a single EU carbon market. This assumption is consistent with the modeling results of the economic assessment carried out by the European Commission, which finds that both markets clear at the same price once the EU cap has been tightened to -30 per cent (2010). This is still the case in our scenario with a -20 per cent target for 2020 because market actors assume that the EU carbon budget over the long run is kept unchanged and have the incentive to overcomply in the near-term – achieving emissions reductions beyond the -30 per cent target in 2020. Furthermore this is the only market result that makes sense from a cost-efficiency perspective. Figure 4.2 illustrates the scale of the EU carbon market as a result of adding the Effort Sharing Decision (ESD) market to the EU ETS.

The fact of modeling a global carbon market does not necessarily preclude that not all countries or regions implement economy-wide cap-and-trade programs. Different policy tools could contribute in the same way towards the same environmental goal and co-exist with the carbon markets. On the other hand, from the perspective of the market actors it is relevant to forecast the global carbon market-clearing price because it is the best estimate available to inform its investment decisions even if all parties do not implement cap-and-trade systems to achieve emissions reductions.

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[9] The data is available at http://gains.iiasa.ac.at/gains/EUR/index.login?logout=1

[10] The EU ETS and the market established by the Effort Sharing Decision (ESD). The ESD caps the emissions from the Kyoto protocol sectors non-covered under the EU ETS excluding LULUCF and international bunkers.

4.3.3 Benchmark scenario and policy scenarios for uncertain additional credits/allowances

In order to assess the potential role played by international credits and allowances in the EU carbon market, we compare model results from several scenarios.

6. *Benchmark scenario*. The global carbon market is designed upon the existent European carbon markets, which essentially exclude forest related mitigation actions from contributing.
7. *Surplus AAUs*: 10,000 Million tCO_2 surplus AAUs from KP are allowed into subsequent commitment periods. This is a stress-test scenario that assumes that the surplus AAUs are allowed to be used without constraints. Although there is not consensus yet on this issue, most of the options under consideration assume that only a fraction of such credits would be allowed if any.
8. *REDD credits from Brazilian Amazon*. We assume that Brazil adopts an alternative national baseline to the constant 1996-2005 historical baseline. The alternative baseline is the average of the previous 10 years and is reset every 5 years. The hypothetical reference level for crediting is set at 50% of the targeted reductions below the alternative national baseline. Only reductions below this reference level are eligible for crediting through the carbon market (Figure 4.4). The marginal abatement cost (MAC) curves for Brazilian deforestation developed by Wood Holes Research Center (WHRC) (Nepstad et al., 2007).
9. *Additional REDD as of 2020*. Based on IIASA's estimates (Kinderman et al., 2008). Supply constrained in a similar fashion than that of the Brazilian Amazon above.
10. LUCF from EU 27. In order to illustrate the potential role a biased accounting rule for *Forest Management* could have we assume a hypothetical case with *net-net 1990-1999*, which results into no-cost credits or allowances – depending on

how the program is regulated – amounting for at least 106 Million tCO_2e per year.[11]

4.3.4 Modeling results

The starting point is the global carbon market of our benchmark scenario, which is sequentially exposed to the additional lower cost credits/allowances described above. According to preliminary modeling the amount of international credits banked by the EU market actors by 2020 would range between 4,045 and 5,693 Million tCO2e with carbon prices ranging between $21 and $19/tCO2e in 2013 – rising 5 per cent in real terms (table 4.1).

Even if no regulatory limit were placed on the use of surplus AAUs for compliance with cap-and-trade programs, if forest carbon credits from avoided deforestation throughout the developing world became gradually available within the next 8 years, and even if the EU adopts LULUCF accounting rules that de facto loosen the EU cap, our model projects that the market price of GHG allowances would drop just 7 per cent relative to the benchmark scenario.

As concluded in chapter 2, the crucial factor that sustains prices at a moderate level is the ability to bank allowances for the future. However, the potential importance of banking depends on the extent to which climate policies provide a credible, long-term price signal that enables market participants to anticipate future compliance obligations.

4.4 CONCLUSIONS AND POLICY RECOMMENDATIONS

A longer policy horizon creates robust demand for alternative sources of international credits. Formally extending the EU emission reduction target to at least 2030 in line with 2050 goals and – very importantly – detailing the eligibility of the international credits to

[11] For a discussion on LULUCF accounting rules see the dossier pertaining to the LULUCF stakeholder meeting organized by the European Commission, downloadable at http://ec.europa.eu/clima/events/0029/index_en.htm

be allowed in Phase IV would help market actors to optimize the timing of their abatement strategies and investment portfolios. Thus extending the EU emission reduction targets to 2030 would increase the depth of the EU's carbon market.

Greater certainty over future policy would increase market incentives for research and development and other long-lived investments and for greater emissions reductions over the near term for the purpose of banking credits for future use. This would maintain the stability of its market through 2020, while allowing the EU to extend access to its carbon market. This would strengthen the EU's position in the international negotiations and enable greater reductions domestically as well as from tropical deforestation and other activities internationally.

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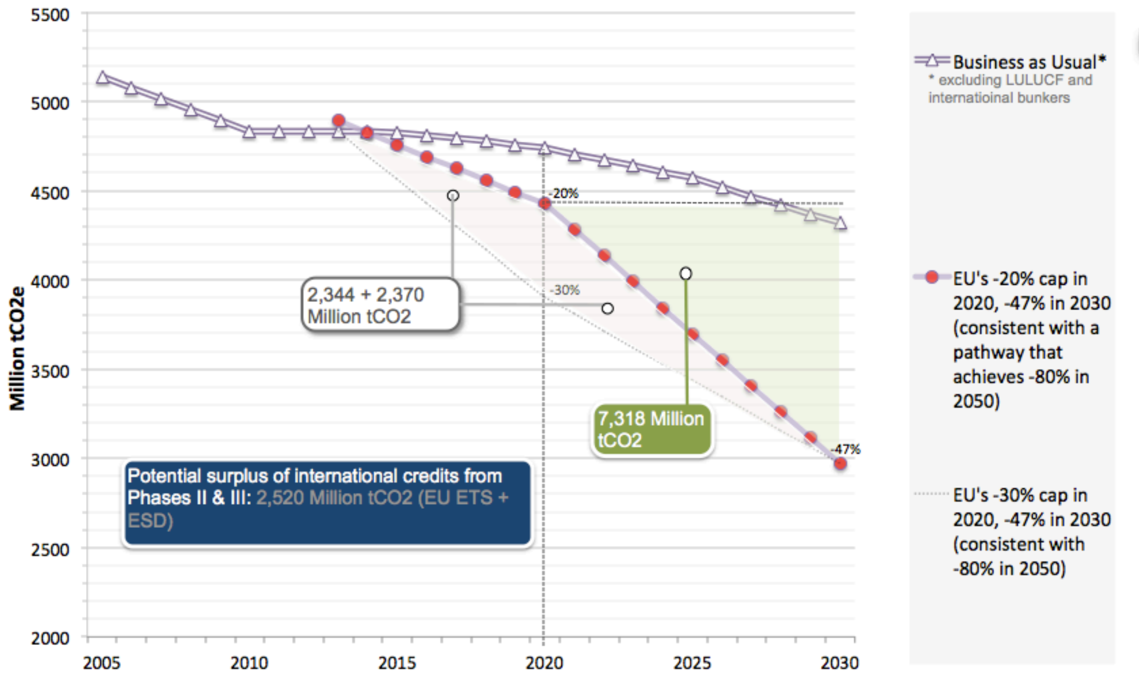
TABLES AND FIGURES

Table 4.1 Modeling Results

1. Benchmark scenario	*Carbon price** **$20.6 /t$CO_2$e**	
Sequentially added:		
2. Surplus AAUs	-2%	[$20.1]
3. REDD credits from Brazilian Amazon	-3%	[$19.9]
4. Additional REDD as of 2020:	-6%	[$19.4]
5. LUCF EU-27:	-7%	[$19.2]

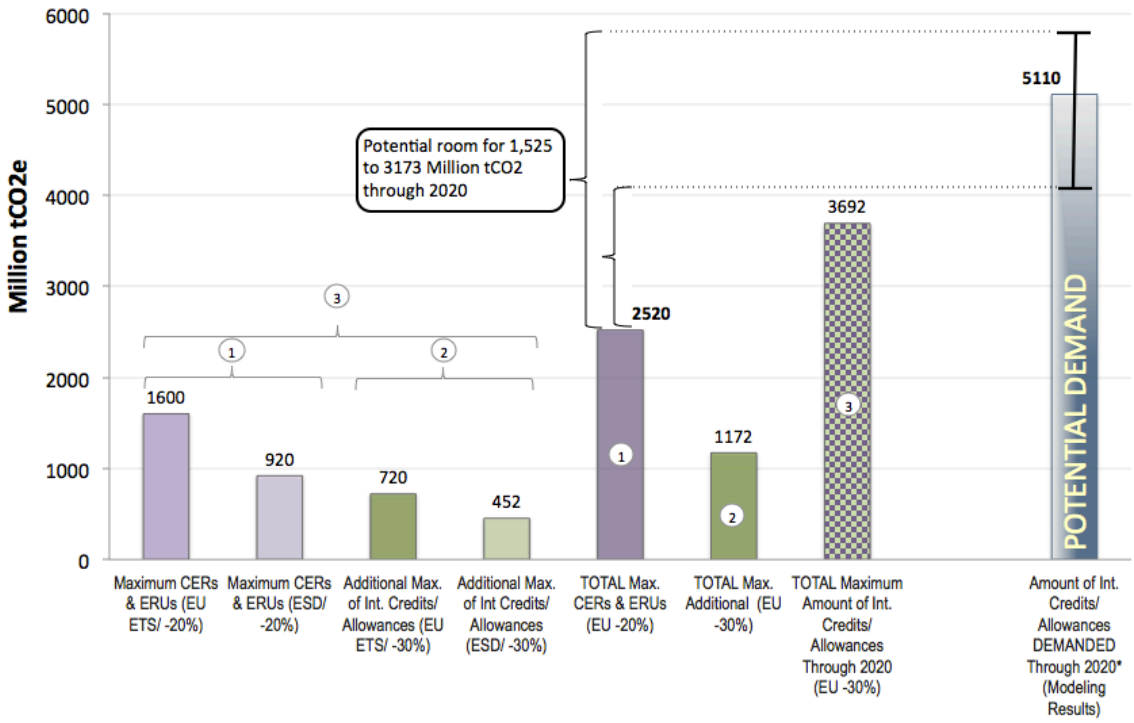
**In 2013 rising 5% per year afterwards*

Figure 4.1 Hypothetical Additional Required Abatement for 2021-2030



*In the hypothetical case were a 50% supplementarity rule for "Phase IV" (2021-2030) applied relative to -20% in 2020, the potential use of int. credits would be **3,649 Million tons**, or 1,139 Million tons above the probable surplus from Phases II and III. If the cap in 2020 were tightened to -30 per cent, an additional 2,344+2,370 Million tCO2e would need to be abated under this hypothetical case, half of which might potentially be achieved with international credits and allowances.*

Figure 4.1 Potential Amount of International Credits and Demand Through 2020



**The green bars represent the maximum potential additional amount of international credits derived from the tightening of the 2020 cap to -30 per cent. Given the large amount of international credits already allowed under the system, the political feasibility of this maximum to materialize appears to be slim though.*

Figure 4.2 The EU ETS and ESD Caps in Context

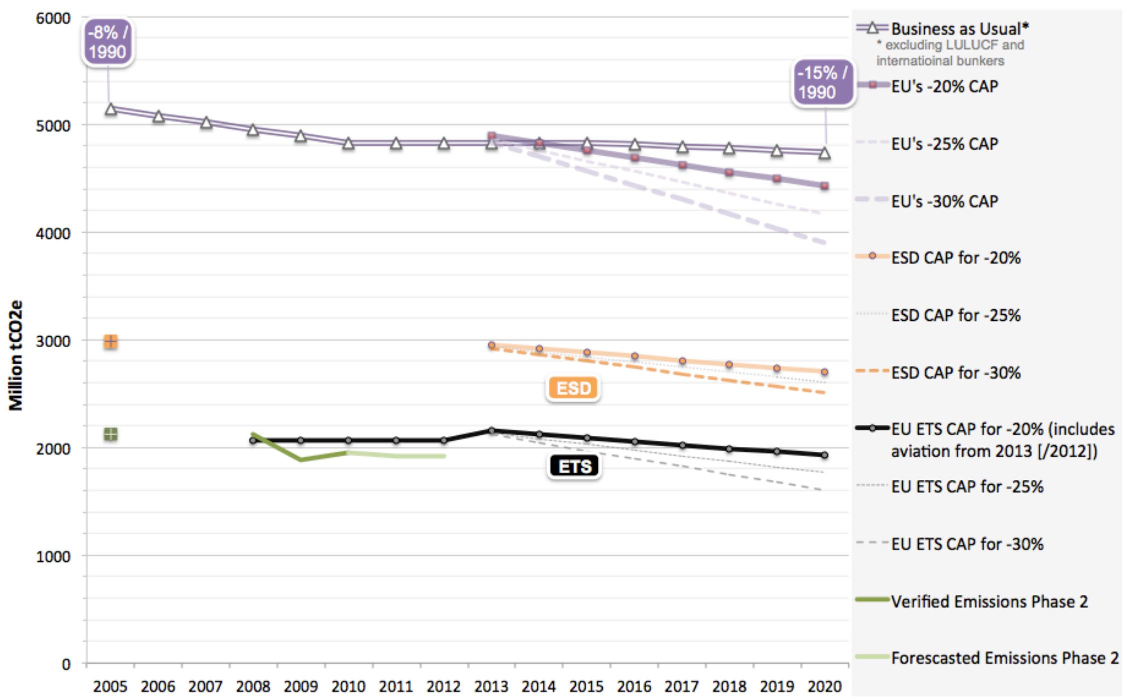
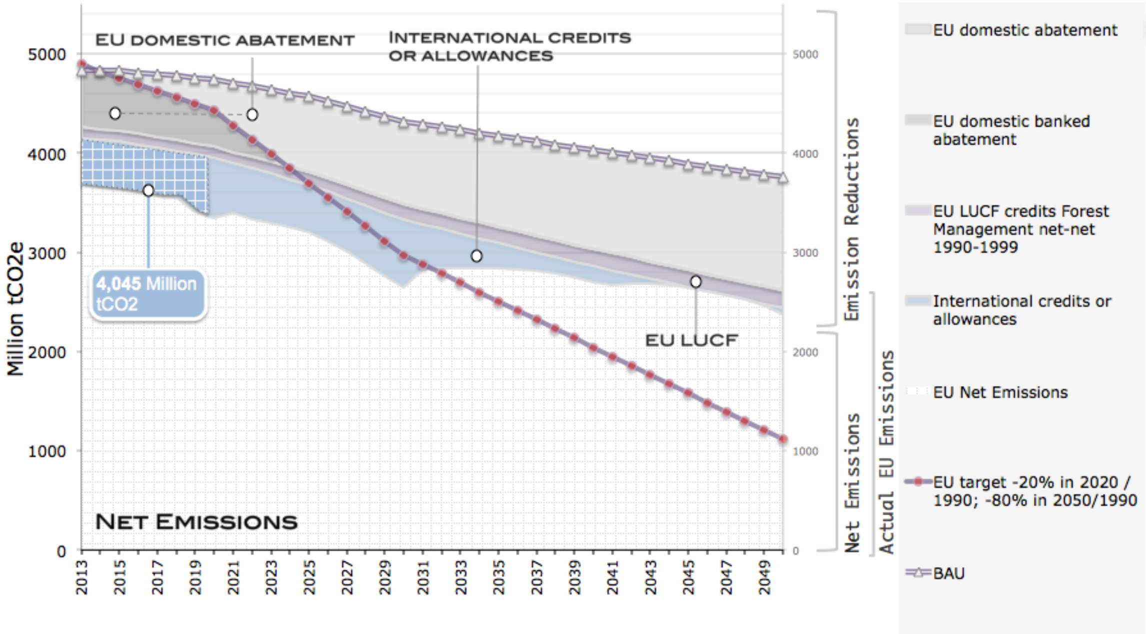
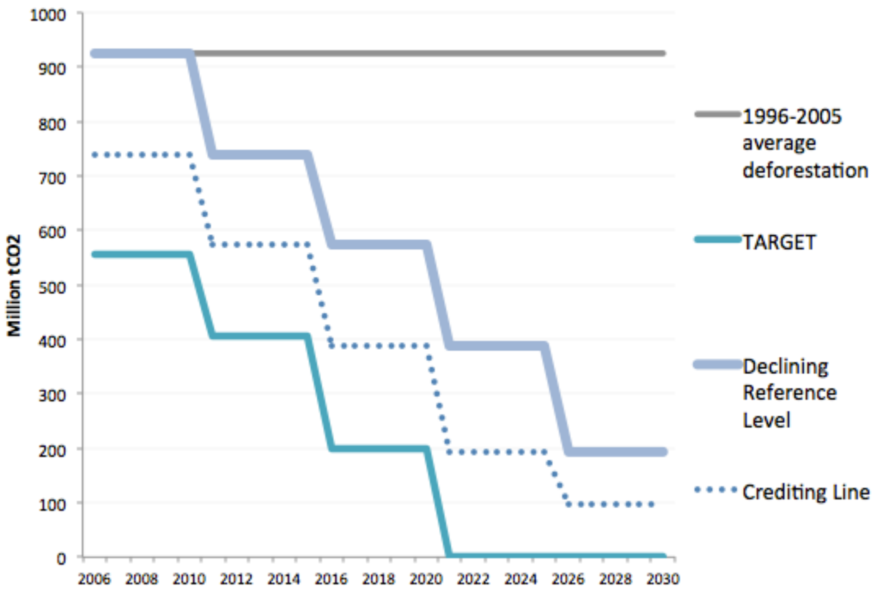


Figure 4.3 Modeled Emissions and Reductions Through 2050



Under a scenario with surplus AAUs from the Kyoto Protocol of 10,000 Million tCO2 in 2013 and with REDD and EU LULUCF credits available ($19.5/tCO2e in 2013, rising 5 per cent in real terms afterwards). In this scenario the total amount of international credits and allowances banked through 2020 amount 4,045 Million tCO_2e.

Figure 4.5 Brazilian Amazon REDD Assumptions



We assume that Brazil adopts an alternative national baseline to the constant 1996-2005 historical baseline. The alternative baseline is the average of the previous 10 years and is reset every 5 years. The hypothetical reference level for crediting is set at 50% of the targeted reductions below the alternative national baseline. Only reductions below this reference level are eligible for crediting through the carbon market. See chapter 5 for a discussion on reference levels.

5. The Brazilian National Plan on Climate Change: Potential Impacts in a US Cap-and-Trade System*

5.1 INTRODUCTION

The Brazilian government released a national plan on climate change in December 2008 (see Government of Brazil, 2008). One of the key proposals aims at reducing the amount of national deforestation by 40 per cent for the period 2006-2009, relative to the average deforestation for the previous ten-year period (1996-2005). Additionally, the plan calls for policies to decrease the amount of deforestation by another 30 per cent every 4 years until 2017, by which time the carbon emissions from deforestation would be 71 per cent below the 1996-2005 reference level of approximately 712 million tons of CO_2 per year. The goal will accomplish a cumulative reduction of an estimated 4.8 $GtCO_2$ by 2017.

This chapter assesses the potential implications of this proposal for a collaborative Brazil-United States climate policy consistent with the US cap-and-trade system and international forest carbon provisions envisioned under The American Clean Energy and Security Act (ACES) of 2009 (H.R. 2454) sponsored by Chairmen Waxman and Markey and approved by the House of Representatives in June 2009.[45] We examine the potential benefits from Brazil and the US joining a bilateral agreement under a range of scenarios under which a portion of credits derived from Brazil's annual

* This chapter is an adaptation of a paper written by Pedro Piris-Cabezas and Ruben Lubowski.

[45] An overview of the international forest carbon provisions in The American Clean Energy and Security Act is available at: http://www.edf.org/documents/10439_REDD_provisions_in_ACES.pdf

deforestation reductions after 2006 could be used for complying with mandatory obligations under a future US cap-and-trade program, as part of a gradually evolving global carbon market. We model a carbon market in the US that starts in 2013 and extends through 2050, as proposed in ACES and all other recent proposals for cap-and-trade legislation in the US. According to the modeled scenarios, the US is the only country allowing the use of credits from Reduced Emissions in Deforestation and forest Degradation (REDD) until 2020, and Brazil is the only provider of REDD credits during this period.[46] We assume the rest of the world also accepts REDD credits for meeting domestic targets starting in 2021, while Brazil remains the only supplier. After 2017, the Brazilian deforestation target is assumed to become 30 per cent more stringent every four years, following the same pattern as between 2010 and 2017.

Our results indicate that the Brazilian proposal sets the stage for a win-win situation for both Brazil and the US. If a portion of Brazil's reductions is tendered on the carbon market, the US benefits from a reduction in its compliance costs. These cost savings could potentially allow for an increase in the stringency of the US emission-reduction target for 2020, one of the most controversial elements of recent climate proposals, by up to 12 per cent at no additional costs to US companies. Selling a share of deforestation reductions through a direct market-based REDD mechanism would also generate a stream of revenues with an estimated value of $36-$147 billion through 2020 and $48-$248 billion through 2030. This scale of financing could help sustain and enhance the scale of the proposed emissions reductions in Brazil. Linking the proposed climate protection efforts of the US and Brazil through a

[46] As of 2021, we assume that REDD credits can also be used by the rest of the word, while Brazil remains the only supplier. After 2017, the Brazilian deforestation target is assumed to become 30 per cent more stringent every four years, following the same pattern as between 2010 and 2017.

future carbon market could thus multiply the effectiveness of each nation's program and achieve greater combined climatic benefits.

The next section discusses our methodology and assumptions in more detail. Section 5.3 presents our key results, and Section 5.4 concludes with a discussion.

5.2 METHODOLOGY

5.2.1 Carbon Market Model

We analyze the impacts of including Brazilian REDD credits in the carbon market using the global carbon market analysis tool described in chapter 2 and incorporating the marginal abatement cost (MAC) curves for Brazilian deforestation developed by Wood Holes Research Center (WHRC).[47] These curves are estimates of the opportunity costs of reducing deforestation in the Brazilian Amazon based on spatially-explicit models of the economic benefits from three alternative uses of the land (ranching, timber extraction, and crop production) integrated with the 'SimAmazonia' modeling system, which simulates future deforestation pressures based on changes in highway paving and other economic variables (Soares-Filho et al. 2006). We model a global carbon market in which the price of permits ('allowances') is determined by the interaction of supply and demand for emissions reductions and where the possibility of generating excess emission reductions and saving ('banking') them for use in future periods is explicitly taken into account.[48] We consider a post-

[47] Nepstad, Daniel, Britaldo Soares-Filho, Frank Merry, Paulo Moutinho, Hermann Oliveira Rodrigues, Maria Bowman, Steve Schwartzman, Oriana Almeida, Sergio Rivero. 2007. 'The Costs and Benefits of Reducing Deforestation in the Brazilian Amazon.' The Woods Hole Research Center. Woods Hole, MA. Available at: http://www.whrc.org/policy/BaliReports/index.htm.

[48] Our simple model solves for an intertemporal equilibrium for the period 2013-2050 in which two conditions are met in every year: (1) the market clears (i.e. the quantity of credits demanded at the current price, including banked tons, equals the quantity supplied at that price); and (2) the present value of the international credit price is equal in every period (i.e., the price rises at the market rate of interest).

Kyoto carbon market that lasts until 2050, as envisioned in ACES and all recent proposals for a Federal cap and trade program in the US.

When long-term targets are credible and anticipated, regulated entities have the incentive to overcomply with their current requirements and bank excess permits for use in later periods when the carbon prices could be higher, as is likely the case with a tightening cap (e.g. Dinan and Orszag 2008; Murray, Newell, and Pizer 2009). Our model allows market participants complete flexibility for banking. To model banking, we treat buyers and sellers as if they have rational expectations of the future, in line with standard economic theory. These assumptions are common practice in current economic modeling of climate policy by, for example, the US Environmental Protection Agency (EPA) and the Massachusetts Institute of Technology (MIT).[49] When banking is allowed, as in ACES and other current US climate policy proposals, rational expectations mean that allowance prices will increase at a constant rate of interest reflecting the real rate of return in the market. In our analysis, this interest rate is an exogenous parameter that must be chosen. We present results with a 5 per cent real (inflation adjusted) interest rate, as assumed in the most recent analyses of US cap-and-trade legislation by US Environmental Protection Agency (EPA).[50] If prices were expected to rise at any rate other than the market rate of return, this would provide systematic opportunities for investors to profit from buying or selling carbon permits. These profit opportunities would be expected to induce buying or selling until the arbitrage opportunities were eliminated.

[49] To implement banking, we adapt the macro program included in the Offset Market Tool developed by the US Environmental Protection Agency (EPA) and made available in the Data Annex to its analysis of the Lieberman-Warner legislation (S.2191).

[50] EPA's interest rate is more conservative than MIT's 4 per cent, which results in more banking due to higher prices in the near term. On the contrary, a higher interest rate would lead to lower equilibrium prices in the near term, rising more quickly over time.

The demand for permits on the carbon market is driven by the limits established by government on greenhouse gas emissions. We assume that the United States implements caps in 2013 according to the targets envisioned in ACES. It proposes a cap estimated to reduce economy-wide US emissions in 2020 and 2050 to 15 per cent and 73 per cent below 2005 levels, respectively. This translates into reducing total emissions to 1 per cent below 1990 levels by 2020 and 68 per cent by 2050. However, a supplementary cap on HFCs, complementary requirements and additional potential reductions envisioned by the legislation are estimated to increase the stringency to 17-23 per cent below 1990 levels by 2020 and 71-77 per cent by 2050 (Larsen and Heilmayr 2009).

With respect to the stringency of international policy, we follow the scenario used by the US Environmental Protection Agency (EPA) in its recent analyses of US carbon market legislation. In particular, we assume that the European Union continues its greenhouse gas emissions trading system and extends it beyond 2012, in accordance with recent announcements; that other industrialized countries follow suit; and that the emerging economies, developing countries, and the Commonwealth of Independent States agree to caps on their emissions as of 2020.[51] These assumptions were followed to provide comparability with EPA's analyses but do not necessarily represent our preferences or expectations for the post-2012 international climate policy regime.

[51] The European Union, Japan, Canada, Australia, New Zealand (Group 1 countries) are assumed to continue reducing emissions roughly in line with the current Kyoto Protocol, reaching 20 per cent below 1990 by 2020 and 60 per cent below 1990 levels by 2050. Brazil and the rest of the world (Group 2 countries) are assumed to emit at business-as-usual levels until 2020, and then reduce emissions steadily to 1990 levels by 2050. While EPA assumes that G2 countries take on caps starting in 2025, our scenario for the G2 countries starts 5 years earlier but includes a steady path of emissions reductions that achieves the same cumulative reductions by 2050.

The supply of permits comes from available abatement and sequestration activities throughout the world. We use the US Environmental Protection Agency's (EPA) marginal abatement cost curves for energy-related and non-CO_2 emissions reductions in industrialized and developing countries, and for non-CO_2 abatement in the United States.[52] The estimates of US energy-related abatement supply curves are taken from an analysis by researchers at the Massachusetts Institute of Technology, using the EPPA model.[53] These marginal abatement cost curves shift over time, reflecting assumed changes in technology and underlying conditions (e.g. areas under deforestation pressure in the Woods Hole analysis). Under our modeled scenarios, the US and other industrialized countries can use a range of forestry activities, chiefly afforestation/reforestation and changes in timber plantation management, for meeting their own domestic emissions reduction targets. The Commonwealth of Independent States can also sell forestry credits from afforestation/reforestation and changes in forest management prior to 2020. We focus on the possibility of reducing emissions from deforestation in Brazil and do not consider other opportunities to mitigate emissions within Brazil's forest sector.

While the availability of Brazilian REDD credits varies across our scenarios, we otherwise allow regulated entities the maximum flexibility for meeting their compliance obligations through trading of emissions permits with other capped countries as well as using domestic and international 'offset' credits for emissions reductions in uncapped sectors (e.g. agriculture and forestry) and countries (e.g. through the Clean Development Mechanism of the Kyoto Protocol). Such flexibility

[52] These estimated marginal abatement cost curves are included in the technical materials provided by the EPA in its Data Annex to its report on S.2191, available at http://www.epa.gov/climatechange/downloads/DataAnnex-S.2191.zip.
[53] We derive energy-related marginal cost curves from the results of MIT's modeling of US climate policy presented in Paltsev et al. (2007).

might be limited in actuality, as US legislative proposals have called for various limitations on the amounts of domestic and international offset credits that can be used for compliance under the regulation. In particular, both ACES and the, Kerry-Boxer Clean Energy Jobs and American Power Act (S.1733), recently introduced in the US Senate, limit domestic and international offsets, including REDD, to a combined total of approximately 2 billion tons annually.[54] Similarly, the EU's Emissions Trading Scheme imposes limits on offsets from the Clean Development Mechanism and has not recognized tons from tropical deforestation. While we do not explicitly impose the limits on offsets, our estimates suggest the US offset limits are unlikely to be constraining in practice.[55]

In addition to the quantitative limits on offsets, the ACES bill imposes a 5:4 trading ratio on all international offsets, including REDD, starting in 2017. This means that 1.25 international credits must be tendered for compliance in lieu of one emissions allowance, thus raising the relative costs of supplying international credits to the US market. Given uncertainty over the specific requirements for REDD in future US legislation, we do not explicitly model this discount on international offsets but instead consider different scenarios for Brazil's REDD trading, which can be thought of as potentially reflecting the effect of the discount. Also, if Brazil takes on a national cap that is considered of equivalent stringency to the US program, then Brazil's REDD credits would be considered allowances, rather than international

[54] The combined annual offset limit of 2 billion tons is the total based on the emissions cap each year but could vary depending on the use of banked allowances.

[55] In the modeled scenarios, the total annual amount of domestic and international credits from outside the US capped sectors falls within the minimum allowable amount of 2 $GtCO_2e$ per year under ACES. In addition, neither the international nor the domestic 'offsets' attain on average the maximum 1.5 and 1.0 $GtCO_2e$ annual limits proposed for each of these categories, respectively. While the proposed limits for the individual categories are exceeded in some years, the excess could be smoothed out over through time through banking. Thus, the proposed constraints are not expected to entail a binding constraint on the level of Brazilian REDD and other international trading.

offsets, and trade without any discount. The fact that we do not raise the costs of other international offsets to reflect the 4:5 discount is a conservative assumption for evaluating the demand for Brazil's REDD credits and their potential to reduce compliance costs in the US.

5.2.2 Brazilian REDD Scenarios

This section describes different scenarios under which deforestation reductions from Brazil would enter a global carbon market, beginning with an exclusive Brazil-US trading arrangement from 2013 to 2020. For the following ten years, 2020-2030, other capped nations are also assumed eligible to purchase REDD credits from Brazil. We model deforestation emissions reductions and potential marketable credits under each scenario through 2050, but do not define the market fungibility of any REDD credits generated by Brazil over 2030-2050. After 2030, credits generated by Brazil are considered part of the aggregate reductions of the Group 2 countries assumed for the global carbon market scenario, described above. As a result, these credits have an impact on the market price. However, this effect is only significant in the first scenario described below. Moreover, there is no requirement that Brazil specifically sponsors or trades any reductions as of 2031. Rearranging the responsibility for these reductions across groups of countries changes the distribution of estimated costs but does not affect the modeled market effects.[56]

Four hypothetical scenarios are considered for setting a 'reference level' to determine the portion of Brazil's annual deforestation reductions – relative to the average of annual emissions for the 1996-2005 period – that generate REDD credits

[56] In the benchmark case without REDD, the aggregate global reduction targets are achieved through other available mitigation options. For the purposes of calculating cost savings to the United States, the rest of the world as a whole is treated as responsible for achieving these target reductions. Assigning a fixed portion of the additional responsibility to the United States would change the total level of US costs but not the relative impacts across the different scenarios.

for the carbon market. Under all scenarios, Brazilian reductions between 2006 and 2012 are considered 'early action' tons that are potentially eligible for crediting in the US carbon market starting in 2013.

- Scenario 1. '*20 per cent of Reductions Extrapolated' as reference*. The initial 20 per cent of the reductions that are achieved each year below Brazil's 1996-2005 historical baseline level is sponsored by the Brazilian government through mechanisms such as the already established Amazon Fund. This initial 20 per cent is not credited through the carbon market. The remaining 80 per cent of the emissions reductions achieved are eligible for crediting through the carbon market. This proposal can be seen as reflecting the requirements in ACES that, after the first five years, all international offset credits would be traded on a 5:4 basis with US emissions allowances.[57]
- Scenario 2. *'Waxman-Markey Target' as reference*. Brazil's reductions would generate tradable credits at levels above and beyond reductions on a comparable scale to those achieved by the United States. In particular, the current Waxman-Markey targets are considered, requiring US emissions to decline 3 per cent below 2005 levels in 2012, 17 per cent by 2020, 42 per cent by 2030, 63 per cent by 2040, and 83 per cent by 2050. The Brazilian reference level is set to achieve this same percentage of reductions relative to its 1996-2005 baseline (roughly 2005 levels) established in its national climate plan. Because the Brazilian program starts in 2006 (rather than 2012 for the US), the trajectory is advanced by 6 years. Thus, Brazil's reference level is set at 3 per cent below its 2005 baseline in 2006 (rather than 2012), 15 per cent by

[57] If the 5:4 rule for international offset would be applied, the initial 20 per cent reductions would be sold to the US as of 2018, and could not be used by Brazil for its own compliance with a potential cap-and-trade program. A similar reasoning would apply to the first 20 per cent of the credited reductions in the other scenarios below.

2014 (rather than 2020), and 36 per cent by 2024 (rather than 2030), reaching 54 per cent by 2030. Any reductions below this reference level are eligible for crediting through the carbon market.

- Scenario 3. *'Waxman-Markey Delayed 10 Years' as reference*. Brazil's reference level is set by applying the Waxman-Markey targets as described above but with a delay of 10 years. Thus, Brazil's reference level starts in 2006 but declines more gradually and now only reaches 15 per cent below its 2005 baseline in 2024, reaching 32 per cent by 2030. Any reductions below this reference level are eligible for crediting through the carbon market.
- Scenario 4. '*50 per cent of Reductions Extrapolated' as reference*. The initial 50 per cent of the reductions that are achieved each year below Brazil's 1996-2005 constant historical baseline level is sponsored by the Brazilian government through mechanisms such as the already established Amazon Fund. This initial 50 per cent is not credited through the carbon market. The remaining 50 per cent of the emissions reductions achieved are eligible for crediting through the carbon market.
- Scenario 5. '*50 per cent of Reductions Extrapolated with Alternative Baseline' as reference.* An alternative national baseline to the constant 1996-2005 historical baseline is considered. The alternative baseline is the average of the previous 8 years and is reset every 4 years. The hypothetical reference level for crediting is set at 50 per cent of the targeted reductions below the alternative national baseline. Only reductions below this reference level are eligible for crediting through the carbon market.
- Scenario 6. *'Brazilian Target Extrapolated' as reference*. The deforestation target in the Brazilian national plan is taken as the basis for the reference

scenario. For the first four years of proposed reductions (2006-2009), Brazil sponsors the first 20 per cent of the reductions below its 1996-2006 historical levels and the remaining 80 per cent is credited through the global carbon market. After 2009, all reductions above and beyond the targets proposed in the Brazilian plan are eligible to generate credits.

Under all scenarios, Brazil only reduces deforestation beyond the reference level if the compensation received through the carbon market exceeds the cost of an additional (marginal) reduction in deforestation. For scenarios 1 to 5 we consider two variations of each case. First, the scale of deforestation reductions achieved by Brazil is constrained to the level of the targets proposed in the national plan for 2006-2017 (the target extrapolated after 2017, at the 2010-2017 rate of 30 per cent further reductions over each successive 4-year period). In other words, the proposed target is taken as the limit of what can realistically be achieved in terms of deforestation reductions. In second variation, the scale of deforestation reductions is not constrained and is allowed to reach the full economic potential. Thus, deforestation emissions are reduced as long as the carbon price exceeds the estimated opportunity cost of reducing those emissions.

Scenarios 5 and 6 are designed to illustrate the impact of particularly conservative reference levels used for crediting. For scenario 6, we only consider one set of constraints: over the initial 2006-2009 stage of reductions, the feasible reductions are constrained to the Brazilian proposed target. After 2009, as only reductions below the reference level are eligible for credit, deforestation reductions are allowed to continue below the target as long as they are economically advantageous at the margin.

5.3 RESULTS

This section summarizes the estimated impacts from introducing Brazilian REDD credits into the global carbon market under each of the reference level scenarios. Each scenario is evaluated relative to a benchmark case in which there is no trading of Brazilian REDD.

Under each modeled scenario, Brazil either reduced emissions to the level of the target of the national plan or, when this is not treated as a constraint, exceeds the target in all years. As shown in Figures 5.1A through 5.1K, extrapolating Brazil's target beyond 2017 means that Brazilian deforestation is reduced by 80 per cent by 2020 and 93 per cent by 2030. When deforestation is not limited by the scale of the national target (extrapolated after 2017), deforestation reductions are even more dramatic, decreasing by 60 per cent in the first year and then falling to 92 per cent (98 per cent) by 2020 (2030).

Reducing deforestation to the level of the (extrapolated) national target produces cumulative emissions reductions over 2006-2020 of 6,496 $MtCO_2$ or 464 $MtCO_2$/year. Table 5.1 summarizes the total deforestation reductions over 2006-2020 and 2006-2030. Over 2006-2030, cumulative reductions are 12,719 $MtCO_2$ or 530 $MtCO_2$/year. When reductions are not limited by the extrapolated target, estimated cumulative reductions are 29 per cent higher over 2006-2020 and 19 per cent higher over 2006-2030. Estimated cumulative reductions are 8,346 (15,165) $MtCO_2$ over 2006-2020 (2006-2030), translating into additional annual reductions of 132 (102) $MtCO_2$.[58] The *Brazilian Target* scenario is a hybrid case for which estimated total reductions fall in between the other cases at 7,495 and 14, 313 $MtCO_2$ (535 and 596 $MtCO_2$/year) over

[58] Continuing to extrapolate the Brazilian target through 2050 yields cumulative reductions of 13,653 $MtCO_2$ and 13,842 in the constrained and unconstrained cases, respectively (or about 310 and 315 $MtCO_2$/year over the period).

2006-2020 and 2006-2030, respectively.[59] In each reference level scenario, a different shares of the reductions achieved by Brazil is converted into carbon market credits, as shown in Table 5.1. The *Waxman-Markey Target Delayed 10 Years* scenario (#3), has the highest shares through 2020 and 2030, with 82-85 per cent of the reductions generating credits over 2013-2030, for example. This compares to 80-83 per cent in the *20 per cent Reductions* scenario (#1), 61-67 per cent in the *Waxman-Markey Target* scenario (#2), 50-58 per cent in the *50 per cent Reductions* scenario (#4), 19-28 per cent in the *50 per cent Reductions with Alternative Baseline scenario* (#5) and just 18 per cent in the *Brazilian Target* scenario (#6).

The tons available exclusively for trading with the US prior to 2020 are between 5 and 8 billion tCO_2 in scenarios 1-4, between 2 and 3 billion tCO2 in scenario 5 and almost 2 billion tons in scenario 6 (see table 3 for estimated REDD credits sold on the market). As of 2020, Brazilian REDD credits can be bought for compliance by other countries. Consequently, the US has to compete with the rest of the world and the resulting amount available for US compliance is considerably reduced. The US purchases between 61 per cent to 81 per cent of the total traded credits over 2013-2030. Over 2013-2020, the total deforestation emissions reductions sponsored by Brazil for each ton of REDD traded between the US and Brazil range from 0.1 to 0.4 tCO_2 in scenarios 1-3, from 0.6 to 2.6 tCO_2 in scenarios 4-5, and are 2.9 tons in scenario 4. Over 2013-2030, the total REDD tons sponsored by Brazil for each REDD credit traded with all buyers range from 0.2 to 0.6 tCO_2 in scenarios 1-3, from 1 to 4.3 tCO2 in scenarios 4-5, reaching 4.7 tons in scenario 6.

[59] The 'Brazilian target as reference' scenario constrains deforestation reductions to the national target over 2006-2009 and then allows reductions to exceed the target in each of the following years.

REDD credits from Brazil are estimated reduce the carbon price in the market by providing greater flexibility to meet compliance obligations at lower cost (Table 2). Without REDD, the carbon price is estimated to start at \$24.2 in 2013, rising at 5 per cent to reach about \$53/tCO_2 and \$142/tCO_2 by 2030 and 2050 respectively.[60] Under scenarios 1, 2, 3 and 4 respectively, REDD credits from Brazil reduce the price by an estimated 4-5 per cent, 2-3 per cent, 3-4 per cent and 2.7-3.2 per cent relative to the case without REDD, with the lower and upper range depending on whether or not Brazil's deforestation reductions are constrained to the targets in the national plan. In general, the impacts on the carbon market depend on the amount of REDD credits that can be used to satisfy compliance obligations, based on the total emissions reductions achieved as well as the share that is credited. Scenario 5 and 6 generate the fewest tradable credits and reduce the carbon price by an estimated 0.5-0.9 per cent and 0.5 per cent respectively. In the case of scenario 3, while the amount of credits released into the market before 2030 exceed the quantities under scenario 1, the price reduction is moderated because fewer reductions are available for Brazil and/or the other G2 countries to use for meeting the assumed aggregate targets for this entire group after 2030. This means a higher price as these reductions must then be achieved through higher cost actions in other sectors.

For scenarios 1-3 (4-5), the total amount of Brazil's REDD tons used for compliance in the US equals about 16-25 per cent (7-17 per cent) of the total required US abatement over 2013-2020 and 4-6 per cent (1-2 per cent) over 2013-2030. For scenario 6 with the lower quantity of tradable credits, total REDD credits are 7 per cent and 1 per cent of required reductions over 2013-2020 and 2013-2030, respectively. Across all scenarios, total REDD credits from Brazil represent just 1-4

[60] Carbon prices and all other monetary estimates from our model are reported in 2005 \$US.

per cent of total required US abatement through 2050 (234,469 $MtCO_2$; see Table 3). Figure 2 shows the sources of reductions for the US over 2013-2050 under the *20 per cent Reductions* scenario (#2), when the deforestation reductions achieved by Brazil are not constrained to the national plan. The total amount of Brazil's REDD tons used for compliance in the US represents about 3 per cent of the total required US abatement over this entire period. An estimated 84 per cent of the required reductions take place in the US itself, with the remainder from other international sources.

The black line in Figure 2 indicates the increasing schedule of required abatement in the US under ACES (H.R. 2454) over all years of the program. The figure shows that total abatement exceeds this required abatement for the first two decades of the program, as market participants establish a 'bank' of relatively low cost emissions-reductions for use in later periods. The amount of abatement supplied by Brazilian REDD is smaller than the amount of this over-compliance. This shows that during this time period it is still economical for the US to abate the full amount of its targets through means other than REDD, even when the option of purchasing REDD credits from Brazil is introduced into the market. Rather, by contributing to the creation of the emissions bank, REDD helps enable the cumulative reductions proposed by the US to be achieved more quickly than would be economically feasible otherwise.

The cost savings to the US as a result of the added flexibility provided by the introduction of Brazil's REDD credits could finance an increase in the stringency of the US emissions cap while keeping the costs of compliance in the US the same as in the case without REDD credits. We apply two methodologies for calculating the cost savings from REDD that could potentially be used to tighten the US climate target. From the perspective of the United States overall, the net present value (NPV) of the cost savings[61] from the introduction of Brazilian REDD in the carbon market is on the order of $15 to $33 billion (and $3 billion) for scenarios 1-4 (and scenario 5-6) from 2013 to 2050. These estimates represent approximately 0.9-1.5 per cent (and 0.2 per cent) reductions in the net present value of total US compliance costs over this period (Table 5.2).

These estimates provide a lower-range estimate that Brazilian REDD could finance up to a 1 per cent increase in the stringency of the cumulative US emissions cap. If the proposed cap is tightened by 1 per cent in each year, this would translate into specific targets for 2020 and 2050 that increase the stringency of the US target from -1 per cent below 1990 by 2020 and -68 per cent below by 2050 to about -2 per cent and just over -68 per cent, respectively. Alternatively, if the long term targets are held constant but the cost savings are used to increase the rate of reductions in the years before 2025, our lower-range estimate is that, depending on the reference level scenario, the introduction of Brazilian REDD would enable an increase in the US target from -1 per cent below 1990 by 2020 to about -3 to -5 per cent in 2020 while keeping constant the US policy costs (and the targets for 2025-2050) (see Table 5.2).

For this lower-range analysis, only the costs of achieving domestic emissions reduction plus any monetary flows outside the country are included in the calculation of the policy costs to the US. Monetary transfers among domestic entities – including payments from companies to the government if emissions allowances are auctioned off – simply involve a reallocation of resources and are thus not economic costs from the perspective of the nation. However, such monetary outlays will surely be a critical

[61] The US compliance costs are computed by considering the full market value for the international abatement bought by the US in the global market and only the opportunity costs for the abatement that takes place in the US. These are the costs for the US as a whole, with transfers among domestic entities, including transfers between entities and the government, not considered costs from the perspective of the entire nation.

consideration from the perspective of the regulated entities, many of whom will be net buyers of emissions allowances. Most US cap-and-trade policy proposals, such as the recent Waxman-Markey bill, envision a combination of free distribution of allowances as well as government auctions, with the share sold by the government increasing in the later years of the program. As a result, some entities may have some or all of their compliance obligation fully covered by free allowances and some market participants may actually gain from the sale of allowances (or of domestic offset credits). Nevertheless, changes in the price of carbon will be a critical indicator of the program's cost from the perspective of the regulated entities.

In a situation where the government auctions 100 per cent of all the domestic allowances (so regulated entities must buy all of their allowances or other credits, either domestically or internationally), the introduction of Brazilian REDD would lower the net present value of the purchase costs to regulated entities by 105-$227 billion (and 17-$25 billion) in scenarios 1-4 (and scenario 5-6). If this measure of financial outlays (rather than economic costs) is considered as the politically relevant constraint on increasing the stringency of the cap, then our upper-range estimate is that Brazilian REDD could result in as much as a 5 per cent tightening of the total US cap and the potential national target in 1990 and 2050 could then be -6 per cent and -69 per cent relative to 1990 levels by 2020 and 2050, respectively. If these financial savings are targeted at increasing the near term rate of reductions, then the cap in 2020 could be 6-13 per cent below 1990 levels compared to -1 per cent in ACES (Table 5.2).

While REDD trading offers potential cost savings for the US, REDD trade also offers the opportunity to generate significant economic benefits for Brazil. The REDD credits under the Brazilian target that could enter the US market would be valued at full market price, creating the potential for significant 'rents' (profits above the costs incurred in supplying the reductions). However, it should be noted that the Woods Hole Research Center's opportunity cost curves are estimated for a period of 30 years. Consequently further funds would likely be needed to compensate the opportunity costs beyond that point, attenuating the above-mentioned rents. Table 5.4 reports both the revenues generated in the US for purchasing the REDD credits and the opportunity costs directly associated with the reductions that generate the tradable portion of the deforestation emissions reductions and the costs of sponsoring the portion of the target that is not traded. Under all scenarios, the net revenues raised by the Brazilian government under these assumptions are substantially larger than the forecasted $21 billion to be raised under the Amazon Fund by 2020 according to the Brazilian authorities. Even under the *Brazilian Target* scenario (#6), which is most conservative in terms of net benefits for Brazil, the small portion of reductions traded generates a net present value of almost $50 billion in revenues for $20 in added costs by 2030, for a net benefit from trade of approximately $30 billion.

5.4 DISCUSSION

The cost savings from trading REDD credits in a carbon market system offer the opportunity for Brazil and the US to be able to achieve greater atmospheric reductions together than separately. Depending on the amount of deforestation reductions that Brazil sponsors with its domestic resources, generated by contributions to the Amazon Fund for example, crediting any further reductions through the carbon market has the potential to provide greater atmospheric benefits. This is because the cost savings provided by the additional REDD credits could be used to more than simply 'offset' US emissions on a 1-for-1 basis.[62] Tables 5.5 and 5.6 compare the quantities of REDD credits sponsored by Brazil to the total potential additional US reductions that could be achieved at no additional cost beyond the case without REDD. Depending on Brazil's domestic contribution, the market could thus multiply the overall benefits to the atmosphere. As Brazil sponsors a greater share of the reductions through non-market means, this means that fewer tons are available to trade on the market, which, in turn, means that total potential additional reductions that could be financed by the US are lower.

For example, in the *20 per cent Reductions* scenario, if the remaining tons beyond what is sponsored by Brazil are allowed to trade on the carbon market, for each ton of deforestation emissions reductions sponsored by Brazil over 2006-2020, the market could potentially leverage between 0.4 to over 6 additional tons of reductions from the United States at no additional cost compared to the case without REDD. At the other extreme, in the *Brazilian Target* scenario, most of the tons are sponsored by Brazil and thus not eligible to increase the cost-effectiveness of the US and global cap-and-trade program. Here, just 0.04-0.1 additional potential tons of reductions are generated from each REDD credit sponsored by Brazil. So, it is cost-effective for US companies to use REDD credits instead of reducing emissions through other means, but the result is that the US could reduce more emissions in total by using REDD at no additional cost, and even less cost, as the case without REDD.

Some would argue that if Brazil could secure the necessary domestic resources to achieve all of its potential deforestation reductions without any linkage to the carbon market, then it should not trade these reductions as REDD credits because these

[62] If the US buys a REDD credit equivalent to 1 ton of deforestation reductions and this allows the US to then increase domestic emissions by exactly 1 ton, then this is a 1-for-1 offset that just shifts emissions from one country to another. This has the potential to generate significant cost savings but has a neutral effect on the atmosphere.

would serve to only 'offset' emissions in the US or other countries on 1-for-1 basis and thus provide no added gains for the atmosphere. Even if the US increases its cap as a result of the resulting cost savings, the additional reductions the US could achieve are not necessarily as large as the amount of credits being traded. Tables 5.5-6 allow comparison of the amounts of Brazil's REDD credits sold to the U.S. under each scenario with the quantities of potential additional reductions which the US could achieve for no additional cost over the case without REDD.

For the *20 per cent Reductions* scenario (#1), when the deforestation reductions are constrained to the national target, we estimate the US could potentially increase its reductions by about 1.2 to 5.2 billion tCO_2 and 1.4 to 6.8 billion tons over 2013-20 and 2013-30, respectively, for no additional cost beyond the case without REDD. This is achieved with purchases of REDD credits from Brazil of 5.2 billion tCO_2 over 2013-20 and 6.2 billion tons over 2013-30. Thus, in this case, the upper range of estimates shows that the US could increase its emissions on a roughly 1-for-1 or even slightly more than 1-for-1 basis with each REDD credit purchased from Brazil. For the lower estimates and in all remaining cases, the potential increases in US emissions are less than 1-for-1 with the quantities of REDD purchased by Brazil.[63] This means that the US on its own may not be able to provide the same additional atmospheric benefits as the situation where Brazil achieved the entire range of its potential reductions domestically and then did not trade any REDD credits on the carbon market (where they could be used to offset emissions elsewhere).

While the carbon market is unable to leverage sufficient tons from the US alone, we have not yet considered the potential additional reductions that the market could

[63] Over 2010-2020, the ratio of potential additional US reductions achievable at no additional cost over the case without REDD to the quantities of REDD credits traded from Brazil are 0.12 to 0.22 (lower estimate) and 0.4 to 1.0 (higher estimates). Over 2013-2030, the ratios are 0.1 to 0.23 (lower estimate) and 0.5 to 1.1 (higher estimate).

leverage from Brazil (and other countries as well). The potential resources earned by Brazil from trading REDD offer significant opportunities to achieve greater deforestation reductions or other atmospheric benefits at home or abroad. For example, some portions of these benefits could be used to replenish and bolster the Amazon Fund and to invest in other conservation and development efforts that would perpetuate and extend the deforestation reductions achieved in the first decades of the program. Additional resources could also be deployed to fund other parts of the Brazilian national climate plan or even to contribute to deforestation reduction efforts in other nations. For example, some researchers (e.g. Cattaneo 2008) have proposed directing a portion of the rents from REDD trading towards preventing possible future increases in deforestation in those high-forest countries which have low historical rates of in deforestation rates and which, depending on the reference levels, would perhaps not be eligible to receive compensation through a carbon market system.

Considering the reductions that Brazil could generate by reinvesting its profits from the carbon market, as well as the potential to increase reductions in the US, linking Brazil's REDD to the carbon market can potentially leverage significantly greater atmospheric benefits compared to a case where Brazil achieves all its potential reductions and does not link to the market. The last column of Tables 5.5-6 show how many additional emissions reductions allowances/credits could be bought (and potentially retired) at the prevailing global market price based on the estimated net benefits (revenues minus opportunity costs) that would be earned by Brazil. Over 2013-2020, we estimate that Brazil could buy and then retire between 4.4 and 6.9 billion tCO_2 worth of emissions allowances with the profits generated in scenarios 1-3, 1.4 and 6.1 billion tCO_2 in scenarios 4-5, and 1.3 billion credits in the case of scenario 6. Over 2013-2030, the estimated quantities rise to 9.5-11.6 billion tCO_2 in scenarios 1-3, 1.7 and 8.2 in scenarios 4-5 and about 1.5 billion tons in scenario 6. Added to the additional reductions potentially achievable by the US, these reductions exceed the total estimates of deforestation reductions in Brazil.

The quantities of REDD tons that Brazil could purchase at the global market price are a slight overestimate as they do not include the increase in market price that would result from Brazil's added demand in the market. However, these estimates are a significant underestimate of the potential of Brazil to achieve added reductions using the profits for REDD, as Brazil presumably could achieve reductions domestically at far lower costs than the global market price. Based on the estimated marginal abatement cost curves that we use from the U.S. Environmental Protection Agency, the actual opportunity cost of generating a ton of emissions reductions in the Group 2 countries (developing countries, economies in transition, and the Commonwealth of Independent States) is approximately 30 per cent of the global carbon market price over the 2013-20 and 2013-30 periods. This means that if Brazil's profits could be used to achieve domestic or international reductions at around these levels of actual opportunity costs, then more than three times greater emissions reductions could be achieved than if credits were purchased at the global market price. Taking these reductions into account shows that REDD trading provides considerable potential for generating additional gains for the atmosphere through enhanced efforts in both the US and Brazil, beyond the scope of the reductions that either nation would achieve independently. The figures Table 5.5-6 also do not include additional emissions reductions that could be achieved in countries other than the US as a result of the cost savings generated by linking Brazil's REDD to the carbon market.

Figures 5.3-4 graphically illustrates this potential of the carbon market to leverage greater global reductions beyond what Brazil and the US could achieve independently. Figure 5.3 shows the net global atmospheric benefits that could be achieved as a result of Brazil's REDD program, with without trading, for the case of the *20 per cent Reductions* scenario over the period 2013-2020 during which Brazil and the US are assumed to trade exclusively.[64] As reported in Table 5.5, under this scenario, Brazil's deforestation reductions are about 1.3 billion tCO_2 up to its reference level between 2006 and 2020. The estimated reductions in deforestation emissions beyond this reference level are 5.2 to 7.0 billion tCO_2, depending on whether or not reductions are limited by the level of Brazil's target. These reductions, up to and beyond the reference level, are shown in the first bar of Figure 5.3 and represent the total emissions reductions that could be achieved by Brazil's REDD program if all the potential reductions through 2020 were achieved domestically without any linkage to the carbon market.

The second and third bars in this figure show our estimates for the total increase in global reductions that would be achieved by Brazil's REDD program if Brazil traded REDD credits (based on reductions beyond the reference level) and then the US tightened its cap so that its costs remained the same as in the case without REDD. Both these bars are lower than the total height of the first bar indicating what Brazil, at least in principle, could achieve without linking to the carbon market. This is because REDD credits traded in the marketplace would be used to offset emission reductions in the US and, under this scenario, there is a less than 1-for-1 potential to tighten the US cap for each REDD credit traded with Brazil.

The final two bars show the total possible global emissions reductions that could be leveraged in both Brazil and the US as a result of REDD trading. These bars include the potential additional reductions that Brazil could achieve, either at home or

[64] Figure 5.4 presents the same analysis for the *50 per cent of Reductions Extrapolated with Alternative Baseline* scenario.

abroad, by reinvesting the $94-119 billion in estimated carbon market profits generated by trading REDD with the US over 2013-2020 (see Table 5.4). The dark blue bars show the quantities of emissions reductions that could be purchased with these funds if Brazil simply purchased emissions allowances the global carbon market price. Adding in these potential extra allowances that Brazil could buy and retire from the system, the total net emissions reductions that could be achieved globally exceeds what would be achieved independently under Brazil's deforestation reduction program if there was no carbon market linkage. If Brazil could use its REDD proceeds to achieve emission reductions at less than the global carbon market price, then the purchasing power of its REDD profits could be extended further. The light blue portion in the last two bars shows the added reductions that could be achieved if Brazil could use its REDD proceeds to reduce emissions at the average cost of the Group 2 countries, estimated at just 30 per cent of the global carbon market price during this period. Taking all these sources of potential reductions into account, linking Brazil's REDD plan to the US carbon market could leverage as much as 23-28 billion tCO_2 in net global emission reductions over 2006 to 2020. All of these reductions would be additional to the reductions achieved under a US cap-and-trade based on H.R. 2454's targets. These estimates compare to total deforestation emissions reductions of 6.5 to 8.3 billion tCO_2 if all of Brazil's estimated REDD potential was achieved independently with no carbon market linkage.

These results indicate how the Brazilian deforestation reduction proposal in its national climate plan sets the stage for a win-win situation for both Brazil and the US. If a portion of Brazil's reductions, above a pre-determined reference level, were sold as carbon market credits, the US would gain by reducing its compliance costs and could potentially increase its emissions reductions at no additional cost over the case without REDD. At the same time, Brazil could raise sizable revenues that, at least in part, could expand the scale of its planned climate change initiatives. In this way, linking REDD to proposed US carbon markets offers the potential to leverage the climate protection efforts of both the US and Brazil and multiply the combined impact of the two national programs.

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FIGURES AND TABLES

Table 5.1 Deforestation Reductions and Traded REDD Credits, by Reference Level Scenarios.

Reference level scenarios for Brazil's REDD crediting[a]	REDD limited to Brazil target[a]	Total REDD tons[b] ($MtCO_2$) 2006-20	Share of REDD tons traded with US[c] 2013-20[d]	Total REDD tons[b] ($MtCO_2$) 2006-30	Share of REDD tons traded with all buyers[c] ($MtCO_2$) 2013-30[c]	Total REDD tons[b] ($MtCO_2$) 2006-50	Share of REDD tons potentially traded 2013-50[c]
20% Reductions	Yes	6,496	80%	12,719	80%	26,372	80%
	No	8,346	84%	15,164	83%	29,006	82%
Waxman-Markey Target	Yes	6,496	73%	12,719	61%	26,373	42%
	No	8,348	79%	15,166	67%	29,012	47%
W-M Target Delayed 10 Years	Yes	6,496	89%	12,719	82%	26,372	62%
	No	8,348	92%	15,165	85%	29,009	65%
50% Reductions	Yes	6,496	50%	12,719	50%	26,373	50%
	No	8,347	61%	15,165	58%	29,010	54%
50% Reductions with Alternative Baseline	Yes	6,496 [3,644]	28% [50%]	12,719 [4,799]	19% [50%]	26,373 [5,464]	10% [50%]
	No	7,498 [4,646]	38% [61%]	14,319 [6,399]	28% [62%]	28,187 [7,278]	16% [62%]
Brazilian Target Extrapolated	-	7,495	25%	14,313	18%	28,226	10%

[b] Total REDD tons include all deforestation emissions reductions achieved in Brazil, including reductions sponsored by the Brazilian government as well as those compensated through the carbon market. Reductions are relative to Brazil's 1996-2005 average annual emissions levels. For the 50% Reductions with Alternative Baseline scenario (#5) the total REDD tons also include those between the historical baseline and the alternative one. The figures in brackets show the same results without the REDD tons between the historical baseline and the alternative one.
[c] Brazil is the only seller of REDD credits. The US is assumed to be the only buyer of REDD credits through 2020, after which points other buyers compete for purchasing the REDD credits from Brazil until 2030. The fungibility of REDD credits from Brazil is not defined over 2030-2050.
[d] While carbon market trading only begins in 2013, all of the credits generated by Brazil over 2006-2012 are sold to the US as "early action" credits over 2013-2020.

Table 5.2 Impacts of REDD on the Carbon Price, Associated Cost Savings, and Potential for Increasing Stringency of the U.S. Cap in 2020

Reference level scenarios for Brazil's REDD crediting[a]	REDD limited to Brazil target[a]	Carbon price in 2013 ($/tCO₂)[b]	Change in price relative to no REDD	Change in US climate policy costs relative to no REDD (2013-2050)[c]		Potential tightening of US cap in 2020 for same cost as without REDD [d]
				Lower estimate	Upper estimate	
20% Reductions	Yes	23.2	-4.3%	-1.4%	-4.4%	4-11%
	No	23.1	-4.8%	-1.5%	-4.9%	4-12%
Waxman-Markey Target	Yes	23.7	-2.2%	-0.7%	--2.3%	3-7%
	No	23.6	-2.7%	-0.9%	-2.8%	4-8%
W-M Target Delayed 10 Years	Yes	23.5	-3.3%	-1.0%	-3.3%	4-9%
	No	23.3	-3.8%	-1.2%	-3.9%	4-10%
50% Reductions	Yes	23.6	-2.7%	-0.8%	-2.7%	4-8%
	No	23.5	-3.2%	-1.0%	-3.2%	4-9%
50% Reductions with Alternative Baseline	Yes	24.1	-0.5%	-0.2%	-0.4%	2-4%
	No	24.1	-0.9%	-0.3%	-0.9%	3-5%
Brazilian Target Extrapolated	-	24.1	-0.5%	-0.2%	-0.6%	2-4%

[a] Reference level scenarios described in the paper. Brazil's target is extrapolated after 2017.

[b] Prices in 2005 US$. The carbon price rises at 5% per year afterwards in real (inflation adjusted) terms.

[c] The range depends on the methodology used to calculate the costs of US climate policy, either in terms of economic costs or financial compliance costs to regulated entities. Costs are discounted at 5% over 2013-2050.

Table 5.3 Volumes of REDD Traded and Relation to Total Estimated U.S. Abatement

Reference level scenarios for Brazil's REDD crediting[a]	REDD limited to Brazil target[a]	Total REDD credits traded[b] ($MtCO_2$)	Total US abatement ($MtCO_2$) [c]	Total REDD credits bought by US[b] ($MtCO_2$)	Total US abatement [c] ($MtCO_2$)	Total REDD credits traded[b] ($MtCO_2$)	REDD credits as share of total US abatement
		2013-2020 [d]		2013-2030 [d]			2013-50 [d]
20% Reductions	Yes	5,197	29,405	6,179	85,316	10,175	3%
	No	7,047	30,156	8,158	86,065	12,620	3%
Waxman-Markey Target	Yes	4,755	29,072	5,340	84,426	7,788	2%
	No	6,607	29,790	7,314	85,146	10,235	3%
W-M Target Delayed 10 Years	Yes	5,790	29,465	6,707	85,201	10,469	3%
	No	7,641	30,188	8,683	85,923	12,915	4%
50% Reductions	Yes	3,248	28,587	3,842	84,137	6,360	2%
	No	5,099	29,329	5,817	84,887	8,806	2%
50% Reductions with Alternative Baseline	Yes	1,824	27,962	1,938	82,894	2,403	1%
	No	2,823	28,339	3,053	83,357	3,996	1%
Brazilian Target Extrapolated	-	1,910	27,996	2,025	82,932	2,505	1%

[a] Reference level scenarios described in the paper. Brazil's target is extrapolated after 2017.

[b] Brazil is the only seller of REDD credits. The US is assumed to be the only buyer of REDD credits through 2020, after which points other buyers compete for purchasing the REDD credits from Brazil until 2030. The fungibility of REDD credits from Brazil is not defined over 2030-2050.

[c] Total estimated abatement prior through 2050 includes REDD credits and varies with each scenario due to banking. The cumulative required abatement over 2013-2050 is 234,469 $MtCO_2$ based on H.R. 2454 targets and business-as-usual emissions projections.

[d] While carbon market trading only begins in 2013, all of the credits generated by Brazil over 2006-2012 are sold to the US as "early action" credits over 2013-2020.

Table 5.4 Estimated Opportunity Costs of Reducing Deforestation and Carbon Market Revenues for Brazil

Reference level scenarios for Brazil's REDD crediting[a]	REDD limited to Brazil target[a]	Net Present Value of Total Revenues for Brazil (US$ millions 2013-2020[b]	Net Present Value of Total Costs for Brazil (US$ millions 2006-2020[c]	Net Present Value of Total Revenues for Brazil (US$ millions 2013-2030[b]	Net Present Value of Total Costs for Brazil (US$ millions 2006-2030[c]
50% Reductions	Yes	63,128	7,862	123,609	13,060
	No	125,246	18,101	171,276	24,087
20% Reductions	Yes	103,171	8,990	194,481	13,320
	No	133,934	15,256	239,853	24,317
Waxman-Markey Target	Yes	92,850	7,942	152,082	13,138
	No	128,296	15,235	198,744	24,173
W-M Target Delayed 10 Years	Yes	111,794	8,016	202,153	13,326
	No	146,714	15,293	247,981	24,341
50% Reductions	Yes	63,128	7,862	123,609	13,060
	No	125,246	18,101	171,276	24,087
50% Reductions with Alternative Baseline	Yes	36,233	7,735	47,731	12,762
	No	55,863	12,412	79,092	21,188
Brazilian Target Extrapolated	-	37,943	11,377	49,763	20,143

[a] Reference level scenarios described in the paper. Brazil's target is extrapolated after 2017.
[b] Total revenues based on the global carbon market price and the quantities of REDD credits traded. Transaction costs are not included. While carbon market trading only begins in 2013, the credits generated by Brazil over 2006-2012 are sold to the US as "early action" credits over 2013-2020. Only the REDD credits available at a price below or equal to $10/t CO_2 are considered in this "early action" analysis.
[c] Costs are based on the opportunity costs of reducing deforestation for 30 years based on estimates from the Woods Hole Research Center (Nepstad et al. 2008).
Note: All costs and benefits are expressed in 2005 US$ and discounted at a 5% rate.

Table 5.5 REDD Tons Sponsored by Brazil and Potential for Additional U.S. Reductions, 2013-2020

Reference level scenarios for Brazil's REDD crediting[a]	REDD limited to Brazil target[a]	REDD tons sponsored by Brazil[b] ($MtCO_2$) 2006-20	Total REDD credits sold to US[c] ($MtCO_2$) 2013-20	Total potential for additional US reductions at no added cost over the case without REDD[d] ($MtCO_2$) 2013-2020		Total reductions that could be purchased by Brazil at the global market price with profits from REDD trading[e] ($MtCO_2$) 2013-2020
				Lower estimate	Upper estimate	
20% Reductions	Yes	1,299	5,197	1,152	5,180	4,934
	No	1,299	7,047	1,352	6,093	6,245
Waxman-Markey Target	Yes	1,741	4,755	484	2,462	4,355
	No	1,741	6,607	706	3,166	5,823
W-M Target Delayed 10 Years	Yes	706	5,790	817	3,972	5,368
	No	706	7,641	1,040	4,679	6,856
50% Reductions	Yes	3,248	3,248	595	2,980	2,846
	No	3,248	5,099	818	3,785	6,072
50% Reductions with Alternative Baseline	Yes	4,676 [1,824]	1,824	42	544	1431
	No	4,676 [1,824]	2,823	248	974	2421
Brazilian Target Extrapolated	-	5,585	1,910	234	697	1,340

[a] Reference level scenarios described in the paper. Brazil's target is extrapolated after 2017.

[b] For the 50% Reductions with Alternative Baseline scenario (#5) the total REDD tons sponsored by Brazil also include those between the historical baseline and the alternative one. The figures in brackets show the same results without the REDD tons between the historical baseline and the alternative one.

[c] We report quantities from the scenarios before tightening the US cap. There are only slight differences between these scenarios and those where the tightening of the US cap has been carried out due to the changes in the carbon price.

[d] The lower and upper estimates depend on the methodology used to calculate the costs of US climate policy, either in terms of economic costs or financial compliance costs to regulated entities, respectively.

[e] These are a slight overestimate as they do not consider the impact of Brazil's added demand on the market price. They are also reported without considering the increase in price due to the US potentially tightening its target, which would reduce these quantities by 0.4-4.8%. These are an underestimate of the potential to achieve reductions using Brazil's REDD profits as they do not account for the opportunities to achieve lower cost domestic reductions within forestry or other sectors.

Table 5.6 REDD Tons Sponsored by Brazil and Potential Additional U.S. Reductions, 2013-2030

Reference level scenarios for Brazil's REDD crediting[a]	REDD limited to Brazil target[a]	REDD tons sponsored by Brazil[b] ($MtCO_2$) 2006-30	Total REDD credits sold to US [c] ($MtCO_2$) 2013-30	Total potential for additional US reductions at no added cost over the case without REDD[d] ($MtCO_2$) 2013-2030		Total reductions that could be purchased by Brazil at the global market price with profits from REDD trading[e] ($MtCO_2$) 2013-2030
				Lower estimate	Upper estimate	
20% Reductions	Yes	2,544	6,179	1,402	6,826	9,491
	No	2,544	8,158	1,613	7,908	11,341
Waxman-Markey Target	Yes	4,931	5,340	699	3,615	7,126
	No	4,931	7,314	933	4,445	8,991
W-M Target Delayed 10 Years	Yes	2,250	6,707	1,050	5,396	9,767
	No	2,250	8,683	1,285	6,232	11,667
50% Reductions	Yes	6,360	3,842	816	4,226	5,694
	No	6,360	5,817	1,051	5,175	8,183
50% Reductions with Resetting Baseline	Yes	10,323 [2,403]	1,938	116	933	1,749
	No	10,323 [2,403]	3,053	236	1,401	3,330
Brazilian Target Extrapolated	-	11,808	2,025	234	923	1,494

[a] Reference level scenarios described in the paper. Brazil's target is extrapolated after 2017.

[b] For the 50% Reductions with Alternative Baseline scenario (#5) the total REDD tons sponsored by Brazil also include those between the historical baseline and the alternative one. The figures in brackets show the same results without the REDD tons between the historical baseline and the alternative one.

[c] We report quantities from the scenarios before tightening the US cap. There are only slight differences between these scenarios and those where the tightening of the US cap has been carried out due to the changes in the carbon price.

[d] The lower and upper estimates depend on the methodology used to calculate the costs of US climate policy, either in terms of economic costs or financial compliance costs to regulated entities, respectively.

[e] These are a slight overestimate as they do not consider the impact of Brazil's added demand on the market price. They are also reported without considering the increase in price due to the US potentially tightening its target, which would reduce these quantities by 0.4-4.8%. These are an underestimate of the potential to achieve reductions using Brazil's REDD profits as they do not account for the opportunities to achieve lower cost domestic reductions within forestry or other sectors.

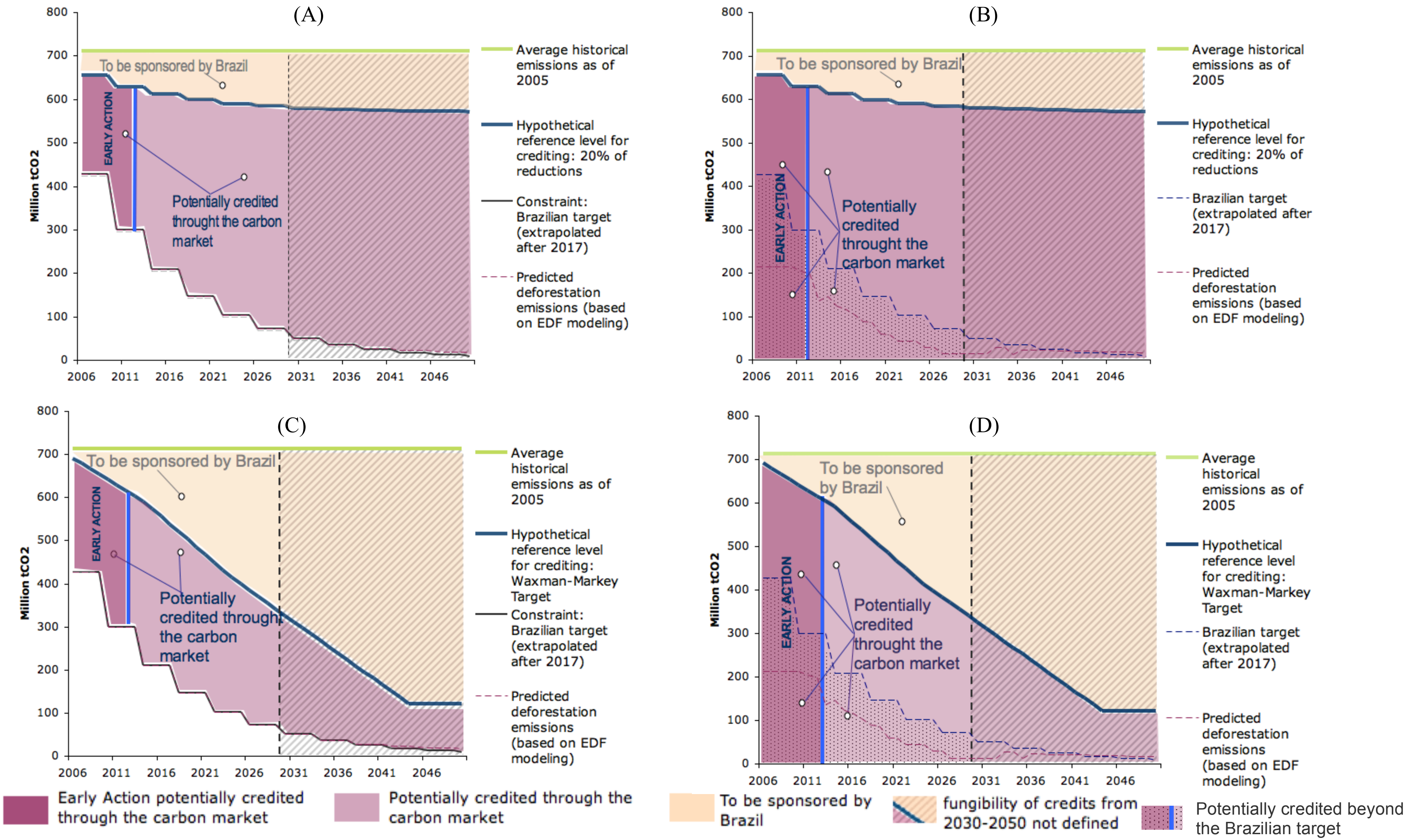


Figure 5.1 Alternative Scenarios for Brazilian REDD Crediting Level*: (A) Scenario 1.1 "20% of Reductions Extrapolated" with constraint; (B) Scenario 1.2 "20% of Reductions Extrapolated" without constraint; (C) Scenario 2.1 "Waxman-Markey Target" with constraint; (D) Scenario 2.2 "Waxman-Markey Target" without constraint.*

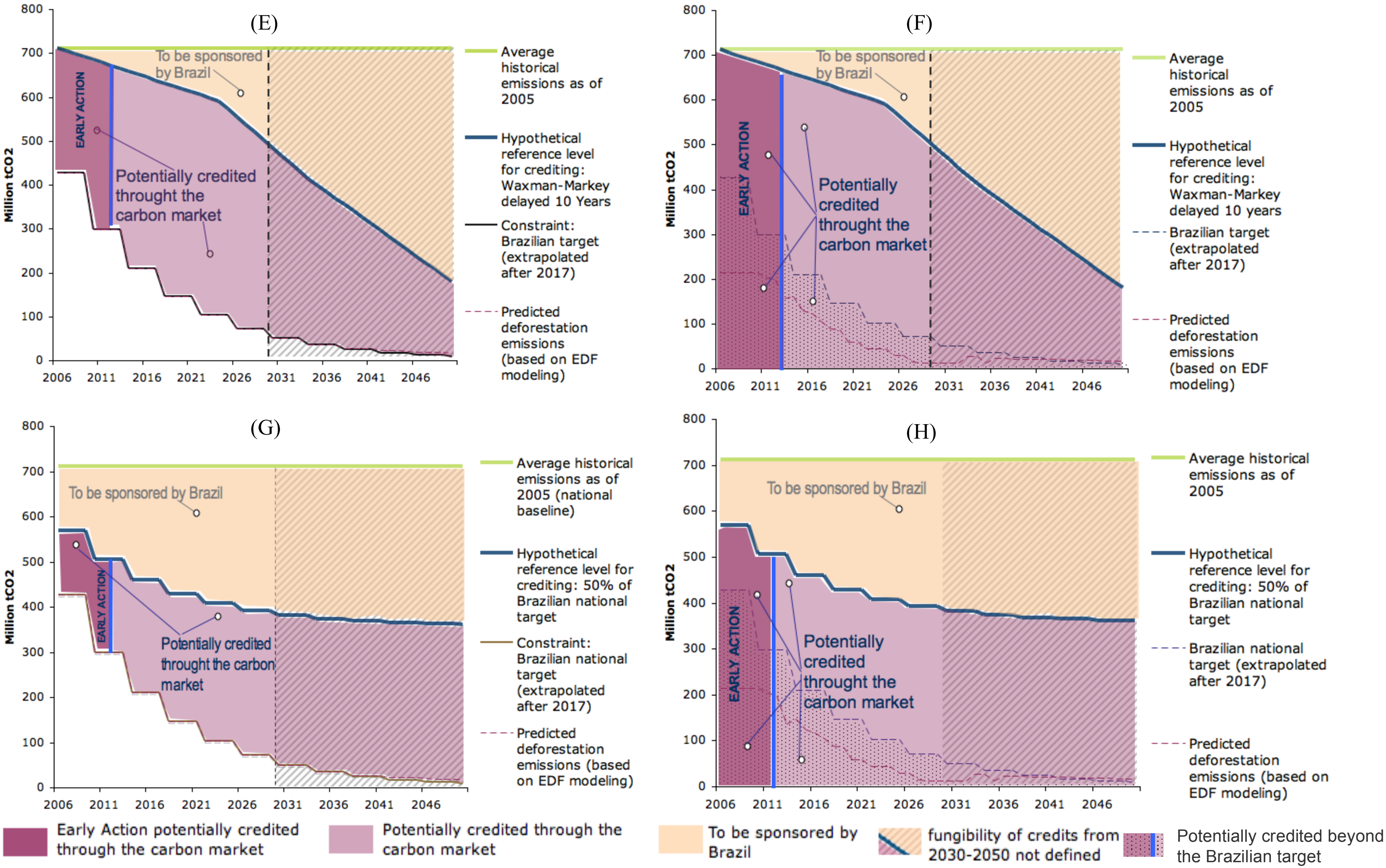


Figure 5.1 (CONTINUED). Alternative Scenarios for Brazilian REDD Crediting Level: (E) Scenario 3.1"Waxman-Markey Delayed 10 Years" with constraint; (F) Scenario 3.2"Waxman-Markey Delayed 10 Years" without constraint; (G) Scenario 4.1 "50% of Reductions Extrapolated" with constraint; (H) Scenario 4.2 "50% of Reductions Extrapolated" without constraint.

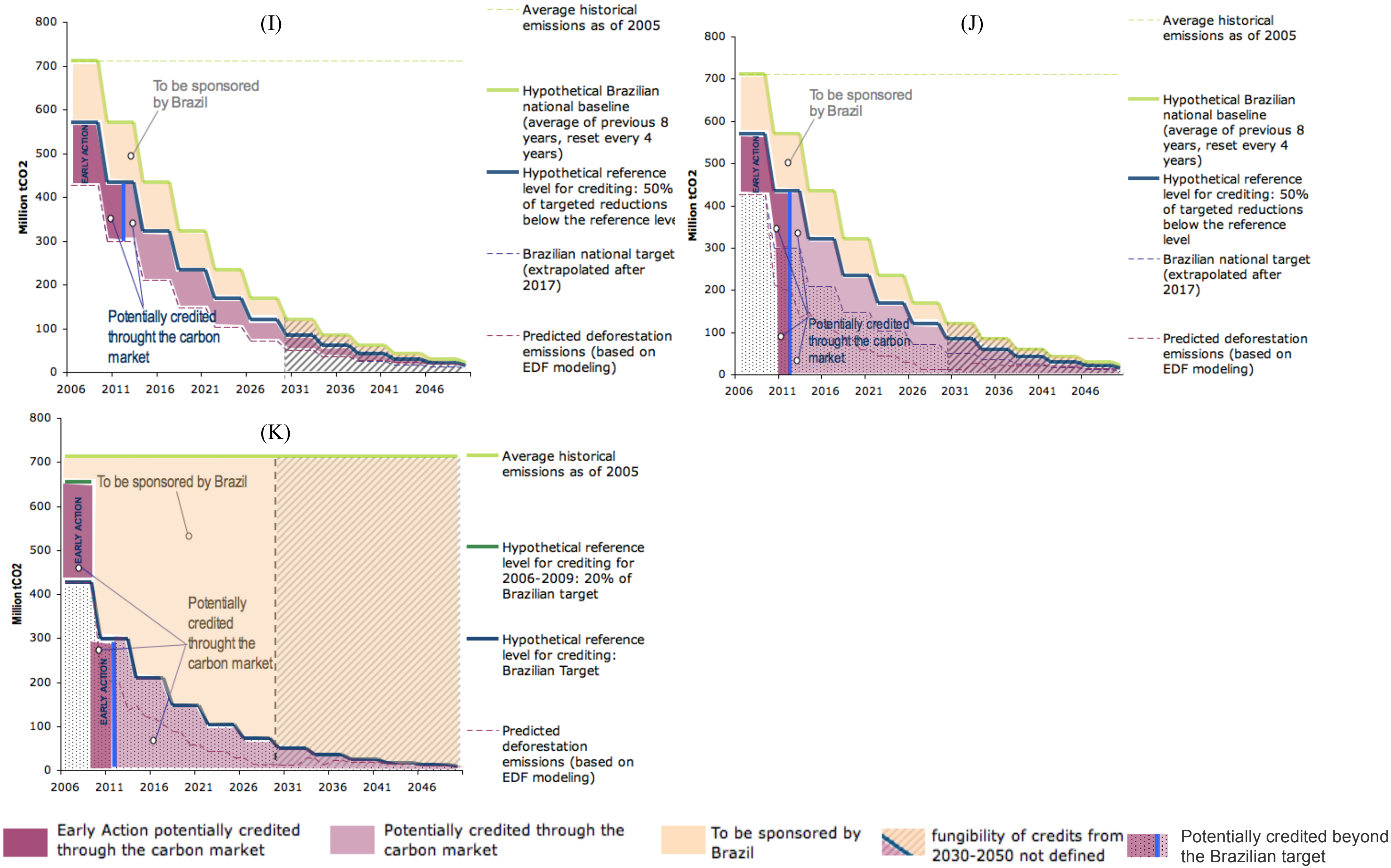
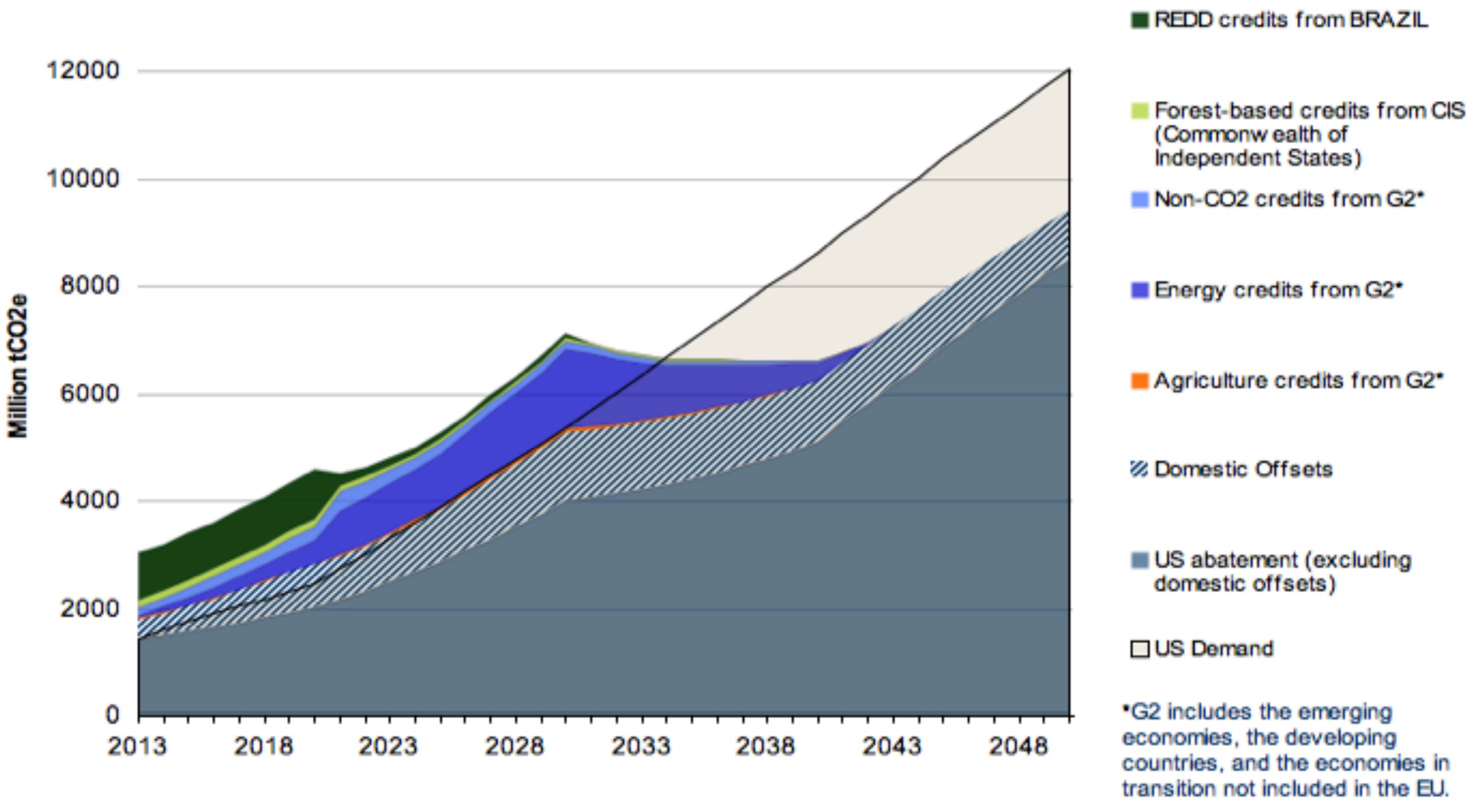


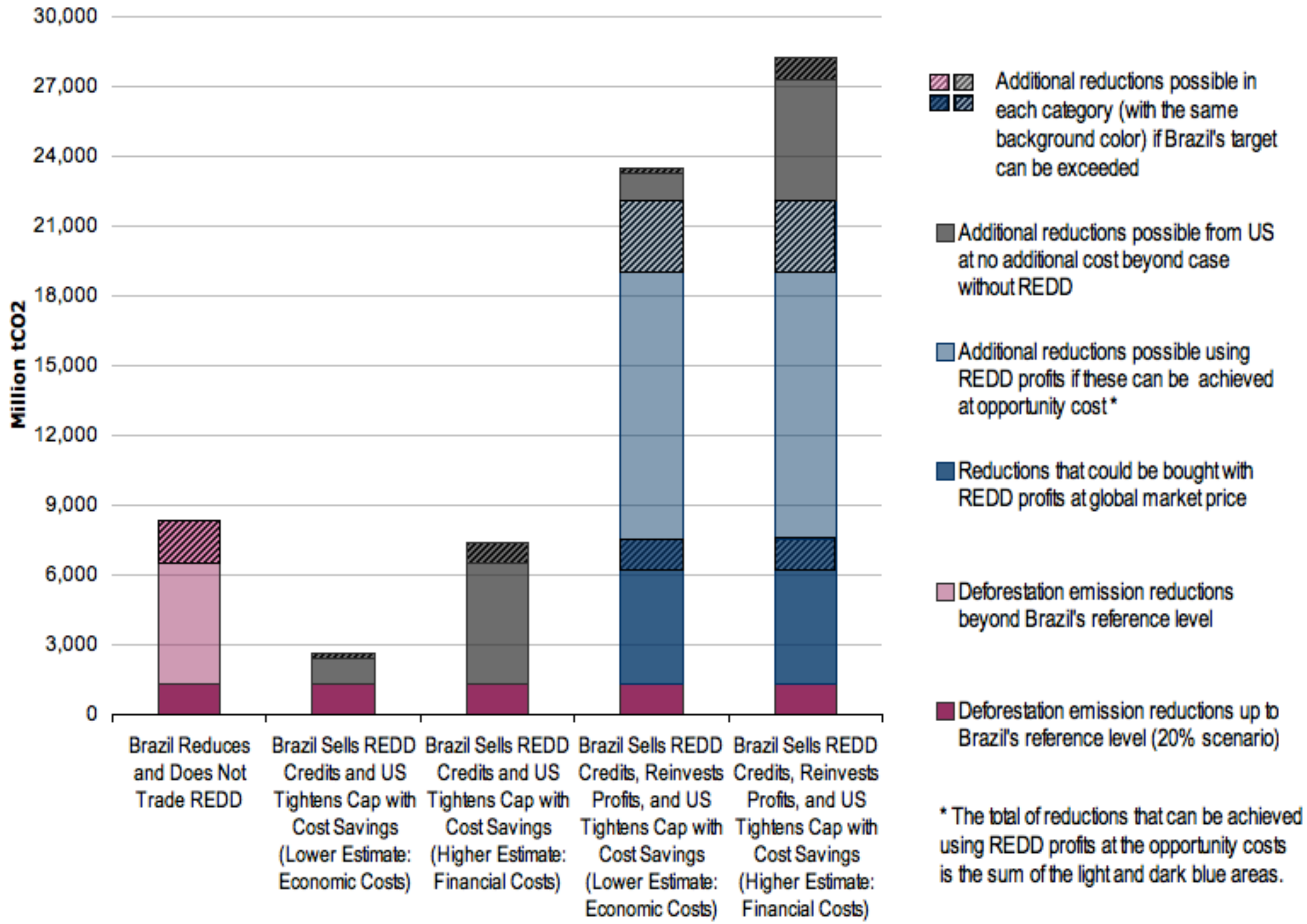
Figure 5.1 (CONTINUED); (I) Scenario 5.1"50% of Reductions Extrapolated with Declining Baseline" with constraint; (J) Scenario 5.2"50% of Reductions Extrapolated with Declining Baseline" without constraint; (K) Scenario 4 "Brazilian Target Extrapolated."

Figure 5.2 Estimated US Domestic Abatement and International Purchases (2013-2050)



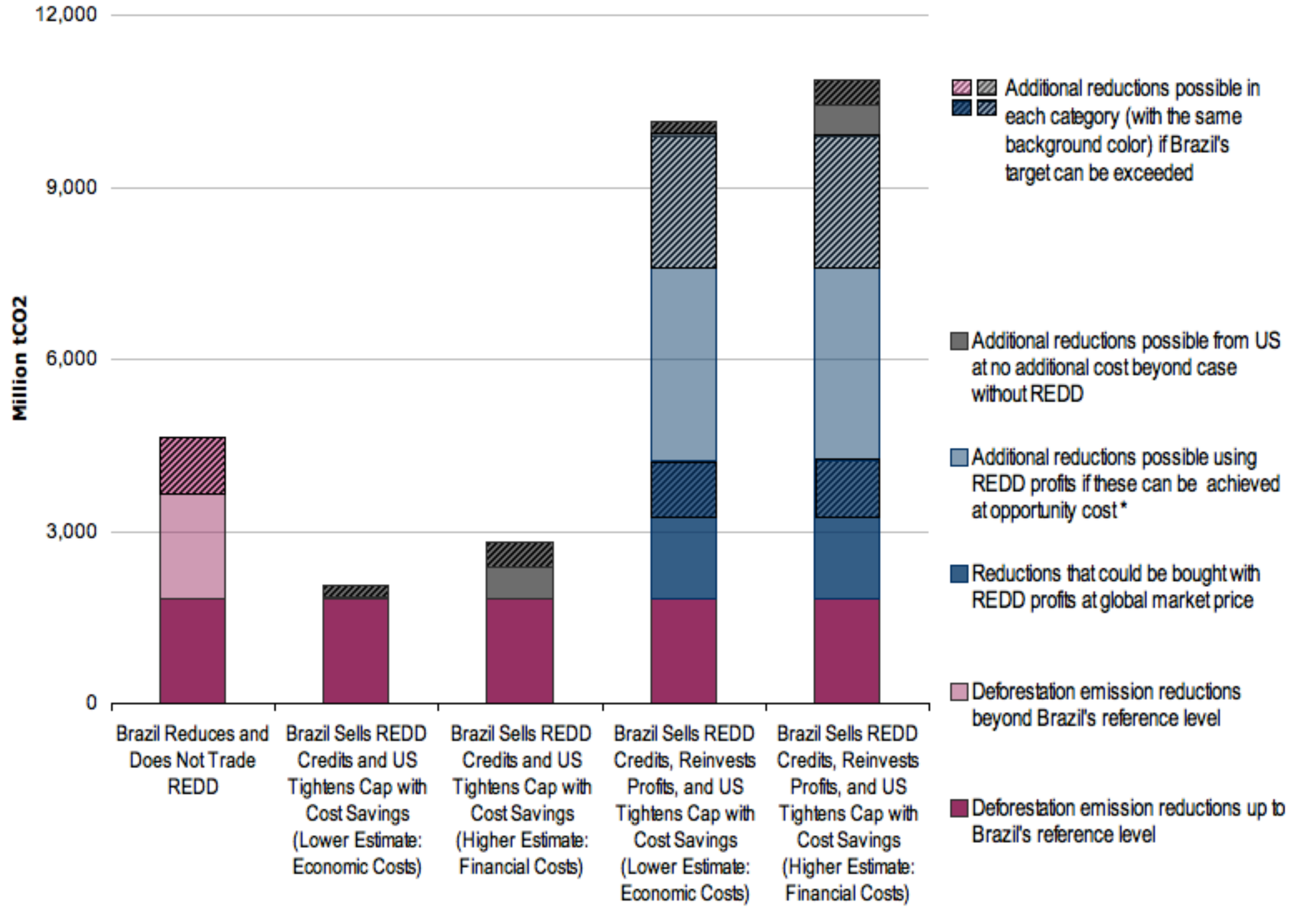
Note: Figure illustrates 20% of Reductions scenario without the constraint of Brazil's national target. The black line indicates the total required abatement in each year based on the US target and projections of US business-as-usual emissions.

Figure 5.3 Potential of REDD Trading to Leverage Net Emission Reductions from US and Brazil (2013-2020) (Scenario #1, 20% Reductions)



Note: The figure shows net changes in US and Brazil emission reductions under different scenarios for carbon market linkage and use of REDD proceeds based on our 20% Reductions reference level scenario for 2013-2020. The estimates used in the figure are reported in the first and second rows of Table 5. The patterned lines indicate the portion of each region of the bars that depends on whether or not deforestation reductions are constrained by Brazil's national target. The potential additional reductions indicated by the light blue region are based on estimates that the opportunity costs of mitigation in the Group 2 countries are approximately 30% of the global carbon market price.

Figure 5.4 Potential of REDD Trading to Leverage Net Emission Reductions from US and Brazil (2013-2020) (Scenario #5, 50% Reductions with Alternative Baseline)



Note: The figure shows net changes in US and Brazil emission reductions under different scenarios for carbon market linkage and use of REDD proceeds based on our 50% Reductions with Alternative Baseline reference level scenario for 2013-2020. The estimates used in the figure are reported in the first and second rows of Table 5. The patterned lines indicate the portion of each region of the bars that depends on whether or not deforestation reductions are constrained by Brazil's national target. The potential additional reductions indicated by the light blue region are based on estimates that the opportunity costs of mitigation in the Group 2 countries are approximately 30% of the global carbon market price. The REDD tons between the historical baseline and the alternative are not included in this figure.

6. Potential Opportunities for a Domestic and International Cap-and-Trade Program in Brazil: Preliminary Modeling Results[*]

6.1 INTRODUCTION

The Brazilian government has emerged as a leading international actor in the fight against climate change. Further to the Brazilian National Plan against Climate Change adopted in 2008, which established a voluntary target for avoiding deforestation in the Legal Amazon, the government has adopted Law nº 12,187 in December 2009 establishing a voluntary and unilateral economy-wide emissions reductions target. Article 12 of the above mention piece of legislation establishes an economy-wide target of 36.1 per cent to 38.9 per cent relative to the projected emissions in 2020. Furthermore, under the framework of The Copenhagen Accord[1], early this year the Brazilian government submitted the nationally appropriate mitigation actions (NAMA) that would lead to achieving such objective. Such mitigation actions could be funded either through voluntary domestic contributions, voluntary contributions from Annex I countries and/or eventually through a market-based international emissions trading mechanism.

The objective of this analysis is to assess from an economic perspective the possible configurations that such economy-wide target could take in Brazil. The following design options are considered: (1) Sector-by-sector reduction targets without domestic or international trading; (2) Economy-wide domestic market; and (3) Economy-wide market

[*] This chapter is an adaptation of a paper written by Pedro Piris-Cabezas and Ruben Lubowski.
[1] The CPH Accord was agreed upon during the UNFCCC Conference of the Parties of 2009 in Denmark.

linked to an international carbon market.

The next section discusses our methodology and assumptions. Section 6.3 presents our key results and conclusions.

6.2 METHODOLOGY

We model Brazilian mitigation options and quantify the benefits and costs under various policy scenarios for domestic and international emissions trading. The modeling is carried out with the EDF carbon market tool supplemented with marginal abatement cost curves derived from the World Bank, McKinsey, the Woods Hole Research Center and other sources. We model a global carbon market where the price of permits is determined by the supply and demand for emission reductions and the possibility of generating excess emissions reductions and saving (banking) them for use in future periods is explicitly taken into account. This analysis supplements a prior analysis in chapter 5 focusing on the potential carbon market impacts of Brazil's national deforestation reduction target.

The modeled period for Brazil could run between 2010 and 2030. However, for the sake of clarity and absent commitments on behalf of the Brazilian government for the next decade, in this analysis we focus on the first decade (2010-2020). Meanwhile, for the market configurations involving linkage with the international carbon market we consider price paths consistent with the rational expectations of the market participants, in line with previous modeling with the partial equilibrium model described in chapter 2.

The national targeted submitted to the CPH Accord can be divided among three main sectors, namely, Deforestation (legal Amazon and Cerrado), Agriculture and Energy/Industry/Transport/Waste (AEITW). These are the three major sectors considered in the subsequent modeling[2]. This analysis relies on existing studies to leverage the wealth of existing information. The marginal abatement cost curves (MACs) that provide the costs of emission reductions for Agriculture and Energy/Industry/Transport/Waste are mostly derived from a recently released report by the World Bank in collaboration with the Brazilian Government (2010), and complemented where necessary with those inferred from a report by McKinsey (2009). The MACs for reducing emissions from deforestation (e.g. REDD) are derived from modeling by the Woods Hole Research Center (Nepstad et al. 2007).[3]

Our estimates imply a business-as-usual (BAU) emissions trajectory that is lower than the government's business-as-usual projections, principally due to our use of World Bank assumptions for the energy sector. At the same time, our total BAU estimates are significantly higher than the World Bank's given our reliance on data from the Woods Hole Research Center which is closer to the government's estimates. The main distinction stems from whether the historically record low rates of deforestation in recent years are assumed to continue in the future under a business-as-usual scenario. Our

[2] For the cases without domestic trading, we consider alternative sectoral caps for the three major sectors. Since approximately 75 per cent of the national target stems from avoiding deforestation we consider cases with alternative targets that give more prominence to the other sectors. Our core scenario with no domestic trading assumes that 50 per cent of the cap envisioned for the Legal Amazon is mandatory, i.e., only half of the 80 per cent deforestation is mandatory. A similar approach is used for the Cerrado for which the government foresees a target of 40 per cent by 2020. Hence we assumed that only 20 per cent of the historical emissions have to be avoided under the reduced cap. This means that 50 per cent of the sectoral cap on deforestation has to be reallocated to the other two sectors to achieve the domestic target. First, we distribute such required abatement using the same relative proportions between the agricultural sector and Energy/Industry/Transport/Waste as those found originally in the government's submitted NAMA proposal. As a result of our modeled BAU for Energy/Industry/Transport/Waste sector being considerably lower than the government's, the required abatement for such sector is not as large as it would be in the case of using the government's BAU. We consider a second alternative where the remaining cap is split equally between those two sectors. As a result the Energy/Industry/Transport/Waste cap becomes more stringent than under the first option.

[3] In the absence of better data, based on the government's 40 per cent reduction target for the Cerrado versus 80 per cent of the Amazon by 2020, for illustrative purposes, we make the rough assumption costs of reducing emissions in the Cerrado are twice as high as in the Amazon.

modeling assumes that higher rates closer to the historic average prior to 2005 would prevail in the absence of Brazil's climate policy.

For the modeling extending through 2050, international targets are taken in line with goals set by the G8 nations. Estimated marginal abatement costs through 2030 are taken from the World Bank, assuming relatively modest continued emissions growth. The World Bank's emissions and abatement potential for agriculture is assumed to continue growing at 1 per cent annually after 2030. For Energy/Industry/Transport/Waste, the emissions and abatement potential are assumed to grow at 0.5 per cent per year after 2030. The deforestation target is assumed to gradually tighten every 4 years following the same pattern as in 2010-2020.

6.3 MAIN RESULTS AND CONCLUSIONS

We consider the impact of emissions trading scenarios based around the upper (more stringent) bound of Brazil's economy-wide target. This target requires emissions to decline from approximately 1,825 Mt CO2 in 2010 to an estimated 1,652 Mt CO2 in 2020. This represents about an 25 per cent reduction relative to 2005 levels and an 18 per cent reduction if 2005 emissions are adjusted using an 10-year historic average for deforestation emissions, the baseline level proposed in Brazil's national climate plan.

Domestic cap and trade would lower the costs of meeting this national climate target compared to sector-specific targets, where policy-makers rather than market incentives determine the share of emissions reductions achieved in different sectors. The costs of achieving the national target under different configurations of a domestic-only program are shown in Figure 6.1.

In particular, the estimated costs of achieving 4,745 Mt CO2 in targeted reductions over 2010-2020 would range from US$2.43 billion under a deforestation-only program. The costs rise to US$5-6 billion if only half of the national deforestation target is used towards the economy-wide target, depending on whether reductions can be banked and on the allocation of responsibility for the remaining reductions between Agriculture and Energy/Industry/Transport/Waste. These estimates likely underestimate the costs of a program without domestic trading as we assume the only modeled inefficiency stems from allocation of effort across rather than within sectors.

The net present value of costs falls to $2.40 billion over the decade in a case with free trading between domestic sectors. Theses costs are just under the costs of a program based solely on reductions in deforestation emissions but more than 60 per cent lower than our case which allocates proportionately higher relative responsibility to the agricultural sector. Regardless of how responsibility for reductions was allocated, cap-and-trade would allow firms in other sectors to lower costs by, for example, buying credits from the forestry sector if this was the cheapest available option. Under this scenario, costs can be minimized, as covered entities are free to buy reductions from each other to the point where the marginal costs of abatement are equalized. This means that abatement effort is distributed in the most cost-effective because there are no profits to be made from reallocating emission reduction responsibilities.

Linking to an international carbon market would leverage Brazil's domestic climate protection efforts, even with relatively modest global demand as reflected in carbon prices. This would allow achieve greater reductions, finance the costs of deforestation reductions and other low-carbon growth strategies, and generate a significant economic surplus. The most ambitious bound of the national target is estimated to produce reductions of 4,745 Mt CO2 over 2010-2020. Under scenarios where this target is taken as a domestic cap, Brazil could earn international revenues by trading reductions below this cap. Figure 6.2 illustrates the potential costs, benefits, and total reductions achieved under alternative international trading scenarios. At an international carbon price of $3.2/ton of CO2 in 2013 (rising at 5 per cent/year), estimated international revenues allow country to precisely cover the estimated costs of these reductions. In this scenario, Brazil achieves total reductions estimated at 7,720 Mt CO2. This generates 62 per cent more abatement than the national target over 2010-2020. At higher prices, Brazil generates more abatement and international revenues more than cover the domestic abatement costs. For prices of $10 to $25 ton of CO2 in 2013, total abatement is 9,720 to 10,419 Mt CO2 over 2010-2020 and the Brazilian economy earns international rents (profits) valued at $25 to $95 billion over the next decade.

Based on national targets in line with goals agreed to by the G8 nations, the modeled international carbon market generates a carbon price signal of $16.5/ton CO2 in 2013, rising at 5 per cent per year. With this price path, Brazil's abatement is 10,290 Mt CO2 and international rents (profits) are valued at $52 billion over 2010-2020. This and other scenarios based on this price path are summarized in figure 6.3. At this price, significant rents persist even if costs are significantly higher than the models predict. The value of rents is $35 billion if costs are twice as high as modeled and $11 billion if costs are five times as high.

While deforestation reductions in the Amazon account for the majority of Brazil's cost-effective reductions, mitigation potential in other sectors is important to lower costs and expand trading opportunities. Figure 6.4 shows the sectoral distribution of abatement over time for the core international trading scenario, while figure 6.5 illustrates the financial flows in each year. At \$16/ton in 2013, deforestation reductions in the Amazon and the Cerrado represent 62 per cent of Brazil's total abatement over 2010-2020. Reductions in the legal Amazon entail about 53 per cent of the total while deforestation reductions in the Cerrado contribute an estimated 9 per cent. Reductions from agriculture provide another 30 per cent while reductions from Energy/Industry/Transport/Waste contribute the remaining 8 per cent.

Brazil generates the greatest reductions and rents when all major sectors trade emissions internationally, in contrast to a REDD-only program. To recall, with the economy-wide target and a price of \$16, Brazil receives about \$52 billion in benefits and abates 10,290 Mt CO2 over 2010-2020. If economy-wide cap is maintained but REDD is the only source of abatement, for \$16 in 2013, abatement is limited at 6,335 Mt CO2 and international rents fall to \$14 billion over the same period. If half of the REDD reductions is tradable internationally below a forest-sector only baseline, international trading would generate rents valued at \$36 billion over the decade, almost one third below the economy-wide potential. Furthermore, about \$17 billion of these rents would need to be reinvested to achieve reductions equal to those achieved under economy-wide trading. These results assume 1-for-1 fungibility of REDD credits in the international marketplace so would overstate the benefits of REDD trading if this is not the case.

These results imply that at \$16 and economy-wide trading below the national target, total abatement rises by 62 per cent while the economic rents rise by 44 per cent compared to trading below the lower REDD-only sectoral baseline (shown in figure 6). The greater potential reductions available across the entire economy imply that international credit sales rise by 75 per cent from 3,167 to 5,546 Mt CO2 despite the more stringent baseline.

Trading below a national baseline would also be beneficial if it assures full fungibility of Brazilian credits in the international carbon market compared to a REDD-only or sectoral trading case. The estimated economy-wide emissions reductions are 9,881 Mt CO2 and rents fall to $46 billion when Brazilian credits are traded internationally on a 5-for-4 discount basis after 2016 (see figure 6.3). This is the condition in America's Climate and Security Act (ACES; H.R. 2454), passed in the U.S. House of Representatives last June, for reductions from REDD and other sector-wide "offset" programs, as opposed to 1-for-1 trading of allowances from under an economy-wide cap.

The profits generated through international emissions trading in Brazil could help finance greater low-carbon development plans and/or commitments. Some of the rents from international trading could be reinvested domestically to achieve additional reductions than would be paid for directly through the international marketplace. For example, if the international market price is $16/ton in 2013, an investment of $11 billion would cover the opportunity costs of about 500 Million tons in additional domestic reductions over 2010-2020 at prices above $16 but below $50.

Given the potential scale of available financing, Brazil could also choose to forego some payments and sponsor a greater share of the emissions reductions achieved in the country. At a price of $16/ton in 2013, Brazil is estimated to break even on the costs of its entire climate program (e.g. international revenues completely cover the costs of the reductions but no surplus remains) under an emissions cap set at close to 1,400 Mt CO2 in 2020. This represents about a 30 per cent reduction from 2005 adjusted levels compared to the reduction of about 18 per cent under the upper bound of the current national target. This scenario is shown in figure 6.7.

Cap-and-trade implemented at both domestic and international levels can create a significant economic opportunity for Brazil with the potential to finance greatly expanded low-carbon development in the country over the coming decades. This potential increases as more economic sectors are engaged across the economy. More detailed modeling of alternative policy scenarios is necessary using updates estimates of economic opportunities to reduce emissions across sectors. The potential for greater reductions and financial flows that could be achieved over a longer term market framework extending to 2050 is shown in figures 6.8 and 6.9. Under the base-case economy-wide cap for 2020 and $16 price in 2013, Brazil's reductions reach 45 per cent below adjusted 2005 levels in 2050. While significant, these credits are still a modest share of required global abatement. The share of Brazil's credits traded internationally would comprise just 12 per cent of total required abatement in the US if the US were the sole purchaser during over 2013-2050.

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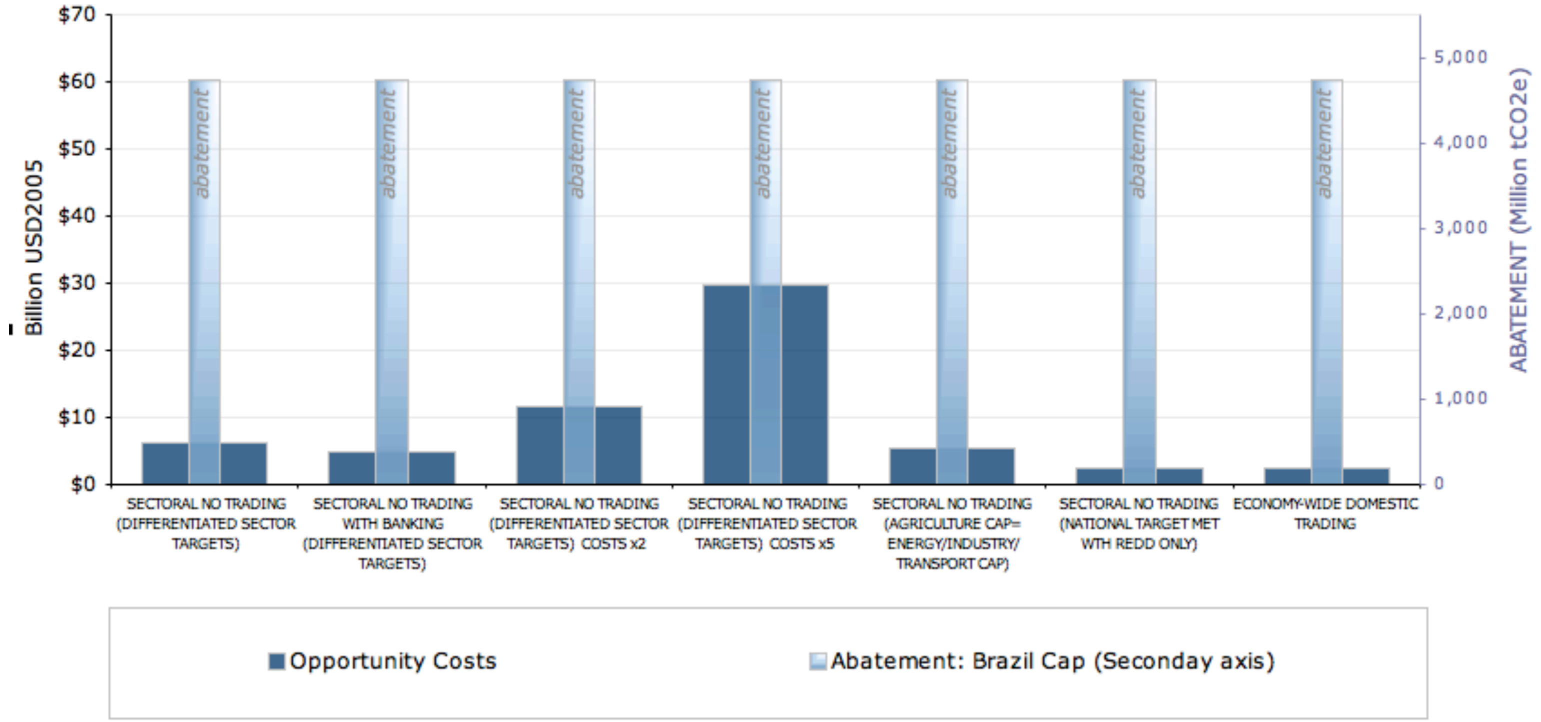
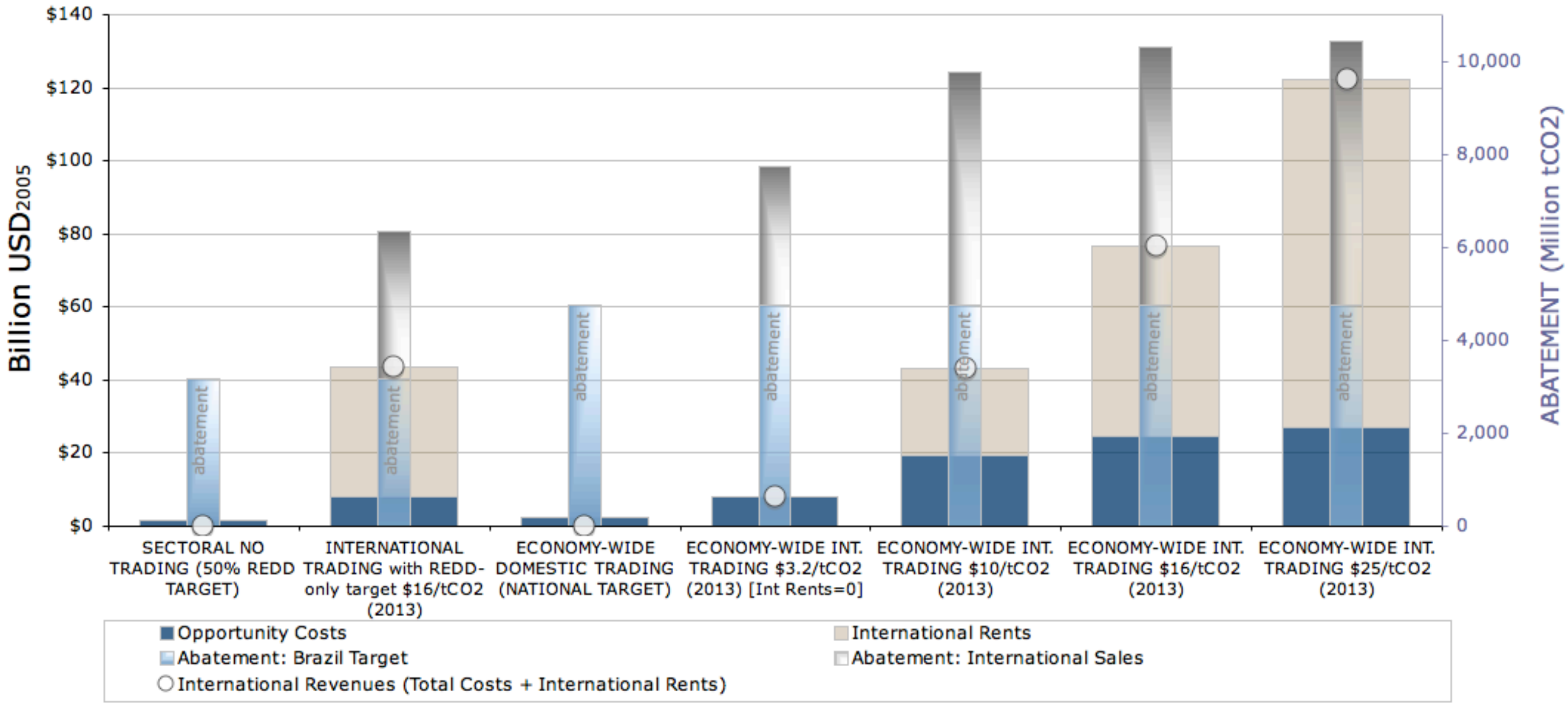
FIGURES

Figure 6.1 Total Costs of Meeting the Economy-Wide Climate Target Under Alternative Sectoral Arrangements Versus Economy-Wide Trading, 2010-2020



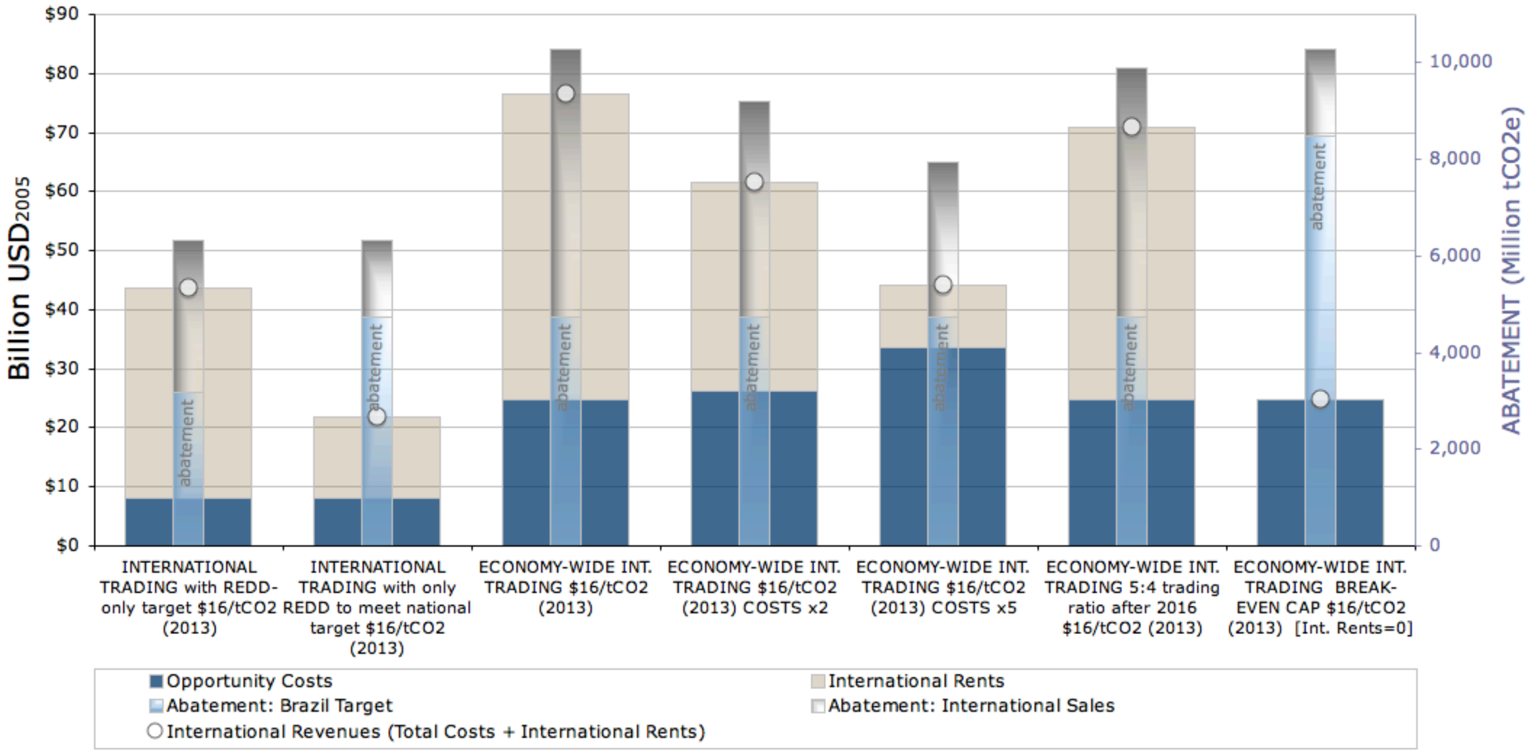
Note: Costs expressed in net present value terms based on a 5 per cent interest rate. Alternative scenarios described in text. The national climate target examined is the upper bound of the government's proposal.

Figure 6.2 Potential Costs, Revenues, Net Benefits (Rents), and Abatement Under Alternative Targets and International Trading Scenarios, 2010-2020



Note: All monetary values are net present values using a 5 per cent interest rate. Alternative scenarios described in text. The national climate target examined is the upper bound of the government's proposal.

Figure 6.3 Potential Costs, Revenues, Net Benefits (Rents), and Abatement Under REDD-Based and Economy-Wide Trading Scenarios Over 2010-2020, for Price of $16/ton CO2 in 2013 (rising at 5 per cent)



Note: All monetary values are net present values using a 5 per cent interest rate. Alternative scenarios described in text. The national climate target examined is the upper bound of the government's proposal.

Figure 6.4 Distribution of Brazilian Abatement with International Trading below Economy-Wide Target, at Price of $16/tCO2e in 2013 (rising at 5 per cent), 2010-2020

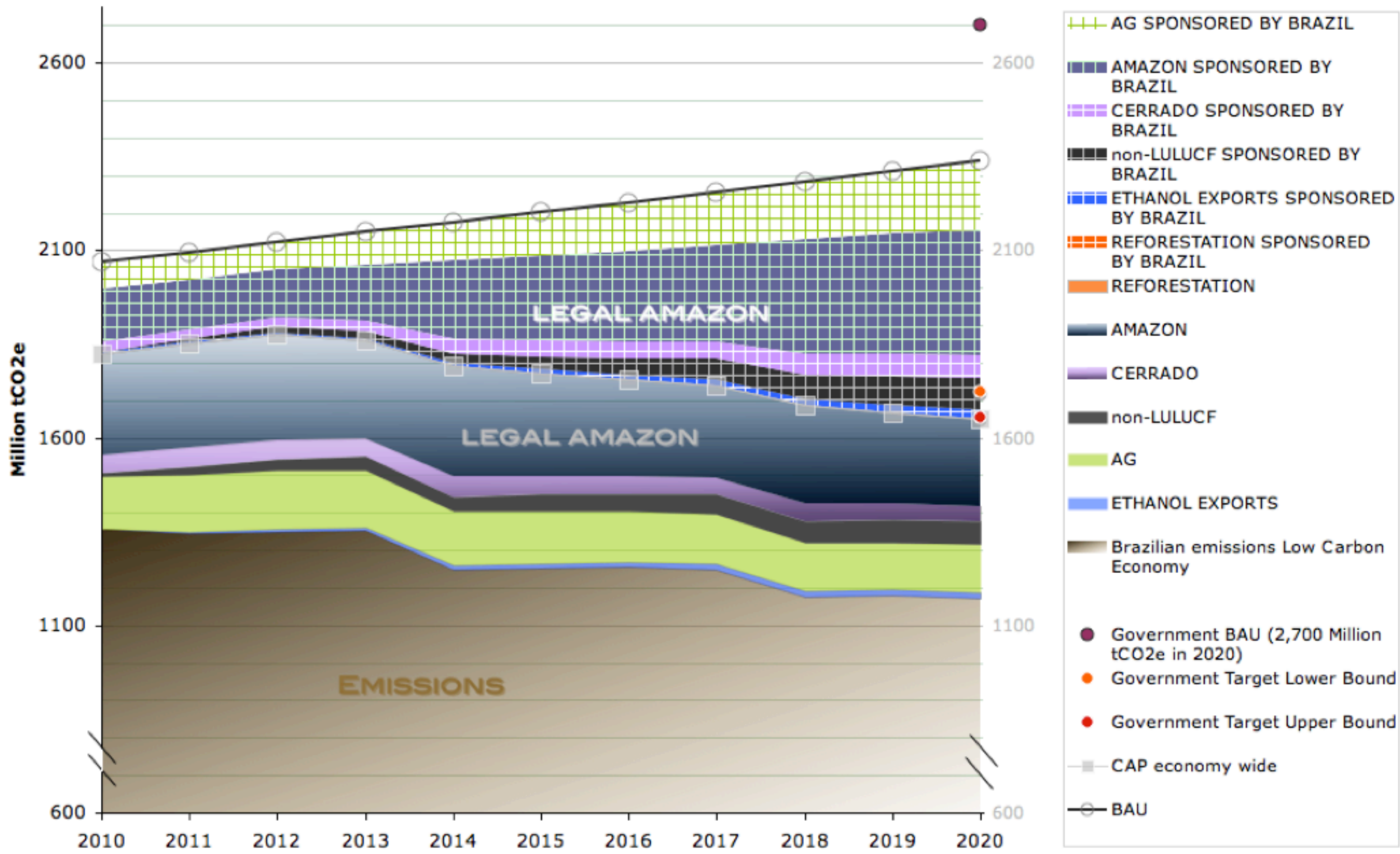
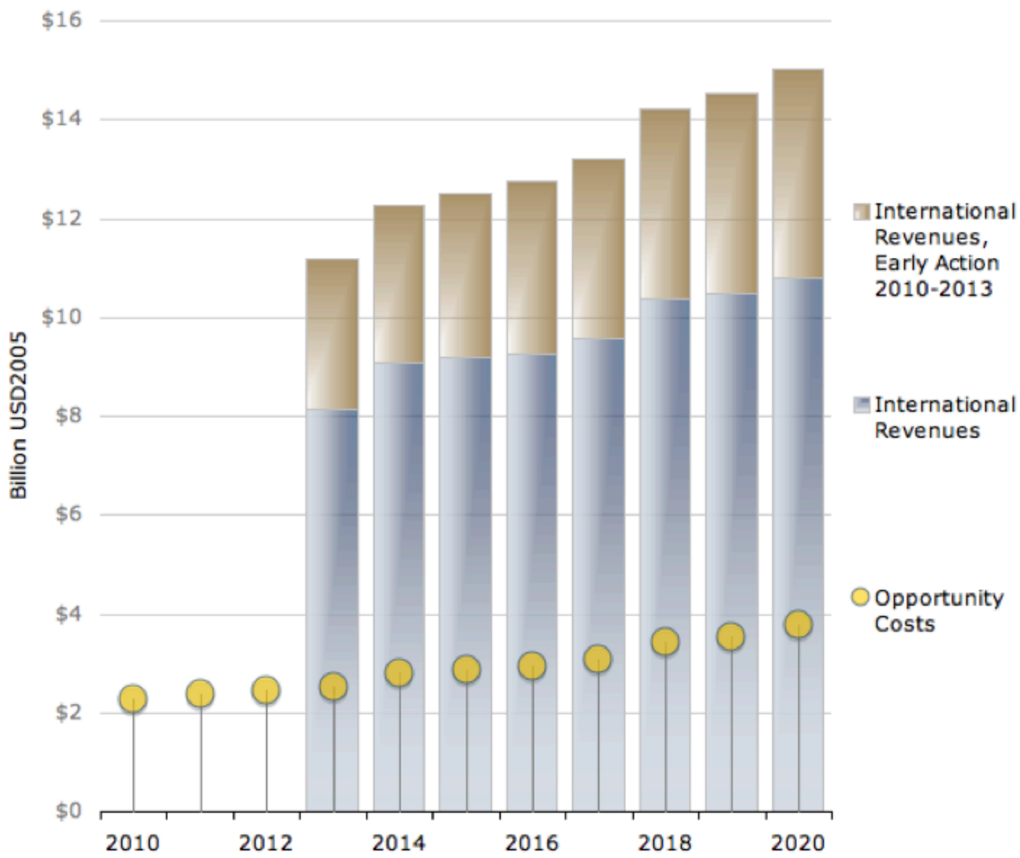


Figure 6.5 International Revenues and Opportunity Costs with International Trading Below Economy-Wide Target, at Price of \$16/tCO2e in 2013 (rising at 5 per cent), 2010-2020



Note: These financial flows correspond to the scenario in Figure 4. International trading starts in 2013. Earlier reductions as of 2010 are treated as “early action” credits that accrue evenly over 2013-2020.

Figure 6.6 Brazilian Abatement with REDD-only Target (set at 50 per cent of Deforestation Target), for Price of $16/tCO2e in 2013 (rising at 5 per cent)

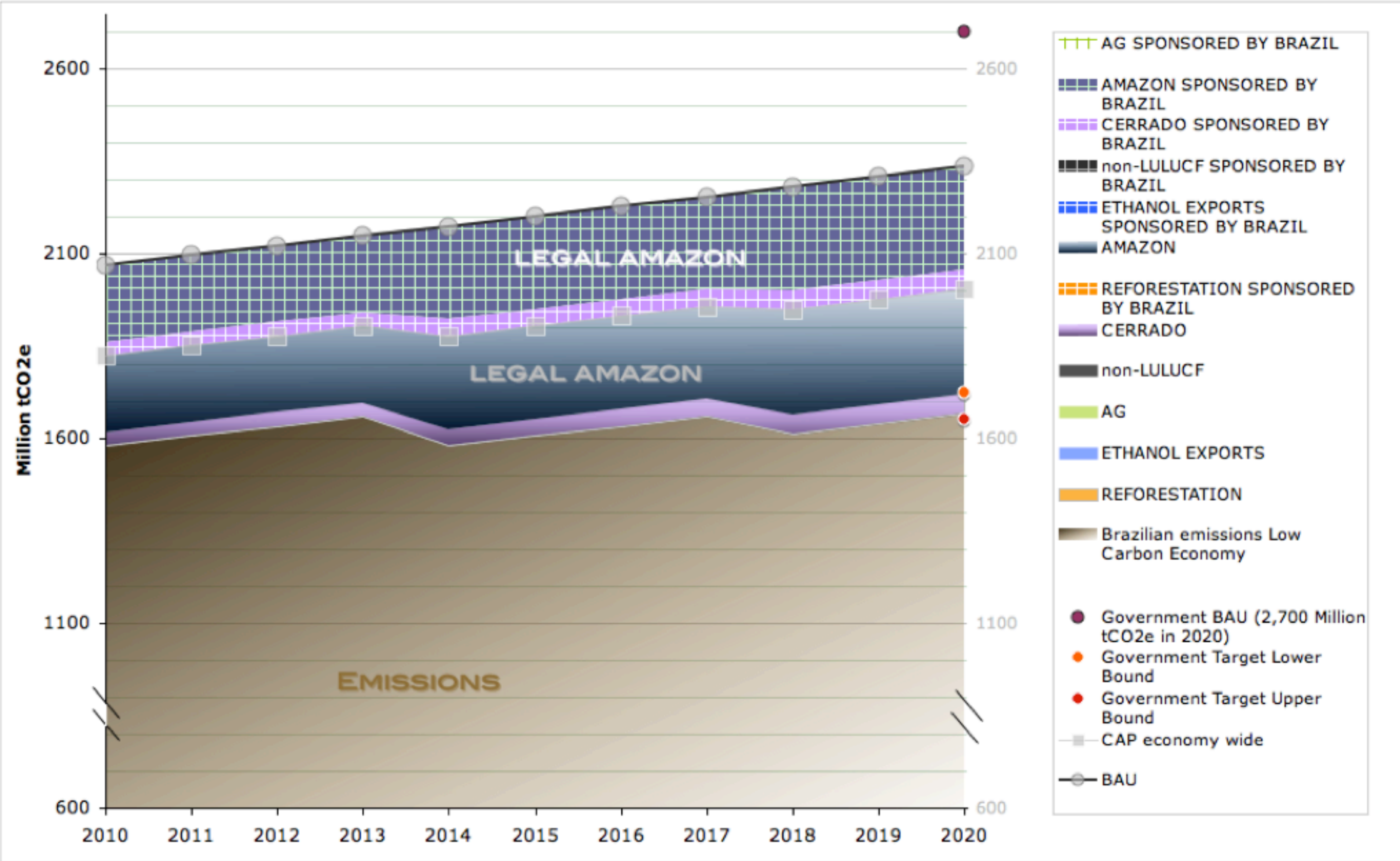
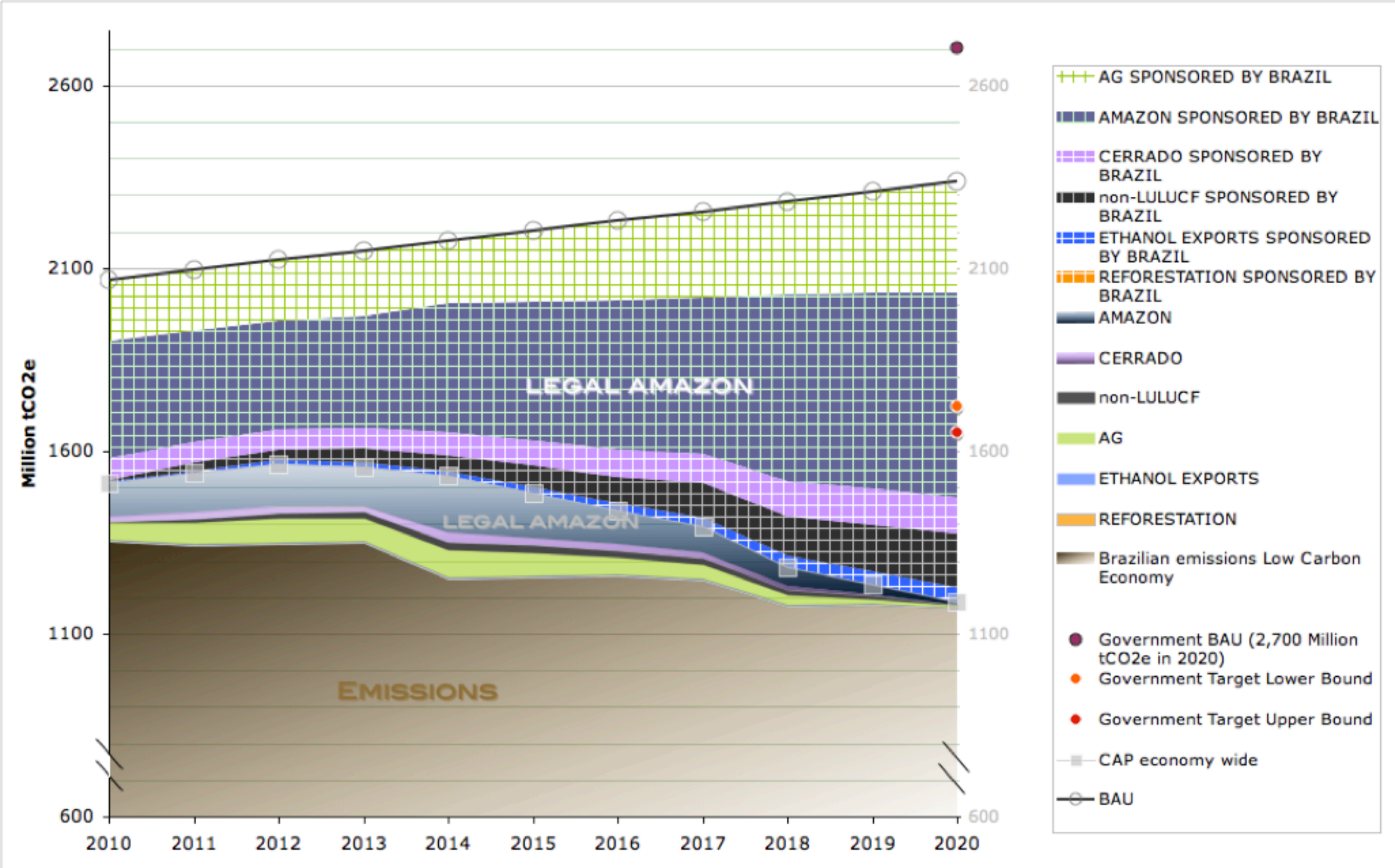
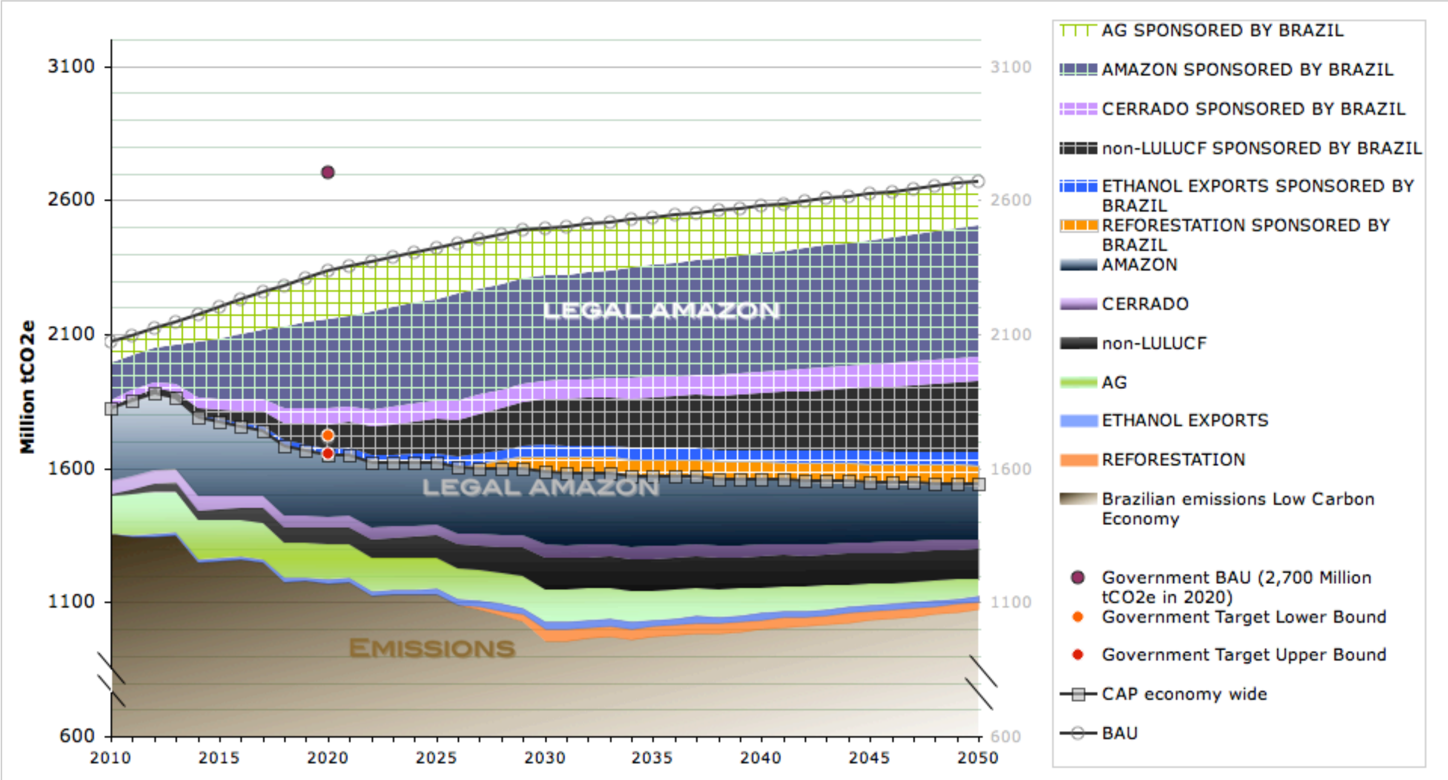


Figure 6.7 Distribution of Brazilian Abatement under "Break-Even" Cap, for Price of $16/tCO2e in 2013 (rising at 5 per cent)



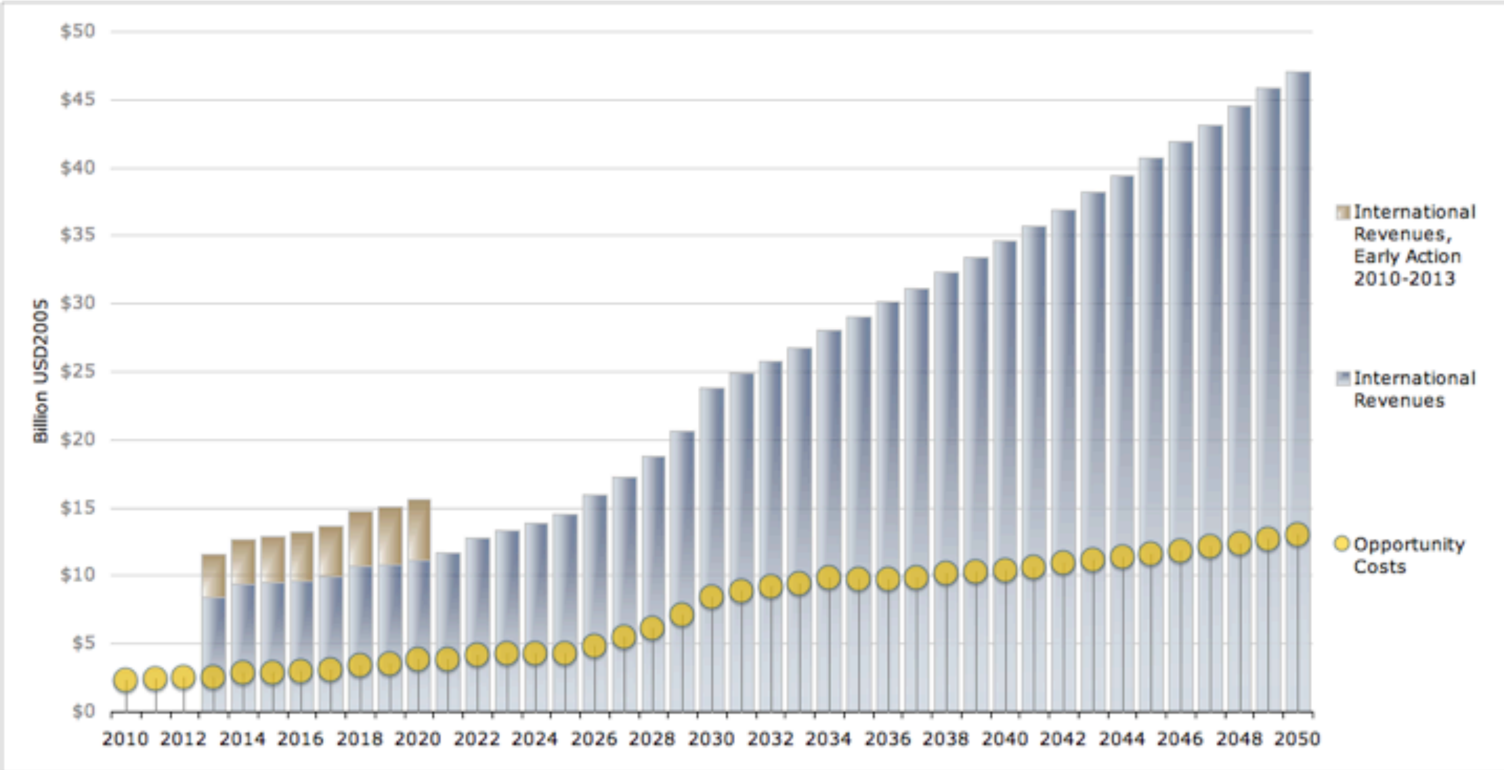
Note: The "break-even" cap is the most stringent cap that is still predicted to yield international revenues sufficient to fully cover the opportunity costs of Brazil's program.

Figure 6.8 Distribution of Brazilian Abatement Under Economy-Wide Cap, for Price of $16/tCO2e in 2013 (rising at 5 per cent), 2010-2050



Note: Assumptions through 2050 described in text. Deforestation target assumed to continue tightening every 4 years as over 2010-2020. Remainder of national target remains unchanged after 2020.

Figure 6.9 International revenues and Opportunity Costs with International Trading Below Economy-Wide Target, at Price of \$16/tCO2e in 2013 (rising at 5 per cent), 2010-2050



Note: These financial flows correspond to the scenario in Figure 6.7. International trading starts in 2013. Earlier reductions as of 2010 are treated as "early action" credits that accrue evenly over 2013-2020.

7. Principal Design Elements for a Brazilian Economy-Wide Cap-and-Trade Program with International Linkage

7.1 INTRODUCTION

Brazil has various strategic alternatives in order to embark on a path of low-carbon economic growth. The size, economic characteristics, and emissions profile of Brazil uniquely position the country to benefit on an unprecedented scale from establishing a domestic cap-and-trade system for greenhouse gases. As of 2005, Brazil was the third largest emitter of greenhouse gases on an individual country basis, behind China and the US, with its emissions principally derived from deforestation and land use activities. The country has enormous opportunities to reduce emissions in these and other sectors at relatively low economic costs. A broad-based cap-and-trade system in Brazil would provide certainty of meeting the national target and would use the market to stimulate innovation and direct investments into the most promising emission reduction opportunities. This would lower the costs of meeting the national climate target compared to sector-specific targets, where policy-makers rather than market incentives determine the share of emissions reductions achieved through different activities. The cap would also create a base of domestic customers for emission reduction solutions that would encourage domestic and international investments in Brazil to supply these needs and help the country enhance its competitiveness in clean energy and other emerging low-carbon industries.

As illustrated in chapters 5 and 6, linking a domestic trading system to an international carbon market would further leverage the benefits of Brazil's domestic climate protection efforts, with even modest levels of global demand. The potential scope for international trading increases as more economic sectors are engaged in the cap-and-trade system across the economy. Under a market-based system for Reducing Emissions for Deforestation and forest Degradation (REDD), and even more so under an economy-wide cap with international linkage, emissions reductions can become a valuable asset, rather than simply a cost for the public and private sectors in Brazil. International trading of reductions in excess of the national cap has the potential to generate an economic surplus and finance greatly expanded deforestation reductions, energy efficiency, clean energy growth, and other low-carbon development and innovation over the coming decades.

To harness the significant potential for cap-and-trade to generate economic wealth and environmental benefits in the country, Brazil can draw on a wide base of experiences accumulated since the pioneering implementation of the US SO2 market. In particular, Brazil can draw on the work carried out by the EU with the EU Emissions Trading Scheme (EU ETS), the flagship of the European Climate Change Policy since 2005. When the European Commission (EC) first considered the idea of introducing a EU-wide carbon market, it was in many ways charting new territory, as the scale and scope of the carbon market envisioned by the EC was unprecedented. Since then other countries such as New Zealand or Japan have emulated the EU, providing valuable case studies, although none represent a breakthrough of the scale of the contribution Brazil could make by adopting a cap-and-trade system. The EU Emissions Trading Scheme was the result of an arduous political and innovative process that, together with recent efforts to establish cap-and-trade in the US, has generated valuable lessons that could help inform the debate on various design elements for cap-and-trade in Brazil (see appendix 1 for an overview of the EU ETS).

The objective of this chapter is to explore the main design elements of a potential cap-and-trade program in light of the peculiarities of Brazil, keeping a focus on the role of deforestation and forest degradation. The next section highlights the five steps for the implementation of a well-designed cap-and-trade program. Section 7.3 proposes policy design recommendations on general design elements and Section 7.4 on the key economic sectors that would be covered under the cap-and-trade program.

7.2 FIVE STEPS FOR A CAP AND TRADE PROGRAM

A cap and trade system caps the overall level of emissions allowed but, within that limit, allows participants to buy and sell emission permits, either domestically or internationally. A well-designed and credible cap and trade program matches a firm, clear environmental target with broad flexibility on how to reach the target in a cost-effective manner. The following steps are the pillars for a well-designed cap and trade:

1. Set the cap. The government sets an absolute limit on the allowable levels of domestic emissions for each year into the future.

2. Allocate permits. The second step is for the government to assign 'allowances', with each one representing a ton of carbon dioxide emissions or equivalent, so that their total number equals the cap. Allowances can be distributed to firms for free and/or auctioned off, with a wide range of intermediate combinations.

3. Measure emissions. Firms or other entities generating emissions would then be required to monitor and report their emissions. Electric utilities, for example, can install equipment on smokestacks of power plants that measures pollution in real time. In the case of emissions from deforestation, Brazil is already leader in satellite technology used for monitoring deforestation that can be combined with other approaches to monitor these emissions.

4. Ensure compliance. At the end of each year, every regulated entity would be required to turn in enough allowances to cover its emissions.

5. Guarantee flexibility. Combining the cap with flexibility over how, where, and when to mitigate emissions will reduce the costs of meeting domestic goals, drive innovation and attract investment in lower cost approaches to reduce emissions.

7.3 GENERAL CONSIDERATIONS FOR BRAZIL

** Setting an absolute cap that provides for emissions to decline over time.* Launching a cap-and-trade system requires Brazil to establish a hard cap that sets a path for emissions to decline from current levels in absolute terms over the near, medium, and long terms. The cap would establish a legally binding limit on absolute emissions at the national level for each year through 2020 and beyond. The goal should be to achieve emission reductions at least as large as the national target through the deployment of both domestic and international financing. Extending the cap beyond 2020 into subsequent decades will help ensure that domestic goals would be met, and even exceeded, and provide market certainty to encourage long-term investment. The national target requires emissions to decline from approximately 1,825 Mt CO_2 in 2010 to an estimated 1,652 Mt CO_2 in 2020.[1] This represents about an 25 per cent reduction relative to 2005 levels and an 18

[1] These estimates imply a business-as-usual (BAU) emissions trajectory that is lower than the government's business-as-usual projections, principally due to our use of World Bank assumptions for the energy sector. At the same time, our total BAU estimates are significantly higher than the World Bank's given our reliance on data from the Woods Hole Research Center which is closer to the government's estimates. The main distinction stems from whether the historically record low rates of deforestation in recent years are assumed to continue in the future

per cent reduction if 2005 emissions are adjusted using an 10-year historic average for deforestation emissions, the baseline level proposed in Brazil's national climate plan.[2]

* *The cap-and-trade system should ensure broad coverage of economic sectors, including deforestation and agriculture.* In 2005, Brazil's emissions totaled about 2,197 MT CO2 (about 6.5 per cent of the world's total based on the latest WRI-CAIT estimates), with almost 80 per cent of these emissions coming from forestry and agriculture. According to the provisional national inventory for 2005, about 58 per cent of Brazil's emissions were from deforestation and other forestry and land-use change activities, 22 per cent from agriculture, 16 per cent from energy, 2 per cent from industry, and 2 per cent from waste treatment (Government of Brazil, 2009).

This emissions profile means that any cap-and-trade system in Brazil should be flexible enough as to accommodate the deforestation and agriculture sectors that account for the bulk of the emissions. As discussed further below, these sectors present particular

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under a business-as-usual scenario. Our modeling assumes that higher rates closer to the historic average prior to 2005 would prevail in the absence of Brazil's climate policy.

[2] In the previous chapter we considered a hard cap scenario for Brazil that would set emissions to decline steadily to 1,652 Mt CO2 in 2020 starting in 2012 and to continue at a more modest pace through 2050.At an international carbon price of $3.2/ton of CO2 in 2013 (rising at 5 per cent/year), estimated international revenues will allow Brazil to precisely cover the estimated costs of these reductions. For prices of $10 to $25 ton of CO2 in 2013, total abatement is 9,720 to 10,419 Mt CO2 over 2010-2020 and the Brazilian economy earns international rents (profits) valued at $25 to $95 billion over the next decade. The profits generated through international emissions trading in Brazil could help finance greater low-carbon development plans and/or commitments. Some of the economic surplus from international trading could be reinvested domestically to achieve additional reductions than would be paid for directly through the international marketplace. For example, if the international market price is $16/ton in 2013, an investment of $11 billion would cover the opportunity costs of about 500 Mt in additional domestic reductions over 2010-2020 at prices above $16 but below $50. Given the potential scale of available financing, Brazil could also choose to forego some payments and sponsor a greater share of the emissions reductions achieved in the country. At a price of $16/ton in 2013, Brazil is estimated to break even on the costs of its entire climate program (e.g. international revenues completely cover the costs of the reductions but no surplus remains) under an emissions cap set at close to 1,400 Mt CO2 in 2020. This represents about a 30 per cent reduction from 2005 adjusted levels compared to the reduction of about 18 per cent under the upper bound of the current national target.

challenges in terms of the point of obligation, monitoring, reporting and verification. In addition to the large number of small and dispersed actors, there are concerns about emissions leakage (shifting of emissions from one area to another). Options for addressing these issues are discussed in the sections on REDD and agriculture below.

The deforestation sector alone accounts for the majority of the low-cost reduction opportunities necessary to meet the national target. However, mitigation potential in other sectors is also important to further lower costs and harvest the benefits of the cap. A broad scope that includes other economic sectors, particularly agriculture, power generation, industry, and transport is essential to achieving higher levels of cost-effective reductions, which could potentially be sold internationally, and to encourage innovation and other environmental benefits across the entire economy.

* *The points of obligation/regulation should aim at obtaining comprehensive coverage and minimize transaction costs.* The stationary sources of GHG emissions are relatively easy to regulate and therefore to cover under the cap and trade system. However not all the sources of emissions can be monitored or verified at the source and would need to be regulated indirectly by choosing a point of regulation as far upstream as possible. For example, the transportation sector consists of millions of mobile sources. If these were to be regulated at the source of the emissions – a downstream point of regulation – then the transaction costs would be outstandingly high. The transportation sector can achieve exactly the same result by shifting the point of regulation upstream, that is by making refineries and fuel importers responsible for the emissions associated to the products distributed for the transportation sector. This will reduce considerably the number of regulated entities and minimize the transaction costs. Such regulated entities would simply pass-through the costs of emission allowances to the end-consumers,

generating the price signal that will boost the deployment of cleaner technologies and behavioral changes. Special considerations for particular sectors are discussed further below.

* *Allocation and other mechanisms should be designed in a fashion to engage economic actors and mitigate risks to competitiveness.* The government has a wide range of options for allocating and sharing the burden for reducing emissions down to the level of the cap. The level of allowances distributed to a covered entity can be allocated free of charge (for example with a grandfathering rule), auctioned, or a combination of the two, with many interim possibilities for dividing the total allowance value. The combination of approaches in line with the EU's approach appears as a powerful mechanism for the first stages of implementation of a cap-and-trade system in Brazil to help ease the transition into the system.

Free allocation is a powerful policy design tool that can positively engage operators in the system. It can be a useful tool in the early stages of a cap and trade system that can ease concerns about its effects on the international competitiveness of the affected entities, but raises issues over fairness from differential allocations.

Auctioning is potentially the simplest system. It eliminates windfall profits and put new entrants and actors growing faster than average on the same competitive footing as existing installations (European Commission, 2009). Revenue generated from selling allowances can also be redistributed in a variety of ways to address distributional issues and fund additional government priorities, including the potential to reduce taxes in a revenue neutral fashion.

How the allowances are allocated across the economy and sectors matters for the distribution of costs and benefits but does not matter for the environmental integrity. The environmental integrity of the cap simply depends on the total level of allowances and on adequate monitoring of emissions and enforcement of compliance with the cap. This is distinct from the concept of the Clean Development Mechanism or of "offsets" programs for projects or entire sectors more generally, which require the setting of baselines to ensure that reductions are additional. With a cap, overall additionality is ensured by the total level of the cap and its downward trajectory over time.

How the allowances are allocated across the economy is important to ensure fairness and broad support for the program and can also potentially be used to protect consumers and trade-exposed industries. This allocation, however, does not matter from the point of view of the environment, as long as there is compliance with the cap.

* *Flexibility over where, how, and when to reduce emissions.* Flexibility is key to harvesting economic efficiencies and increasing incentives for innovation.

* *International linkage will leverage the economic, environmental, and political benefits to a domestic cap.* The international carbon market will link together qualified emissions reductions programs from both Annex I and non-Annex I countries. A program would only qualify if it imposes an absolute limit on emissions and its stringency is consistent with that of the other programs. Hence, by joining the group of countries that commit to significant absolute emissions reductions and implement cap-and-trade systems, Brazil would be granted access to the international carbon market at an unprecedented scale. An economy-wide cap could secure more favorable terms of trade and help avoid possible limits or discounts on the sale of CDM and other "offsets" from less broad-based programs. Similarly, an economy-wide cap would also help avoid the risk of possible border tax adjustments that nations adopting caps might choose to impose on imports from uncapped nations to level the international competitive field.

7.4 KEY CONSIDERATIONS FOR DIFFERENT ECONOMIC SECTORS IN BRAZIL

The following sectors are considered here: agriculture, industry, transport, power generation and deforestation and forest degradation. Although the latter is the focus of the dissertation we found it relevant for the debate on the potential Brazilian economy-wide cap-and-trade system to deal with the sectors with which the measures to reduce deforestation and forest degradation will interact or compete with.

7.4.1 Agriculture

The GHG emissions associated to the sector are 481 Mt CO2e in 2005 – about 22 per cent of the Brazilian emissions in 2005 – with methane emissions from cattle's enteric fermentation accounting for slightly more than 50 per cent (MCT, 2009). Traditional agriculture practices represent a large share of the Brazilian agriculture. The introduction of newer technologies and practices would substantially increase the adaptation of crops to adverse weather conditions and to climate change, and significantly enhance productivity. This could be achieved while, at the same time, increasing soil carbon sequestration, easing or even stopping land use change pressure on the Brazilian forests and restoring, e.g., pasture land or reforesting degraded lands (WB, 2010).

Given the interactions and similarities with the REDD+ programs the agriculture program should be integrated under the state-level REDD program described above. Each state should be as a general rule responsible for the implementation of the policies aiming at reducing emissions from the sector. A nested approach should also be put into practice in order to directly and effectively incorporate the private sector. Additional resources, perhaps from the sale of allowances, could be reserved to finance complimentary Federal scale activities, such as the various programs for encouraging low-emissions agricultural systems being undertaken by the Brazilian Agricultural Research Corporation (aka EMBRAPA).

Given the peculiarities of the sector and in order to minimize transaction costs, it would be needed to determine GHG emissions through models or proxies, in accordance to international guidelines corresponding to the elaboration of national inventories. Although a national approach is not necessary, the programs could be coordinated at the Federal level in order to avoid multiple approaches and methodologies that would result in market inefficiencies and distortions. The distribution of allowances to the sector should be determined in the same way as for the energy, industry, waste and transportation sectors. States should establish a transparent revenue-sharing mechanism for distributing the revenues among the state market participants.

7.4.2 Industry

The industrial and energy sector (excluding power generation) contributed with roughly 200 Mt CO2e in 2005, around 9 per cent of the total emissions (MCT, 2009).

The European experience is very valuable for the sector, given the similarities with the regulation of the sector under the EU ETS. Therefore the program could be crafted after that of the EU ETS, which establishes the point of regulation at the installation level.

Concerns over possible harm to competitiveness might be raised by the industrial sub-sectors exposed to international competition. For that purpose, a free allocation scheme that phases out over time – similar to the one implemented in the EU – would mitigate such concerns and ease the transition. The cost of such a scheme in terms of allocation is likely to be modest as the industries with the highest trade exposure and competitiveness concerns represent a relatively small share of the industrial emissions in Brazil (based on estimates from Rathmann et al. 2010). Besides, the relatively low prices expected in the early stages of the program and the low impact of the cap and trade program in the cost of electricity would make the transition easier than that of the EU ETS.

The competitiveness concerns could also rapidly vanish after factoring in the potential for the industrial sector to profit from the international trading of reductions in excess of the freely allocated emission allowances, which might have the potential to generate an economic surplus and finance for the sector. In addition, the price signal generated by the cap and trade program will encourage the significant mitigation opportunities in the sector and shift to low-carbon technologies. This will allow firms to adapt and help mitigate any impacts to competitiveness.

7.4.3 Transport

The transport sector emitted for 137 Mt CO2e in 2005, about 6 per cent of the total Brazilian emissions. Road transport accounts for roughly 90 per cent of the transport GHG emissions. The critical issue for including the transport sector in a cap and trade program is the point of regulation. The large number of downstream sources requires an upstream point of regulation in order to minimize the transaction costs (for example, as envisioned in the American Clean Energy and Security Act; H.R. 2454 that passed the US House of Representatives in June, 2009).

The number of upstream entities is relatively small. It includes the Brazilian refineries and oil products importers. Under this framework, oil refineries simply pass-through the compliance costs to the end-consumers, who receive a price signal with the potential to alter vehicle miles demand and provide incentives for the vehicle fleet to become more fuel-efficient.

The forecasted carbon prices under a cap and trade program during the early years of the program will not be excessively large as to become too burdensome to the end-consumer. If the allocation methodology were 100 per cent auctioning and the regulated entities passed-through all the costs, the price increases at the pump could be in the order of 2-3 per cent on average for an international price of carbon of USD16/tCO2 – assuming present currency exchange rates and E25 prices at the pump.

Hence, a range of supplementary policies could be implemented in order to accelerate the transition towards a lower carbon transportation system. These policies could be as assorted as the use of stricter vehicle standards or public investments in common transportation, such as the deployment of bus rapid transit (BRT). These policies should also be aimed at reducing the impact of the program in low-income households, which might be disproportionally exposed to higher fuel prices, and to tap on the ancillary benefits resulting from a low carbon transportation system.

One of the peculiarities of Brazilian road transport is the successful market-penetration of the flex-fuel vehicles, which represents a breakthrough for the transport sector. The expansion of ethanol and other biofuels is a potentially major mitigation opportunity. Emissions from the combustion of biofuels could potentially be offset by greater sequestration from the growth of sugarcane and other agricultural activities, which will be important to accurately take into account.

7.4.4 Power generation

The current GHG emissions from the power generation sector are in the order of 26 MtCO2e, accounting for less than 2 per cent of the total emissions. This relatively low contribution is due fact that most of the power generated in Brazil – 88 per cent – comes from hydropower plants, which have historically dominated the generation mix. The generation costs are relatively lower than those in countries with a more diversified generation mix. However, it makes Brazil very vulnerable to power supply shortages during droughts years–as shown in the energy crisis in the early 2000s.

The Brazilian electricity regulatory framework has gone through a deregulation process since the mid 1990s, in line with those taken place in many OECD countries. It is currently fully deregulated and allows generators to sell future energy generation either through freely negotiated bilateral contracts with private counterparts entitled to buy energy in the free market or through energy auctions under the regulated market for the captive end-consumers. Under this policy framework, energy distributors must contract 100 per cent of their expected demand. The energy auctions ensure that the future generation capacity needs will be met by guaranteeing long-term contracts to the power plant projects that have won bids. The duration of the long-term contracts varies significantly with contracts spanning 8 to 30 years.

Thermoelectric power plants have taken over the lion's share of the newest and forthcoming expansion of the generation mix. In the case of the regulated market, thermopower plants have won contracts for around 72 per cent of the capacity from new generation power plants since 2005. As a result of this trend it is expected that GHG emissions from power generation will double in the next 10 years, particularly if difficulties with environmental licensing of hydropower plants persist (Soliano et al., 2010).

The inclusion of the power sector in a cap and trade system has the potential to alter the dispatching merit order of the existing or planned thermoelectric power plants—resulting in emissions reductions. Additionally, it provides a price signal to the end-consumer, which might result in further emissions reductions. Under the current framework, the Operator of the Brazilian electricity system (ONS) dispatches the thermo power plants based on the merit order stemming from the variable costs declared by the generators and subject to network restrictions. The incorporation of the cost of emissions allowances could therefore be relatively simple, as it would simply need to be added to the other variable costs.

A critical issue would be the inclusion of the current and future power plants with long-term power purchase agreements in the program. Some of the energy contracts expire between 2012 and 2016 but most of contracts pertaining to the new developments would only expire in the 2020s.

The point of regulation should be the power plant for the new developments. The power plants with long-term contracts could be indirectly included in the program by shifting the point of regulation to, e.g., the ONS or a government agency. The related compliance costs might be proportionally pro-rated among all the distributors with long-term contract and thereby passed-through to the end-consumer.

Given the relatively low share of the energy generated by means of fossil fuels, the impact of a cap and trade in both the electricity prices for the end-consumer and the extent of the emissions reductions would be rather small. However, given the potential growth of the Brazilian electricity demand in the years to come, the inclusion of the sector is critical to curb its GHG emissions and to harness the great potential for wind and other clean energy sources in the country.

7.4.5 Deforestation and forest degradation

Deforestation and land-use change could be integrated into the cap and trade program through a point of regulation at the level of the Brazilian States, which could then establish 'nested'[3] programs for crediting reductions within their jurisdiction. This would build directly on the structures and agreements already in place under the Amazon fund and national deforestation reduction plan. The federal government might also choose to provide guidelines to help harmonize distribution of allowances to particular groups at the sub-state level, such as indigenous territories and protected areas.

As noted earlier in the dissertation, Brazil is in a unique position to deliver emissions reductions from avoiding deforestation and forest degradation, while increasing its carbon stock by enhancing the sustainable management of its productive forest, and by carrying out reforestation and afforestation projects. The advanced capacities on remote sensing developed over the years make of Brazil the leading power in the field. Furthermore, on the policy side, Brazil has engaged in an ambitious national plan on climate change, announced in December of 2008, and has established national targets to reduce deforestation. The most updated version of this plan, as adopted by Brazil's Amazon Fund, calls for reducing the amount of national deforestation by 42 per cent for the period 2006-2010, relative to the average deforestation for the previous ten-year period of 1996-2005. Additionally, the plan calls for policies to decrease the amount of deforestation by another 42 per cent every 5 years until 2020, by which time the carbon emissions from deforestation would be 80 per cent below the 1996-2005 historic level of approximately 712 million tons of CO2 per year.[4] Government actions have already been

[3] See Cortez et al. (2010) for an in-depth overview of nested REDD.
[4] This differs from the national deforestation target originally announced in December 2008 that called for a reduction of 71 per cent by 2017 relative to the 1996-2005 level. See Brazilian Government (2008) and Mato Grosso Government (2009).

instrumental in reducing Brazil's deforestation rates to the lowest rates in recent history, but significant challenges remain to sustain and deepen these accomplishments.[5]

Addressing the multiple drivers of deforestation and forest degradation requires implementing a myriad of public policies – that go beyond mere payments for environmental services – encompassing, for example policies aiming at alleviating poverty of forest-dependent communities or at creating the conditions for sustainable economic growth patterns. As a general rule the states will put into practice most of the policies and therefore should be the center figures of the REDD program and the rulers of their own jurisdictions.

The REDD programs should be designed in a way that ensures environmental integrity and establishes appropriate benchmarks over time based on performance at the level of the entire jurisdiction of the host state–and ultimately trued up at the country level given the national character of the program—in order to avoid carbon leakage.

The national REDD program under the Amazon fund could be integrated into a cap and trade program by allocating states the rights to allowances equal to their targets under the national plan. Various schemes are possible for distributing the value of these allowances. A fundamental condition for a national REDD program to work is the existence of a political consensus on a revenue-sharing mechanism among the Legal Amazon states. Otherwise states such as Mato Grosso, where the largest share of the deforestation took place during the historical reference level (1996-2005) would receive a large share of revenues in detriment of, e.g., the Amazon state with historically lower deforestation rates but the largest stock of carbon sequestered. Hence potentially

[5] The policy environment for reducing deforestation in the Brazilian Amazon is discussed by Nepstad et al. (2009).

generating perverse incentives that would undermine the program. Based on the same premise as that outlined in the "Stock Flow with Targets" proposal (Cattaneo, 2009), IPAM suggests that the revenues should be shared based on the following criteria: (1) the opportunity costs related to the reduction of deforestation; and (2) a compensation for the conservation of forest, taking into account the management costs associated to the protected areas of the Legal Amazon (the federal government might be entitled to a share of the revenues for covering the cost of the related public policies implemented at the federal level). Also, in order to encourage states to go beyond their targets, it might be interesting to consider alternative distributional criteria for the revenues resulting from the credits generated beyond the target assigned by the national plan. A possibility would be to make state the sole recipient of the revenues generated by such credits.

Under this framework, when a state reduces deforestation by more than any allowances it might be allocated, it will be entitled to REDD credits (emissions allowances) that could be sold both domestically or internationally. However, it would be critical to tap on the REDD investment that could be potentially mobilized by the private sector. Hence, implementing a nested approach that allows issuing credits (or emissions allowances) to individual projects or other actors within these jurisdictions could play a catalyst role. In this context, successful individual projects will only receive credits based on the overall performance of the state, which is at the same time subject to the overall performance of the country as a whole. A focus on the environmental integrity of the aggregate amount of credits issued at the overall jurisdiction level will encourage more comprehensive deforestation reduction efforts and enable risk pooling and other economies of scale.

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Conclusions

There is a large reservoir of potential net emissions reductions from forests in the developing world – especially from reduced deforestation in tropical areas. These forest carbon tons – especially REDD tons – can play a crucial role in keeping open options for averting 2ºC of warming, as they can serve as a bridge to the time when low-carbon energy technologies are more affordable and more widely deployed. At the same time, if these emissions reductions are channeled through crediting systems, they can help moderate the long-term path of GHG allowance prices in the industrialized countries, helping entities in those countries to manage their costs of compliance with a cap-and-trade program and bolstering political support for deeper reductions in emissions.

The multi-period modeling approach to assess the impact of REDD tons in frameworks with long time horizons provides a new perspective on REDD financing. The long-term horizon, the progressive tightening of ambitious emission caps, and the possibility of banking enable a direct market-based funding mechanism to deliver financing at significant scale and absorb the maximum quantity of REDD credit tons, even in the near-term. Banking creates an economic link across years – so that the value of a ton of abatement in the early years of a program is driven in part by the expected cost of reducing emissions later, when caps are more stringent. Rather than flooding the market and driving down the price in the short run, only to have the price rise sharply again later, forest carbon credits will represent a deep reservoir of low-cost abatement that is available now but can be banked to help manage costs in the future. In our model, allowing the use of REDD credits for compliance by developed countries lowers the projected price of GHG allowances by roughly 13 per cent, even if no regulatory limit were placed on the use of forest carbon credits for compliance with cap-and-trade programs, and even in the improbable case where forest carbon credits throughout the developing world became available within the next five years. Under such a scenario, not only do the flooding concerns appear unfounded but the opposite risks become paramount of insufficient REDD credits being ready to deliver the desired cost savings.

Thus, banking provides an intertemporally cost-effective solution that harvests the relatively cheaper mitigation options that would otherwise be irreversibly neglected due to an unbalanced stringency of the short- and long-term targets that could result from the international or regional negotiations. It thus facilitates the synergies between efforts to curb deforestation and forest degradation – with all the associated ancillary benefits – and the required global abatement necessary for averting 2ºC of warming. Furthermore, as banking accelerates global reduction in the near-term it helps keep options open for meeting even more stringent stabilization targets in the future.

The potential impact of banking highlights the importance of climate policies providing a credible, long-term price signal that enable market participants to anticipate future compliance obligations. That is precisely the shortcoming of the EU climate policy, where the current economic meltdown – combined with an institutional crisis – is undermining the capacity of the EU ETS to provide the strong price signal and the consequent emissions reductions that would be consistent with the environmental goals embraced by the EU.

This is dramatic because – absent political will in the US – the EU emerges as the only region in the world with capacity to absorb the supply of REDD credits that could potentially hit the carbon market in the near term, that is the Brazilian REDD credits. EU energy and climate change package provides an example of climate policy without a credible, long-term cap that would enable market participants to anticipate future compliance obligations. This is the case because the legislation was crafted for a scenario involving a lack of commitment to act on the part of the United States of America and the economically more advanced developing countries. The lack of an overarching international agreement obviously limits the potential to finance REDD via a direct market link to the carbon markets in the long-run – when most tropical nations would be ready to deliver performance-based credits –, but not necessarily in the near-term, when the supply would be constrained by the lack of capacity to deliver performance-based REDD credits by most tropical nations.

Beyond the unfounded flooding argument raised by the EU, there was another powerful reason not to allow for the use of REDD credits. While drafting the EU climate and energy package in 2008, the EU realized that the amount of CERs and ERUs to which covered installations were entitled to for Phase II of the EU ETS were outstandingly large. In order to provide regulatory certitude to such rights – which were just meant for the period 2008-2012 – the EU decided to extend their use through 2020, that is encompassing both Phase II and III. As a result little to none room was left for additional international credits or allowances including REDD credits, even if there is language in the legislation that would allow for its use if an international agreement were reached. In that context, the EU established a voluntary fund-based mechanism in order to address REDD financing needs in order to make a contribution towards the goal of halting net deforestation. However, this voluntary mechanism – left at the discretion of

EU member states – would hardly deliver the funding necessary to contribute towards at least halving gross deforestation by 2020 – an environmental goal endorsed by the EU.

To make things worse, recent analyses show that the EU ETS appears to be at a crossroad due to the a potential misalignment of the current stringency of the EU ETS cap through 2020 and the complementary policies adopted in conjunction with the flagship policy under the EU Climate and Energy package agreed in December 2008. As a result, the EU ETS target through 2020 could be met domestically, that is without the need to surrender any of the CERs and ERUs built into the system.

However, what appears to be a deadlock can be turned into a great opportunity. The EU is in need of a story line for the estimated surplus allowances and credits by 2020. So either it incorporates the banking argument in its narrative by broadening the time horizon of its climate policy, or sticks to its mantra and tries, for instance, to build consensus on the need to tighten the cap through a set aside of allowances, as suggested by the EC, a solution that brings further regulatory uncertainty.

Our take is that the EU could easily address all these issues without necessarily undergoing arduous negotiations for tightening its 2020 target by formally extending the EU emission reduction cap to at least 2030 in line with 2050 goals, and – very importantly – detailing the eligibility of the international credits to be allowed after 2020 at the latest. This would help market actors to optimize the timing of their abatement strategies and investment portfolios, increasing the depth of the EU's carbon market, and creating robust demand for alternative sources of international credits including REDD.

Furthermore, greater certainty over future EU climate policy would increase market incentives for research and development and other long-lived investments and for greater emissions reductions over the near term – both domestically and from tropical deforestation and other activities internationally – for the purpose of banking credits for future use. This would maintain the stability of its market through 2020, while allowing the EU to extend access to its carbon market. This would also strengthen the EU's position in the international and bilateral negotiations. Curiously, the EC has traditionally argued against market-based REDD on grounds of preserving the stability and price signal of the market, when the real issue preventing the EU ETS market from delivering was not REDD but the inappropriate time horizon considered by its legislators.

In a context of lack of international agreement to tackle climate change, the EU – and for that purpose eventually the US too – should stimulate the supply of REDD credits by reaching bilateral agreements with tropical nations ready to deliver performance-based REDD credits – as contemplated both in the EU climate legislation and the US climate proposals.

Among the potential European counterparts, Brazil is in an unrivaled position to achieve large strides toward stopping deforestation in the Amazon Rainforest. Both the technical and political conditions are met for Brazil to implement a sound REDD crediting program. After years of unfulfilled expectations it is time to begin delivering. Otherwise all the impetus generated around REDD would vanish together with millions of rainforest hectares. Hence the importance of stimulating the supply by opening the carbon markets to REDD credits as soon as possible.

Our results indicate that the Brazilian proposal aiming at reducing deforestation by 80% in 2020 sets the stage for a win-win situation not only for Brazil but for the US too – and by the same token the EU if a long-term horizon is eventually adopted as suggested above. Although our candidate for playing a key role is the EU, we consider the REDD-friendly US climate bills as a proxy for assessing the potential impact of a bilateral agreement involving the EU and Brazil. We find that if a portion of Brazil's reductions, above a pre-determined reference level, were sold as carbon market credits, the US would gain by reducing its compliance costs and could potentially increase its emissions reductions at no additional cost over the case without REDD. At the same time, Brazil could raise sizable revenues that, at least in part, could expand the scale of its planned climate change initiatives. In this way, linking REDD to proposed US carbon markets offers the potential to leverage the climate protection efforts of both the US and Brazil and multiply the combined impact of the two national programs.

Some would argue that if Brazil could secure the necessary domestic resources to achieve all of its potential deforestation reductions without any linkage to the carbon market, then it should not trade these reductions as REDD credits because these would serve to only 'offset' emissions in the US or other countries on 1-for-1 basis and thus provide no added gains for the atmosphere. Actually the cost savings from trading REDD credits in a carbon market system offer the opportunity for Brazil and the developed countries to be able to achieve greater atmospheric reductions together than separately. Considering the reductions that Brazil could generate by reinvesting its profits from the carbon market, as well as the potential to increase reductions in the US, linking Brazil's REDD to the carbon market can potentially leverage significantly greater atmospheric benefits compared to a case where Brazil achieves all its potential reductions and does not link to the market. For instance, these cost savings could potentially allow for an increase in the stringency of the US emission-reduction target for 2020, one of the most controversial elements of recent climate proposals due to the perceived lack of stringency, by up to 12 per cent at no additional costs to US companies. Selling a share of deforestation reductions through a direct market-based REDD mechanism would also generate a stream of revenues with an estimated net present value of $36-$147 billion through 2020 and $48-$248 billion through 2030 – depending on the reference level, the crediting baseline and the policy constrains considered under the REDD program. This scale of financing could help sustain and enhance the scale of the proposed emissions reductions in Brazil. Linking the proposed climate protection efforts of the US and Brazil through a future carbon market could thus multiply the effectiveness of each nation's program and achieve greater combined climatic benefits.

While deforestation reductions in the Amazon account for the majority of Brazil's cost-effective reductions, mitigation potential in other sectors is important to lower costs and expand trading opportunities. A Brazilian economy-wide cap-and-trade system has the potential to tap on such mitigation potential in a cost-efficient fashion and to bolster the eligibility of REDD credits as international allowances in the EU by linking the Brazilian cap-and-trade with the EU ETS and/or the government-level carbon market deriving from the Effort Sharing Decision.

Among the possible cap-and-trade configurations to achieve the Brazilian unilaterally adopted targets, Brazil generates the greatest reductions and rents when all major sectors are covered under a Brazilian cap-and-trade system and are allowed to trade emissions internationally, in contrast to a REDD-only program considered above. Linking to an international carbon market would leverage Brazil's domestic climate protection efforts, even with relatively modest global demand as reflected in carbon prices. This would allow achieve greater reductions, finance the costs of deforestation reductions and other low-carbon growth strategies, and generate a significant economic surplus.

The profits generated through international emissions trading in Brazil could help finance greater low-carbon development plans and/or commitments. Some of the rents from international trading could be reinvested domestically to achieve additional reductions than would be paid for directly through the international marketplace. Given the potential scale of available financing, Brazil could also choose to forego some payments and sponsor a greater share of the emissions reductions achieved in the country.

Brazil should draw on the experiences and lessons learned from the EU ETS and the thoughtful approaches incorporated in the US legislative proposals to implement a cap-and-trade system. In what regards the groundbreaking implementation of a REDD program Brazil would need to innovate. However, we believe that the Brazilian REDD crediting system could be relatively easily integrated into the cap and trade program through a point of regulation at the level of the Brazilian states, which could then establish so-called ‘nested’ programs for crediting reductions within their jurisdiction in order to engage private investors.

In closing, the EU and Brazil have the potential to make great strides towards averting 2ºC of global warming by stopping deforestation in the Amazon and getting both economies in the right pathway to further decarbonize their economies. Furthermore, bilaterally linking the proposed climate protection efforts of the EU and Brazil through a future carbon market could not only multiply the effectiveness of each nation’s program and achieve greater combined climatic benefits, but also generate intangible and countless ancillary benefits associated with the conservation of the Amazon Rainforest.

Such an agreement has the potential to catalyst the international negotiations by setting an example of successful North-South cooperation that would shape climate policy forever, bringing HOPE to the generations to come.

Madrid, December 8th 2011

APPENDICES

APPENDIX 1

A1. The European Union Emissions Trading System: A Succinct Review

A1.1 INTRODUCTION

The Kyoto Protocol (KP – see box A1.1 below for an overview) requires the European Union (EU) as a region to reduce emissions by 8 per cent below 1990 level by 2008-2012. After the signature of the KP, the EU's Member States reached the so-called 'EU burden sharing agreement', which assigned to each Member State a share of the KP target, which had been negotiated as a single regional bubble under Kyoto. The countries that subsequently joined the EU in 2004 and 2006 kept their individual targets agreed in Kyoto, which in most of the cases equaled that of the EU. Member States are entitled to use the flexibility mechanisms established by the KP to meet their share of the targets assumed in Kyoto subject to limits to ensure these mechanisms are a supplement, rather than a substitute, for domestic action.

Member States have implemented a range of domestic climate policies that encompass the EU Emissions Trading Scheme (ETS) – the EU's cap-and-trade system (for an overview of how a cap and trade system works with a focus on the allocation methodologies see Appendix 3) – together with complementary policies, including energy efficiency measures and feed-in tariffs for renewable energy (see Appendix 4 for a brief discussion on complementary policies).

Box A1.1 The Kyoto Protocol Framework for Emissions Trading[1]

THE KYOTO PROTOCOL FRAMEWORK FOR EMISSIONS TRADING

The Kyoto Protocol (KP) adopted in 1997 under the United Nations Framework Convention on Climate Change (UNFCCC) is an international agreement setting binding targets for industrialized countries –Annex I Parties to the Protocol— on greenhouse gas emissions over the five-year period 2008-2012. These targets amount to an average reduction of five per cent relative to 1990 levels and reflect the principle of "common but differentiated responsibilities" among countries. The detailed rules pertaining to the Protocol are known as the Marrakesh accords of 2001. The KP entered into force in 2005 —when the industrialized countries having ratified the KP amounted for at least 55 per cent of the total carbon dioxide emissions for 1990 from the Annex I Parties. Several industrialized countries that had signed the KP in 1997 –including the United States— eventually did not ratify it domestically.

The United Nations Framework Convention on Climate Change (UNFCCC) is one of three conventions adopted at the 1992 Rio Earth Summit. The UNFCCC was joined by most countries and sets an overall framework that encourages intergovernmental efforts with the goal of preventing dangerous human interference with the climate system. The KP goes a step further by committing signatory countries to quantitative emission reduction targets.

Under the KP, countries must reduce emissions predominantly through domestic actions, which can be supplemented by way of three flexibility mechanisms. The KP flexibility mechanisms are:

(1) Emissions Trading. Countries are issued tradable Assigned Amount Units (AAUs) up to the country's KP target. Those countries that have extra AAUs may sell them to countries that have emissions exceeding their targets, creating so a market of emissions allowances.
(2) The Clean Development Mechanism (CDM). Project-based mechanism that involves investment in projects that reduce emissions in developing countries. These projects generate Certified Emissions Reductions (CERs) that can be used for offsetting emissions in Annex I Parties to the Protocol.
(3) Joint Implementation (JI). Project-based mechanism similar to the CDM but among Annex I Parties. The offsets generated by these JI projects are denominated Emission Reduction Units (ERUs).

The EU ETS establishes a mandatory cap at the level of EU companies and creates a firm-level market connected to the Emissions Trading mechanism established by the KP. The EU also decided to allow flexibility for the regulated companies to meet their targets

[1] Information partially excerpted from UNFCCC's website.

by allowing the use of CERs and ERUs generated under the KP framework, thus creating a direct link with the international carbon market established by the KP.

The EU Emissions Trading Scheme (EU ETS) has been the flagship of European Climate Change Policy since 2005 and the result of a complex political negotiation and technical process. When the European Commission (EC) first considered the idea of introducing an EU-wide carbon market, it was in many ways charting new territory. There were successful stories and valuable lessons learnt from the implementation of the U.S. air pollutants markets and experimental voluntary carbon markets such as that of the UK, but the scale and scope of the carbon market envisioned by the EC was unprecedented.

Within the context of the Kyoto commitments, the EC voluntarily took on the challenge of being the first to implement an international company-level cap-and-trade program for limiting carbon dioxide (CO_2) and other greenhouse gas pollution. The creation of this system was based on broad political support for addressing climate change and a widely shared sense of industrialized countries' responsibilities for it. The EU, the main proponent of carbon taxes during the 1990s leading up to the Kyoto agreement, subsequently embraced the strategy of implementing a cap-and-trade system for cutting its own greenhouse gas emissions cost-effectively and became a leading advocate for this approach.

A1.2 THE EU ETS DESIGN AND IMPLEMENTATION PROCESS

The EU ETS was established by Directive of the European Parliament and of the Council of the EU in October 2003, and amended by the "linking Directive" in October 2004. The linking Directive regulated the linkage of the Kyoto Protocol (KP) project-based mechanisms, i.e., the Clean Development Mechanism (CDM) and the Joint Implementation (JI), to the EU ETS with the goals of increasing the diversity of low-cost compliance options within the EU ETS, while safeguarding its environmental integrity.

The implementation of the EU ETS has proceeded in phases. The first phase was a trial phase—also called the pilot or supplemental phase—and covered the three years (2005-2007) leading up to the first KP commitment year. The second and on-going phase covers the five KP years (2008-2012). A third phase with a revised version of the EU ETS will cover the period 2013-2020. The EU ETS is expected to continue after 2013 regardless of the status of the KP at that point (Ellerman and Joskow, 2008).

The cap covers the electricity and part of the industrial sector (it does not include transportation). The covered installations are grouped into the following sectors: power combustion, oil refining, coke and steel, cement and lime, glass, bricks and ceramics, pulp and paper, and miscellaneous. From 2012, coverage will be expanded to include emissions from aviation. The ETS currently covers greenhouse gas emissions – not limited to CO2, as was the case in the pilot phase – from over 11,000 installations, which are collectively responsible for around half of the EU's emissions of CO2 and 40 per cent of its total greenhouse gas emissions (European Commission, 2009).

Phase I allowed for the use of certified emission reductions (CERs) from CDM projects as offsets—even though the rules pertaining to the CDM were still in the process of being approved under the UNFCCC—but did not permit the use of emission reduction units (ERUs) from JI projects. During phase II, the use of CERs and ERUs has been allowed and calculated as a percentage of the allocation to each installation—around 11 per cent on average.[2]

Figure A1.1 depicts the interactions among the different carbon markets during Phase II of the EU ETS.

Operators are subject to a penalty of €100/tCO2e for any excess emitted by an installation for which the operator has not surrendered allowances (compared to a penalty of €40/tCO2e during the pilot phase).

During both the pilot phase and Phase II, allowances were primarily freely allocated. Although the EC allowed Member States to auction a maximum of 5 per cent of their cap during the pilot phase (up to 10 per cent for Phase II), they hardly used this option at all. Free allocation implies that each Member State has to develop and make public its own national allocation plan (NAP) setting out the amount of allowances that each installation will receive each year and the amount of offsets that they are permitted to use.

Each Member State had to prepare and publish a NAP for the first two phases of the EU ETS. The EC evaluated the NAPs based on a set of criteria. A key criterion was that the proposed total quantity of allowances was in line with the Member State's KP target under the EU burden sharing agreement of 1998.

A1.3 THE POWER SECTOR'S ROLE IN TERMS OF ABATEMENT POTENTIAL IN THE EU ETS

The power-generating sector is by far the largest emitter among the sectors covered by the ETS. Many utilities have the potential to cut CO2 emissions by switching fuels. Such mitigation potential becomes economical when the carbon price is high enough to alter the sequence ('merit order'), determined by variable costs, in which grid operators choose

[2] Carbone Tendences nº16, 2007, available at http://www.cdcclimat.com/Tendances-Carbone-no16-Lessons.html?lang=en

to dispatch different types of plants away from coal plants towards more efficient and less emitting natural gas power plants. This potential is especially relevant during off-peak hours and low demand seasons, i.e., the spring and the autumn.

The EU expected to rely on fuel switching to significantly reduce its emissions over the short term. The significant mitigation potential together with the ability of the power sector to pass through the associated costs to end-consumers – including among them the industrial sectors covered under the EU ETS – contributed to this sector receiving proportionately fewer allowances relative to other sectors.[3]

Generally speaking, the allocation favored other sectors (such as the energy intensive sectors) at the expense of the power-generating sector. This preferential treatment was based, at least in part, on the view that the other sectors required compensation for the increase in electricity tariffs that would be charged to energy intensive industries on top of the cost of allowances. This imbalance in the allocation generated more trading across sectors, adding liquidity in the market, which is reflected in increased market volumes.

A1.4 WHY WAS THERE OVERALLOCATION DURING PHASE I?

The pilot phase was designed as a learning-by-doing test aimed at getting the system started and ready for the KP commitment years. The pilot phase successfully established a price for carbon, trading in emissions allowances across the EU and the necessary infrastructure for monitoring, reporting and verifying emissions. Nevertheless, the European Commission lacked accurate information over Member States' emissions, and the Member States failed to create the necessary scarcity of allowances for the market to function properly as they allocated allowances beyond what was necessary to achieve the desired emission reductions.

The two main criteria established by the EC for allocating the amount of free allowances were: (1) the need to be consistent with the Member States' targets as well as with the assessments of actual and projected progress; and (2) the need to include the technological potential of abatement.[4] These criteria provided room for subjectivity and gaming, as became evident afterwards.

At the time of the allocation process over 2004-2005, the EU in the aggregate was right on track to meet its KP target, which resulted in limited additional required abatement as a general rule. Besides, it was obvious at the time that the burden sharing agreement imposed significantly asymmetrically economic burdens among Member States. This combination of factors set the stage for unreasonable national allocation plans during the pilot phase, with only a few Member States creating scarcity.

In that context, the two successive rounds of NAPs for Phase I and II can be analyzed from a game theoretical perspective. The first round was characterized by asymmetry of information and reliance on collective cooperation among the Member States to sufficiently limit their allocations to create scarcity in the market. Unfortunately, the result was an overallocation of allowances in the system and the subsequent collapse of the price of Phase I allowances when it became evident that supply exceeded demand. For the second round of NAPs the EC filled the information gap with the data revealed during Phase I and made sure that the aggregate quantity of allowances was below the 2005 level of verified emissions– in other words, the lessons from the pilot phase were incorporated in the design of Phase II.

As soon as the Directive regulating the third phase was agreed upon, Phase II and III were linked together by allowing banking between the two periods so that excess allowances could be carried over, something that was not allowed during Phase I. This

[3] As can be inferred from the analysis of the national allocation plans.

[4] Articles 9 to 11, and Annex III of the Directive 2003/87/EC, and communication, COM (2003) 830.

design feature is proving to be of paramount importance and is keeping the price from plummeting as it did in the pilot phase, even though Phase II is ending and it appears that supply will again exceed demand—this time mostly as a result of the contraction of greenhouse gas emissions due to the on-going economic crisis.

A1.5 PRICE VOLATILITY

Figure A1.2 depicts the evolution of historical prices and volumes of the EU ETS. The price of allowances with vintage '06 and '07 plummeted by around 60 per cent the day the verified emissions for 2005 were made public in 2006. At that point market participants realized that there was a risk of overallocation for the whole of Phase I, as was eventually confirmed. The price further declined and then collapsed definitively in the first quarter of 2007. In the meantime, the prices of forward contracts for Phase II allowances resisted the turmoil as the phases operated as distinct markets without the potential for banking.

The price volatility depicted in figure A1.2 is not fundamentally explained by market manipulation as some opponents might claim. Rather, prices have fluctuated due to regulatory uncertainties, the loosening of caps magnified by the economic recession, policy adjustments associated with a market under construction, and by the intrinsic volatility associated with mitigation options such as fuel switching that rely on the evolution of volatile fossil fuels prices such as natural gas, directly linked to oil markets.

A1.6 REVISION OF THE EU ETS TAKING EFFECT IN 2013

A Directive of April 2009 amends the directive establishing the EU ETS so as to improve and extend it to a third phase covering the period 2013-2020. The new Directive is part of the EU energy and climate change package, which unilaterally adopts an economy-wide target of at least 20 per cent emission reductions relative to 1990 levels (or 13 per cent reductions relative to 2005 levels) by 2020, as well as targets on energy efficiency and the production of renewable energy.

The starting point of the new Phase III cap for the ETS sectors will be calculated from the mid-point of the 2008-2012 emissions, which will then linearly decrease by an annual rate of 1.74 per cent per year to reach around 21 per cent below their 2005 emissions levels in 2020. Although the EU ETS covers less than 50 per cent of total emissions, the EU ETS is expected to achieve approximately 75 per cent of the total emissions reductions relative to 2005 levels needed to meet the EU's economy-wide goal.

The third phase of the EU ETS is characterized by the following improvements in design: (1) a harmonized and single EU-wide cap instead of the existing 27 national caps established by the two sets of national allocation plans for Phases I and II; (2) full auctioning of allowances for the power sector as a general rule as of 2013 and progressively more auctioning for the other sectors, for which 20 per cent of the allowances will be auctioned in 2013[5]; (3) transitional free allocation for the non-power sectors will be provided through harmonized predetermined rules in order to minimize disparities among industrial sectors across the EU; (4) the use of CERs and ERUs is harmonized across periods by allowing operators to use such offsets during the period 2008-2020, that is both Phase II and III, for either the amount assigned in Phase II or 11 per cent of their allocation for 2008-2012, whichever is the highest (offset use is constrained collectively to 50 per cent of the required aggregate abatement relative to 2005); (5) harmonization of monitoring, reporting and verification practices across periods; and (6) flexible allocation mechanisms for sectors or sub-sectors vulnerable to carbon leakage.

[5] The amount of auctioned allowances will gradually increase to 70 per cent in 2020 aiming at reaching 100 per cent auctioning by 2027

The existence of a single EU-wide cap eliminates the distortions created in the past through discretionary allocations to compensate or engage Member States, when the targets were negotiated on a country-by-country basis with the EC. The new mechanism is essentially based on the distribution of auctioning revenues. Although, the large majority of the allowances to be auctioned will be distributed to Member States based on their relative share of 2005 emissions, 10 per cent of the total will be distributed to the Member States with lower per capita incomes and/or higher growth prospects. The purpose is to build solidarity among Member States and to compensate and engage the least wealthy Member States. This mechanism is also used to compensate Member States that took the most stringent caps under the EU burden sharing agreement, with 2 per cent of the total allowances reserved for this purpose.

The Directive includes important provisions to adjust the stringency of the economy-wide cap from -20 per cent to -30 per cent upon the conclusion of a substantive international climate change agreement. In a recent Communication (European Commission, 2010) the EC advocates tightening the cap, arguing that as a result of the contraction in emissions due to the recent economic crisis, the cost of achieving the -30 per cent target would scarcely exceed the costs estimated for the -20 per cent target in 2008. The EC estimates that the EU ETS cap for 2020 should be tightened from -21 per cent to -34 per cent relative to 2005 levels to contribute to the -30 per cent economy-wide target.

The EU has set out a vision for the linkage of compatible domestic cap-and-trade systems across the world. In that sense the EU also favors the phase out of CDM in grounds of environmental integrity and argues that such offsets should be replaced over time by sectoral crediting mechanisms (which might include REDD) in the case of the emerging economies. The CDM would rather be focused on Least Developed Countries, which as of 2013 onwards will receive preferential treatment from the EU. Though, such developments would only have a significant role in case the EU tightens its 2020 target.

A1.7 MAIN RESULTS AND CONCLUSIONS.

- The EU ETS has established a price for carbon as a result of trading in emissions allowances across the EU. The total amount of allowances—including the reserves—assigned to the period 2008-2012 is slightly above 10,000 Million tCO2e.
- The EU is on track to meet its targets, i.e., the system is working. Emissions in the covered sectors under the EU ETS reached 1,850 Million tCO_2e, about 12 per cent below the estimated 2005 levels, in 2009. The extent to which the EU ETS has led to significant emissions reductions is difficult to evaluate given the undergoing economic recession, but since there is a price of carbon we can expect that it has translated into abatement.
- The European carbon market has shown a rapid growth since 2005, with massive increases in market volumes, attaining around 600 Million tCO2 in EU allowances (EUAs) exchanged in March 2011.[6] In the 12 months from April 2010 to March 2011, around 5 billion EUAs have been exchanged in total in the secondary markets, with an annual market value of nearly €75 billion. The annual EUA exchanges are around 5,000 Million tCO_2e or 2.5 times the annual cap for the period 2008-2012, including allowance reserves for new entrants. The monthly volumes of the parallel CDM market – predominantly for EU ETS compliance but

not limited to it – are in the order of 100 Million tCO_2. The CERs annual market value is in the order of €15 billion. The ERU market is relatively much smaller to date with only 35 Million tCO_2e in ERUs issued cumulatively by March 2011, versus the 576 Million tCO_2e in issued CERs.

- The regulation has been tested and its weaknesses subsequently strengthened to close unforeseen loopholes. There has been unfortunate gaming by a minority of market participants that have taken advantage of loopholes, such as that involving VAT fraud, but these issues have been corrected.
- The system has lead to significant changes in behavior. Carbon allowances have become a commodity in the EU and most companies already price in its value in its production and investment decisions.
- In addition to the necessary infrastructure for monitoring, reporting and verifying emissions and registries, the system has generated a multitude of related new service providers in the EU such as carbon trading, carbon finance, carbon management and carbon auditing (European Commission, 2009).
- The recognition of international offsets has triggered a substantial flow of investment and technology to developing countries, expanding its impact beyond the borders of the EU. The maximum use of CERs and ERUs for the period 2008-2020, i.e., including both Phase II and III, is around 1,600 Million tCO_2e. In an attempt to address the concerns relating to environmental integrity, value-for-money and geographical distribution, in January 2011, Member States voted to ban

[6] All figures and calculations based on data including spot, futures, exchanges and OTC markets as reported in Carbone Tendences nº57, 2011, and available at: http://www.cdcclimat.com/IMG/pdf/tendances_carbone_cdc_climat_research_no57_eng.pdf

CERs and ERUs from certain projects that destroy industrial gases[7] from use in the EU ETS. Covered entities will be able to use these credits for compliance up to 2012 but not thereafter.

A1.8 KEY LESSONS LEARNED FROM THE EU ETS

- A properly designed cap and trade emissions system can play a significant role in reducing greenhouse gas emissions and spur innovation.
- Long-term policy certainty is fundamental. A long-term planning horizon creates certainty, allowing companies to make wise investments for the future.
- Allowing when-flexibility between the subsequent phases through banking and borrowing provisions solves the problem of plausible overallocations and can reduce severe price fluctuations while helping managing compliance costs.
- Grandfathering of allowances may have political benefits but is prone to gamming and might create, for instance, sectorial distortions among Member States. Full auctioning of allowances, a single EU-wide cap, and the harmonization of transitional free allocation schemes at the EU level tackle such distortions.
- The implementation of a cap and trade emission system should be thoroughly coordinated with the appropriate reforms of the power sector market design in order to deal with undesirable consequences and windfall profits.
- Regulators and market participants need to be vigilant and ready to adapt to evolving attacks and market security threats.

The EU undertook the difficult mission of unilaterally putting into practice a path-breaking cap-and-trade system in the context of a global economy, but without the cooperation of its trading partners. In addition, the EU experienced institutional and political turmoil, and expanded its borders to absorb 12 additional Member States, most

[7] HFC-23 and N2O from adipic acid production.

of which were economies in transition under the KP. Consequently some Member States have been reluctant to take on more ambitious goals.

The EU ETS in Phases I and II has overcome and learned from several obstacles to greater efficiency (e.g., overallocation of allowances in Phase I, lack of harmonization of targets among Member States, and security weaknesses of the registries) but has made carbon emissions a central part of the business planning of the EU energy sector and industry and created the world's first firm-level compliance carbon market, without measurably affecting EU competitiveness or constraining growth.

Europe is making large strides in clean technology innovation, and EU ETS as the cornerstone of the EU's climate policy is playing a role, along with other complementary measures, such as the feed-in-tariffs for renewable energy in certain countries. The share of climate-related inventions is almost three times as high in Europe than in the United States without a comparably strong climate policy (Dechezleprêtre et al., 2011). The EU's climate policy is in this sense an unquestionable success, yielding important lessons and examples for nations contemplating the adoption of cap-and-trade systems to reduce their carbon emissions.

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FIGURES

Figure A1.1 The Linkage Among the EU ETS and the KP Carbon Markets

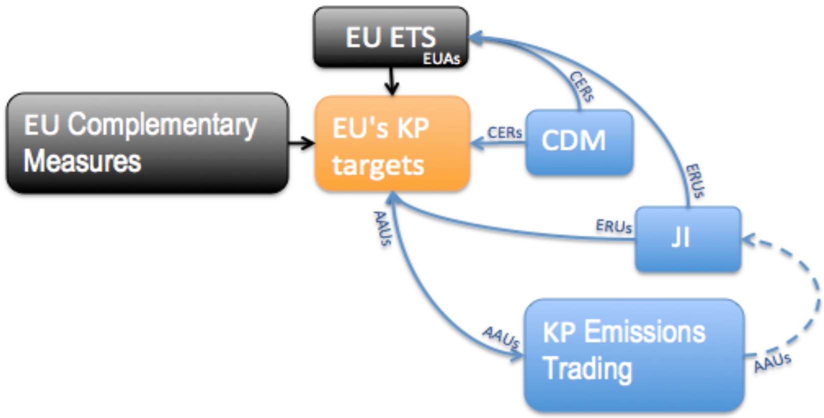
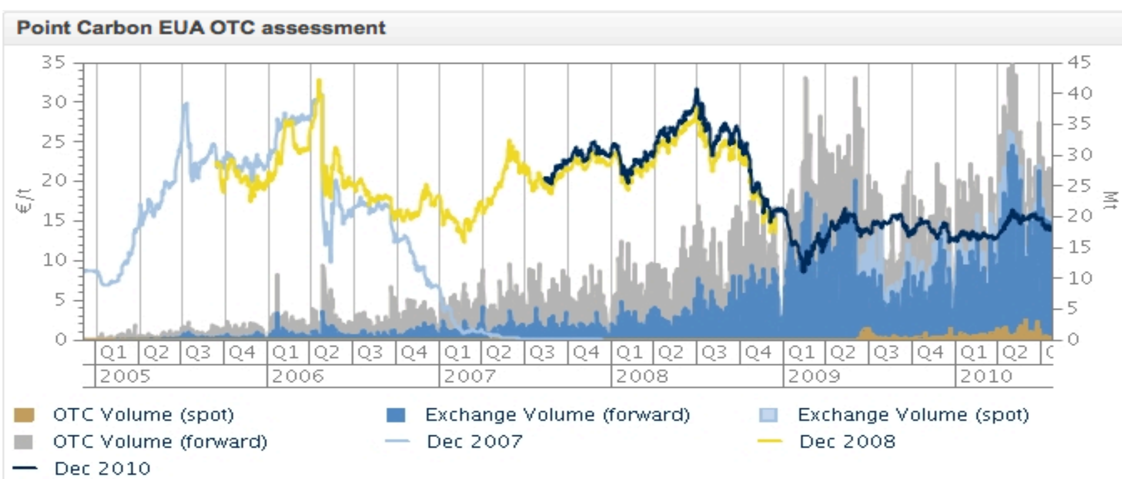


Figure A1.2 Historical Prices and Volumes (Source: Point Carbon)



APPENDIX 2

A2. Complementary Policies: An Introduction

The scope of policies that can complement the reductions achieved under a cap-and-trade system is broad and includes a large assortment of polices such as: (1) tailpipe emission standards or low carbon fuel standards for the transportation sector; (2) building codes; (3) energy efficiency standards for appliances; (4) feed-in tariffs for renewable energy; (5) renewable portfolio standards, which set a mandate for the percentage of electricity consumed or generated that must come from renewable sources; and (5) tax incentives in a broad sense.

The three main roles of complementary policies are to:

1. *Address market barriers that would otherwise limit the use of low-cost mitigation options*. A cap-and-trade program that establishes stringent caps provides important price signals and consequently incentives for firms to invest in cost-efficient mitigation options as well as in the research, development and deployment of the necessary technologies to achieve the targeted environmental goal. However not all the activities respond to the price signal due to market barriers that prevent or impede the diffusion of cost-effective technologies and practices and also impede firms from capturing the full societal benefits of their actions. For example, investments in infrastructure and research and development may have broader benefits that spill over beyond the profits captured by a single firm. In addition, building developers may not be able to recover cost savings from energy efficiency investments that would provide benefits to future tenants. Such situations could be addressed by the implementation of so-called

complementary policies that create incentives or funding for, e.g., energy-efficiency or renewable technologies.

2. P*romote mitigation options with a strategic value or long-term returns*. Ideally, a cap-and-trade system must provide credible commitments to long-run emission targets, expanding decades into the future. This would set the stage right for the appropriate appraisal of investments in research and development and abatement infrastructure, which could consequently be based on the expected allowance prices along the entire life cycle of the investment. However, the nature of many energy-generation technologies implies long-term investments with returns expanding many decades into the future, sometimes covering periods longer than the scope of the established cap-and-trade programs. Given regulatory uncertainty over future policies and absent certainty over long-term commitments – often subject to international cooperation – governments could establish complementary policies that (i) address the uncertainties associated to investments with long-term returns, (ii) stimulate the development of, e.g., renewable energy industries with national strategic value, and (iii) create incentives or funding for research and development in renewable energy technologies.
3. *Reduce emissions from sources excluded from cap-and-trade*. Further, if a program does not cover all sectors of the economy, economy-wide targets may be included in addition to the cap. If this is the case, complementary polices that create incentives or funding for cost-efficient mitigation options could be included to help meet those targets in uncovered sectors. This is the case of the EU, where the 20 per cent emission reduction target by 2020 applies economy-wide meanwhile the EU ETS – the flagship of the EU climate change policy—

regulates less than 50 per cent of the total emissions. The EU approach has been to complement its cap-and-trade with an assorted array of additional policies, some at the Member State level in order to address the national particularities, and others harmonized at the EU level. The EU emission reduction target noted above is further complemented with targets applying to energy efficiency improvements and renewable portfolio standards under the EU climate change and energy legislative package of 2008.

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APPENDIX 3

A3. A Brief Introduction to How Cap and Trade Works

A cap and trade system caps the overall level of emissions allowed but, within that limit, allows participants to buy and sell allowances as they require, in a way that leads to emissions being reduced in a cost-effective fashion. As a result of that trading, the marginal carbon price emerges providing installation operators with a price signal for each ton of carbon emitted, which should spur investments in low-carbon technologies and/or alter the merit order of competing technologies.

The level of emissions allowed to a covered entity can be allocated free of charge (e.g. with a grandfathering rule), auctioned, or a combination of the two. Free allocation is a powerful policy design tool that positively engages operators and even countries – most notably those catching up with the richer ones – in the system. It is a political facilitator in the early stages of a cap and trade system, but prone to distortions such as rent-seeking behavior and allocation disparities among installations, leading for example to distortions of the EU's intra-Communitarian market. Furthermore, under free allocation, a share of the allowances has to be put aside for new entrants, otherwise the allowances allocated free of charge to competing installations would become a market barrier. Auctioning is potentially the simplest system. It eliminates windfall profits and put new entrants and economies growing faster than average on the same competitive footing as existing installations (European Commission, 2009). The revenues generated through the auctioning can be used for multiple purposes by the government.

In the case of free allocation, companies that manage to keep their emissions below the level of their allocated allowances can trade their excess allowances. Those having trouble to remain within their cap would have the choice to: (1) invest in emissions reductions within the facility; (2) buy allowances from companies having reduced their emissions at a lower cost; and (3) buy offsets. In the case of auctioning, companies would simply buy allowances from the government for the emissions that cannot be reduced or offset at a given marginal market price, and fine-tune buying and selling in secondary allowance markets.

APPENDIX 4

A4. The End of Deforestation in the Brazilian Amazon

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ENVIRONMENT

The End of Deforestation in the Brazilian Amazon

Government commitments and market transitions lay the foundation for an effort to save the forest and reduce carbon emission.

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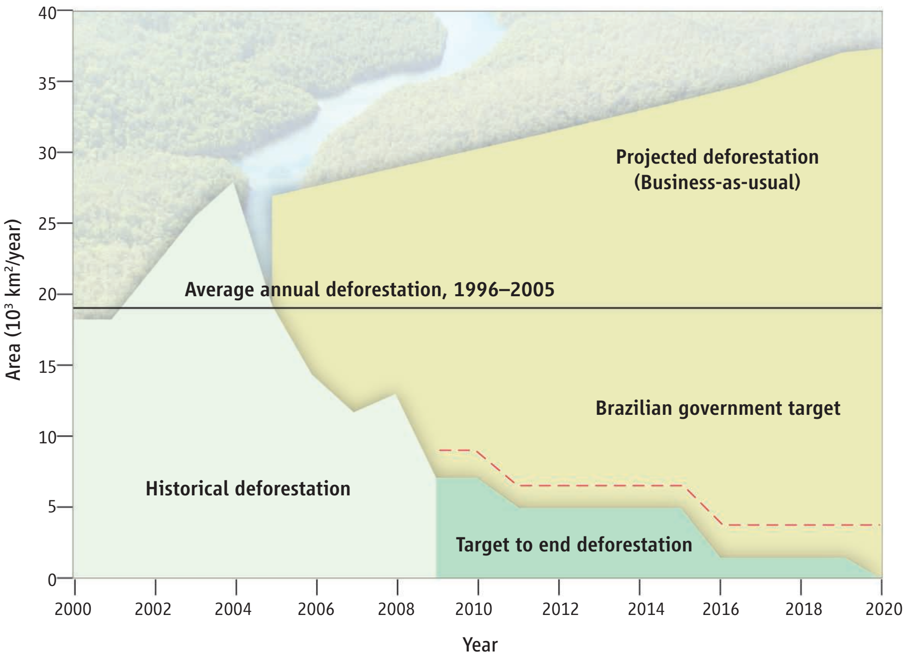
Brazil has two major opportunities to end the clearing of its Amazon forest and to reduce global greenhouse gas emissions substantially. The first is its formal announcement within United Nations climate treaty negotiations in 2008 of an Amazon deforestation reduction target, which prompted Norway to commit $1 billion if it sustains progress toward this target (*1*). The second is a widespread marketplace transition within the beef and soy industries, the main drivers of deforestation, to exclude Amazon deforesters from their supply chains (*2*) [supplementary online material (SOM), section (§) 4]. According to our analysis, these recent developments finally make feasible the end of deforestation in the Brazilian Amazon, which could result in a 2 to 5% reduction in global carbon emissions. The $7 to $18 billion beyond Brazil's current budget outlays that may be needed to stop the clearing [a range intermediate to previous cost estimates (*3*, *4*)] could be provided by the REDD (Reducing Emissions from Deforestation and Forest Degradation) mechanism for compensating deforestation reduction that is under negotiation within the UN climate treaty (*5*), or by payments for tropical forest carbon credits under a U.S. cap-and-trade system (*6*).



Historical deforestation in the Brazilian Amazon and future deforestation under three scenarios. The first scenario simulates deforestation from 2005 into the future under business-as-usual conditions that assume economic trends and governance levels through 2003 (*14*). The intermediate curve is the current deforestation reduction target of the Brazilian government (*8*), and the lower curve, which ends deforestation in 2020, is the scenario analyzed here (SOM, § 2).

Deforestation History

Brazil has been the world leader in tropical deforestation, clearing an average of 19,500 km^2/year from 1996 to 2005. This forest conversion to pasture and farmland released 0.7 to 1.4 GtCO$_2$e (billion tons of CO$_2$ equivalents) per year to the atmosphere (*7*) (SOM, § 1). In 2008, the Brazilian government committed to reducing deforestation to 20% of the historical (1996–2005) rate by 2020 (*8*) (SOM, § 2), motivated by plummeting rates of forest clearing. From July 2005 to July 2009, deforestation declined to 36% of its historical levels (see figure, above). To help achieve this reduction, Brazil expanded the network of Amazon protected areas from 1.26 to 1.82 million km^2; the network now contains 51% of the region's remaining forest area (*9*) (table S4). Federal campaigns to publicize and cancel credit for illegal land holdings, to pressure buyers of Amazon products, and to imprison illegal operators may have contributed to the decline, as did a retraction of the region's cattle and soy industries (SOM, § 3, and fig. S1).

Steps to End Deforestation

For Brazil to build upon its success and end deforestation, even if the profitability of Amazon cattle ranching and soy farming soar in the coming years, it must support low-deforestation livelihoods for forest peoples and smallholder farmers, expand the law-abiding "responsible" fraction of the cattle and soy sectors, improve law enforcement, and effectively manage protected areas.

Indigenous groups and traditional forest communities, totaling 420,000 people, have defended their perimeters from incursions by deforesters (*9*, *10*), but have never received compensation for this enforcement service. There are also 400,000 smallholder farms (up to 100 ha) (*11*) established in forested or marginal lands that could shift to low-deforestation production systems.

Cattle ranching, associated with four-fifths of Amazon deforestation, must stabilize and intensify on a diminishing area of pastureland, ceding space to a modest expansion of relatively lucrative soy production (SOM, § 3). Support within the cattle and soy sectors for declining deforestation could be strengthened by identifying, rewarding, and expanding

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the pool of "responsible" producers striving to comply with the law and to practice good land stewardship. Legal compliance could be facilitated through approval and implementation of land-use zoning plans, which lower the legal forest reserve requirement on private properties in farming and ranching regions (*12*). This requirement was abruptly raised from 50 to 80% of each property in 1996 without effective mechanisms for facilitating compliance (*2*) (SOM, § 6). The substantial flow of federal farm credit could be redirected toward the intensification of cattle production and support for forest-based economies (SOM, § 7). Market exclusion of deforesters (*2*) could be strengthened through government measures that penalize companies and banks that indiscriminately do business with Amazon farmers and cattle ranchers.

Some farmers and ranchers will need compensation for the opportunity costs incurred in maintaining private forests. Five landholder compensation qualification criteria could be used, including forest cover beyond 50% of the property (SOM, § 6).

What Will It Cost and Who Will Pay?

We estimated the potential cost of a 10-year program for ending deforestation (see figure, page1350). Using spatially explicit economic models and programmatic estimates, we assess budgetary costs of ending deforestation assuming that the benefits of reduced deforestation outweigh the opportunity costs to society. These benefits include reduced forest fire, air pollution, flooding, biodiversity loss, soil erosion, and, perhaps, rainfall inhibition (*3*, *13*). They are difficult to quantify and are largely untreated in most economic models (*4*), even though they lower the net costs of reducing deforestation.

Annual investments in community forest-based economic activities, health, education, and cultural preservation for the region's indigenous and traditional forest peoples and smallholder farmers would total \$3.6 to \$7.2 billion from 2010 to 2020 (see table, below and SOM, § 5). The total opportunity cost potentially incurred by landholders is estimated at \$14 billion (table S3 and fig. S9), or \$26 billion if a minimum forest cover of 60% is imposed for each Amazon state to avoid rainfall inhibition (*13*) (SOM § 8). However, our estimate includes only those private forests that would qualify for compensation, which represent only 10 to 15% of potential opportunity costs (see table, below, and SOM, § 6).

Combining these costs with additional investments in law enforcement and protected area management gives a total budget of \$7 to \$18 billion (see table, below, and SOM, § 9). Already initiated by the Norway commitment, this investment could reduce carbon emissions from 2010 to 2020 by ~6 $GtCO_2e$ below the historical baseline and by 12 $GtCO_2e$ below projected emissions (see figure, page 1350) (*14*), culminating in annual emissions reductions that are 2 to 5% of global emissions rates in 2000–2006 (SOM, § 2). Under a REDD system, as designed in the American Clean Energy Security Act passed by the U.S. House of Representatives, reductions under Brazil's deforestation target could generate revenues valued from \$37 billion to \$111 billion between 2013 and 2020 (*6*) (SOM, § 10), providing a margin for expanding the program to end deforestation.

Ending deforestation in the Brazilian Amazon in 2020 with less than 20% of the forest cleared (table S4) would be an extraordinary and extremely difficult achievement, perhaps unique in the history of frontier expansion. The likelihood of success, however, is greatly enhanced by state-level programs that link zoning and property registries with statewide deforestation reduction targets (SOM § 11). The Governors' Climate and Forests Task Force is working to connect these Amazon state programs with international emissions offset programs under development for California and other U.S. states (*15*). State-level programs must also eventually link up with the federal "Amazon Fund," where the Norwegian commitment resides (*1*). Most tropical nations will require time to develop Brazil's institutional capacity, civil society organization, and legal framework (*16*). Ending deforestation in the Brazilian Amazon and reducing it elsewhere in the tropics is a cost-effective approach to climate change mitigation with multiple benefits (*13*, *16*).

Estimated costs of a program to end deforestation in the Brazilian Amazon

Region or state	Forest peoples' fund (10^6 U.S. \$)		Enforcement and landholder compensation (10^6 U.S. \$)		Protected area management (10^6 U.S. \$)		Total cost (10^6 U.S. \$)	
	Low	High	Low	High	Low	High	Low	High
Brazilian Amazon	3,606	7,213	1,459	6,502	1,456	4,368	6,521	18,082
Acre	252	503	106	147	54	163	412	813
Amapá	68	135	13	12	56	168	136	315
Amazonas	565	1,129	229	116	546	1,639	1,340	2,884
Maranhão	189	377	13	248	10	31	212	656
Mato Grosso	335	669	693	4,135	80	240	1,107	5,044
Pará	1,357	2,715	280	639	488	1,464	2,125	4,818
Rondônia	580	1,159	94	1,127	79	238	752	2,524
Roraima	116	231	27	19	90	271	233	522
Tocantins	147	293	4	60	51	154	202	507

Ending deforestation in the Brazilian Amazon by 2020. These estimates for costs incurred from 2010 to 2020 assume that current budgetary outlays from the Brazilian government continue. (SOM § 9)

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