Aix-Marseille Université

École Doctorale de Sciences Economiques et de Gestion N°372

Faculté d'Économie et de Gestion

Groupe de Recherche en Économie Quantitative d'Aix-Marseille (GREQAM) -

Aix-Marseille School of Economics (AMSE)

Thèse pour le Doctorat ès Sciences Économiques

Présentée et soutenue publiquement par

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le 31 octobre 2016

en vue de l'obtention du grade de docteur d'Aix-Marseille Université

Essays on international finance and sustainable growth in natural resource rich countries

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"So abundant natural wealth often creates rich countries with poor people."

Joseph Stiglitz (2004)

Avertissement

Les différents chapitres de cette thèse sont composés d'articles de recherche rédigés en anglais et dont la structure est autonome, à l'exception de l'introduction générale et de la conclusion générale.

Notice

The chapters of this dissertation are self-containing research articles, except the general introduction and the general conclusion.

Résumé

Les questions de croissance durable mêlées aux enjeux d'accès aux marchés financiers internationaux des pays riches en ressources naturelles ont souvent été occultées dans la littérature économique. Or, ces enjeux s'avèrent de plus en plus présents dans le débat public face à la baisse récente des prix des ressources naturelles. Cette thèse tente de mieux comprendre comment des économies dépendantes de leur production de ressources non renouvelables gèrent leur dette externe en vue d'une croissance soutenable dans le long terme et comment les marchés financiers perçoivent le risque souverain lors de l'émission de leurs titres de dette.

Pour y répondre, elle recourt à de la modélisation dynamique, ainsi qu'à des études économétriques. Elle contribue à la littérature des ressources naturelles en intégrant de nouvelles dimensions, comme l'ouverture financière dans un modèle de croissance avec des ressources épuisables, modèles qui jusque là étaient étudiés plutôt sous la forme d'économies fermées. Par ses analyses empiriques, cette thèse ne se limite pas à la seule dimension du prix des ressources, sur laquelle se concentre majoritairement la littérature, mais prend également en compte la notion de volume à travers l'étude des réserves de pétrole et de gaz. Elle n'élude pas pour autant la question des prix, puisque celle ci est analysée sous le prisme des rendements et de la volatilité des prix du pétrole.

Plus précisément, la thèse comprend trois chapitres, dont le premier est un cadre théorique qui s'applique aux pays riches en ressources naturelles non renouvelables de manière générale. Les deux derniers chapitres sont des analyses empiriques et se concentrent sur les questions de risque souverain des pays émergents possédant des ressources naturelles fossiles, comme le pétrole et le gaz.

Le premier chapitre présente un modèle de croissance avec des ressources naturelles non renouvelables. Il s'agit de voir si une petite économie ouverte, pouvant emprunter sur les marchés financiers internationaux, peut dépasser la pénurie de ces ressources, afin d'obtenir

une croissance durable. Le résultat principal de ce chapitre est que l'accès aux marchés financiers internationaux ne permet pas d'avoir une croissance soutenable quand le taux d'intéret est constant. En effet, même l'introduction de progrès technique dans cette partie du modèle n'aboutit pas à résoudre le problème de soutenabilité. Néanmoins, le taux de croissance de la consommation peut être positif avant de décroitre sur le long-terme, lorsque le taux d'intéret est endogène au niveau de dette du pays.

Le second chapitre examine si les réserves de pétrole et de gaz peuvent réduire les coûts d'emprunt de pays émergents exportateurs de pétrole et gaz à travers des données annuelles de panel de 1994 à 2014. Un des résultats principaux est que ces réserves ont un impact significatif sur les spreads souverains. Cependant, la qualité institutionnelle ne semble pas jouer un rôle significatif dans la diminution du coût d'emprunt de ces pays, quand des effets fixes de pays et de temps sont pris en compte.

Le troisième chapitre analyse les effets des rendements du prix du pétrole sur le risque de défaut souverain, à travers l'étude des spreads des Credit Default Swaps (CDS) de deux pays exportateurs de pétrole, la Russie et le Venezuela. En utilisant des données journalières de 2008 à 2015 et un modèle de Markov Switching avec des probabilités de transitions variant dans le temps, les principaux résultats de cette étude sont que les rendements du prix du pétrole expliquent de manière significative les spreads des CDS du Venezuela, mais pas ceux de la Russie. Le prix du pétrole aurait un effet indirect sur les spreads des CDS russes à travers le canal du taux de change. En effet, les deux pays ont un système de change différent, flexible pour la Russie tandis que ce dernier est fixe au Venezuela.

Abstract

The relationship between sustainable growth and international financial market access in natural resource rich countries has been overlooked in the economic literature. However, those issues have become more present in the public debate with the recent drop in oil prices. This thesis tries to better understand how natural resource dependent economies can deal with their external debt and how financial markets view this sovereign risk. To address those issues, this dissertation refers to dynamic optimization, as well as econometric studies. It contributes to the natural resource literature by including new dimensions, such as financial openness in a growth model with exhaustible resources, contrary to most growth models which are studied as closed economies. Concerning its empirical applications, this thesis takes into account natural resource stocks, through oil and gas reserves, whereas most of the empirical literature focuses on the natural resource price dimension. This price issue is also part of the analysis, especially with oil price returns and oil price volatility.

This thesis is composed of three chapters. The first one is a theoretical framework concerning exhaustible natural resource rich countries in general. The two last chapters are more applied studies focusing on emerging oil and gas exporting countries in particular.

The first chapter studies the optimal growth path of a natural resource rich country, which can borrow from international financial markets. More precisely, it explores to what extent international borrowing can overcome resource scarcity in a small open economy, in order to have sustainable growth. First, I present a benchmark model with a constant interest rate. Technical progress is then introduced to see if the economy's growth can be sustainable in the long-run. Secondly, the case of a debt elastic interest rate, with a constant price of natural resources and then with increasing prices, is analysed. The main finding of this paper is that borrowing on international capital markets does not permit sustainable growth for a country with exhaustible natural resources, when the interest rate is constant. Nevertheless, when the interest rate is endogenized the consumption growth rate can be

positive before declining.

The second chapter investigates whether oil and gas reserves can alleviate the credit constraint of emerging oil and gas exporting countries through panel data from 1994 to 2014. The main finding is that those reserves have a significant impact on sovereign spreads. Nevertheless, institutional quality does not seem to play a key role in decreasing the borrowing costs of those countries, when controlling for country and time fixed effects.

The third chapter analyses the impact of oil price returns on sovereign Credit Default Swaps (CDS) spreads for two major oil producers, Russia and Venezuela. Using daily spreads from 2008 to 2015 trough a Time Varying Transition Probabilities - Markov Switching model, we find that crude oil price returns is a critical determinant of Venezuela CDS spreads returns, but does not explain significantly Russian CDS spreads changes. Indeed, oil prices seem to impact Russian CDS spread prices through the exchange rate canal.

Remerciements

Je tiens tout d'abord à remercier mes directeurs Patrick Pintus et Raouf Boucekkine, qui ont été d'une aide précieuse et ont su me guider de manière avisée dans mon travail de recherche. Merci à eux pour m'avoir toujours encouragé et soutenu tout au long de ces années de thèse, de m'avoir aussi bien aidé à résoudre mes systèmes d'équations, qu'à me conseiller dans mes choix de recherche. Je leur adresse ma profonde gratitude pour leurs qualités humaines et scientifiques, pour le temps précieux qu'ils m'ont accordée et leur gentillesse.

Un grand merci à ma famille (mon frère Harry, mon papa, Jean-Noel), et tout particulièrement ma petite maman, qui a toujours été là pour moi, et m'a soutenue dans mon choix de me lancer dans un doctorat. Cela aide beaucoup de se savoir entourée lorsqu'on se lance dans l'aventure d'une thèse, dans ce grand inconnu parfois un peu effrayant face à l'ampleur de la tâche et du défi à relever. Même si je voyais bien que mes Hamiltoniens et mes équations différentielles ne leur parlaient pas vraiment, ils étaient présents quand j'en avais besoin, et c'était le plus important. J'aimerai particulièrement remercier quelqu'un qui a vécu cette thèse au plus près et qui a été d'un soutien sans faille: mon mari, Thomas. Il a été une sorte de troisième directeur de thèse pour moi. Il a su m'écouter et suivre pas à pas les avancées de mes différents articles, en me suggérant des idées de cas pratiques et surtout en me redonnant confiance dans mes moments de doute. Il n'est pas toujours évident de dissocier vie professionnelle et vie privée lorsqu'on est en thèse, il est ainsi parfois difficile de "décrocher", mais Thomas a su partager mon intérêt pour mon sujet de recherche (il est vrai que le sujet des ressources naturelles fossiles ne lui est pas totalement inconnu !). Nous en avons beaucoup discuté, ce qui pour moi stimulait encore plus mes recherches et ma curiosité intellectuelle.

J'ai eu la chance d'être dans un environnement de travail très agréable, avec un bureau à la Vieille Charité, ce qui me donnait l'impression d'aller travailler dans une sorte de "mini-

Panthéon." Je tiens à remercier tous mes camarades, tous ces autres doctorants avec qui j'ai pu discuter et s'encourager, s'entraider. Pour citer leurs noms: Clémentina, Kadija, Manel, Majda, Justine, Illia, Florent, Joao, Nicolas, Anwar, Cyril, Régis. Merci à Thomas Chuffart, mon co-auteur avec qui c'était un plaisir de travailler, et bien sûr une personne en particulier Pauline Morault, avec qui on s'est soutenu jusqu'au bout, avec qui on a pu rire aux éclats, dire ce qu'on avait sur le coeur dans les moments plus difficiles.

Je remercie également la SNCF, qui a rendu possible la réalisation de cette thèse entre Paris et Marseille, deux villes que j'apprécient particulièrement. Le TGV a en effet été une sorte de troisième bureau pour moi, où une partie de mes articles a été rédigée et des copies de mes élèves corrigées.

J'adresse mes remerciements à toute l'administration du GREQAM, qui par son efficacité a rendu les obligations administratives beaucoup moins pénibles, en particulier Bernadette, Corinne, Mathilde, Agnès, Aziza, Carole, Marine, Gregory et Yves. Merci d'avoir rendu possible mes séjours l'étranger, comme au FMI à Washington ou Montréal, de m'avoir financé mes déplacements pour présenter à des conférences internationales comme à Abu Dhabi, Helsinki, Grenade, ou à des séminaires comme Oxford, qui m'ont permis de rencontrer d'autres chercheurs dans mon domaine et d'avoir des retours constructifs sur mes articles.

J'ai eu beaucoup de plaisir à réaliser ma thèse, même si bien sûr cela n'a pas été facile tous les jours. J'ai eu la possibilité d'en discuter avec beaucoup de monde, ce qui a rendu ce travail de recherche encore plus stimulant. Parmi ces chercheurs, je tiens à remercier tout particulièrement Rabah Arezki, qui m'a invité à séjourner au Département de Recherche du Fonds Monétaire International (FMI), et a pris le temps de m'aider dans mes recherches. A Washington, je suis reconnaissante à Bernardin Akitoby du FMI, Horacio Sapriza, Brahima Coulibaly, Nathan Foley-Fisher de la Réserve Fédérale américaine (Fed) pour leurs discussions. A Gilles Dufrénot, Marwan-al-Qays Bousmah d'Aix-Marseille, à Robert Cairns, Hassan Benchekroun et Ngo Van Long de McGill University à Montreal, ainsi que Charles

Seguin et Pierre Lasserre de l'UQAM. Je voudrai remercier également mes rapporteurs pour leurs commentaires, Alain Ayong Le Kama de l'université Paris-Nanterre, et Rick van der Ploeg d'Oxford, qui m'a invité à présenter en séminaire à OxCarre (Oxford Centre for the Analysis of Resource Rich Economies). Je remercie également Sanjay Peters d'avoir accepté d'être membre de mon jury, avec qui j'ai eu beaucoup de plaisir à travailler.

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1 Introduction générale

1.1 Avant-propos

Ces dernières années ont été marquées par la chute des prix des ressources naturelles, et en particulier des prix du pétrole et du gaz. Contrairement aux dernières crises pétrolières de 1973 ou 1979, cette crise est différente, puisqu'elle se caractérise par des prix durablement bas. Les questions de diversification économique ou de la soutenabilité de la croissance des pays riches en ressources naturelles ne sont pas nouvelles, en effet les économistes se sont déjà penchés sur le sujet depuis Hotelling (1931) ou Stiglitz (1974). Néanmoins, ces questions s'inscrivent désormais dans un débat plus vif, où l'enjeu des générations futures (souvent évoqué à travers le concept de "développement durable") rejoint celui des générations présentes, face à l'urgence de mener à bien des réformes macroéconomiques structurelles. Confrontés à une chute des revenus nationaux et des niveaux de dette en augmentation, le débat public a mis en lumière les difficultés économiques de ces pays producteurs. C'est pourquoi l'économie de l'environnement et des ressources naturelles tente de mieux intégrer ces dimensions nouvelles dans ses modèles afin d'apporter des réponses à ces problématiques.

L'objectif de cette thèse est de mieux comprendre les interactions entre ressources naturelles et les caractéristiques macroéconomiques de ces pays possédant ces ressources, en termes de croissance économique et de dette extérieure. La spécificité de ces ressources non renouvelables, qui sont souvent occultées dans la littérature de finance internationale, mettent en lumière de nouvelles questions: comment assurer une croissance soutenable quand la principale source de richesse, que sont ces ressources naturelles non renouvelables, décroit inexorablement sur le long-terme ? Est-ce que ces ressources peuvent permettre à ces pays de réduire leur coût d'emprunt sur les marchés financiers internationaux ? Est-ce que la volatilité des prix du pétrole peut accroitre le risque de défaut souverain de pays exportateurs de pétrole ?

Ce sont autant de questions auxquelles cette thèse tente de répondre à travers différentes approches méthodologiques. Elle propose ainsi une analyse théorique, avec une étude généralisable à tous les pays riches en ressources naturelles, à travers de la modélisation et optimisation dynamique. Elle présente également deux applications empiriques, portant sur des pays en développement possédant des réserves de pétrole et de gaz, à travers des analyses économétriques en données de panel et en séries temporelles.

La thèse se situe au croisement de deux littératures, celle des ressources naturelles et celle de la finance internationale, auxquelles elle contribue en apportant des résultats nouveaux. Une des premières contributions de cette thèse à la littérature théorique des ressources naturelles est d'intégrer une ouverture financière dans les modèles de croissance exogène avec des ressources épuisables. Cette thèse montre ainsi que les pays, dont l'économie ne dépend que de la production de ressources naturelles non renouvelables, avec un accès aux marchés financiers internationaux à un taux d'intérêt constant, ne peuvent avoir une croissance soutenable sur le long-terme. Et cela, même en présence de progrès technique, contrairement aux modèles du type Dasgupta-Heal-Solow-Stiglitz (1974). Cependant, quand le taux d'intérêt est endogène au niveau de dette du pays, l'économie peut espérer croitre à un taux positif sur le moyen-terme avant de décroitre de manière asymptotique. Ce résultat original contribue à la littérature en montrant l'effet de l'accès à l'emprunt international sur la croissance de ce type d'économie totalement dépendante de ses ressources naturelles. De plus, alors que la littérature de finance internationale se concentre sur le prix du pétrole, cette thèse montre que les stocks ou volumes, représentés par les réserves de pétrole et de gaz, jouent également un rôle dans le coût d'emprunt des pays producteurs et exportateurs de ces matières premières. Face à la littérature croissante sur le lien entre institutions et ressources naturelles, elle montre que la qualité institutionnelle n'a pas d'effet clair et significatif sur la contrainte de crédit, ce qui rejoint les résultats de la littérature récente en particulier sur l'absence de relation entre stabilité politique et ressources naturelles (Alexeev et Conrad, 2009; Tsui et Cotet, 2010). Enfin, à travers l'étude des spreads des Credit Default Swaps (CDS) de deux exportateurs de pétrole, la Russie et le Venezuela, cette thèse montre que les rendements du prix du pétrole peuvent avoir des effets différents sur l'évaluation du risque de défaut souverain, selon le régime de change du pays. Ainsi les rendements du prix du pétrole expliquent de manière significative les spreads des CDS du Venezuela, dont le système de change est fixe, mais pas ceux de la Russie, où le prix du pétrole aurait un effet indirect sur les spreads des CDS russes à travers le canal du taux de change, qui est flexible. La thèse complète ainsi la littérature sur les CDS, abondante concernant les pays développés commes les Etats-Unis ou la zone euro (Longstaff et al., 2011; Pan and Singleton, 2008), mais encore peu existante sur les pays émergents exportateurs de pétrole.

Cette introduction générale présentera les enjeux de croissance économique et de dette auxquels sont confrontés les pays riches en ressources naturelles, en replaçant la thèse dans l'histoire de la littérature dans ce domaine. Elle mettra en exergue le rôle que peuvent jouer les institutions dans ces pays ainsi que les défis futurs qui se posent pour ces économies, en particulier la nécessité de diversifier la structure de leurs exportations.

1.2 La croissance des pays riches en ressources naturelles

1.2.1 Des niveaux de croissance plutôt faibles et la "malédiction des ressources naturelles"

Paradoxalement, les pays riches en ressources naturelles, percevant d'importantes recettes, affichent des résultats économiques souvent bien plus décevants que des pays qui en sont dépourvus. La littérature empirique s'est beaucoup penchée sur la question (Auty, 1993, Sachs et Warner, 2001), et en a émergé le concept de "malédiction des ressources naturelles". Sachs et Warner (1995, 2001) ont popularisé cette notion en mettant en évidence une relation négative entre la dépendance aux ressources naturelles et la croissance économique. De plus, ces pays affichent souvent des taux de pauvreté plus élevés que des pays moins bien dotés de ces ressources. Comme le souligne Stilglitz (2004), les ressources naturelles ont tendance à rendre des "pays riches avec une population pauvre". En effet, comment se fait-il qu'au Nigéria, premier producteur et exportateur de pétrole en Afrique, plus de la moitié de la population vit avec moins d'un dollar par jour ? C'est ce que Terry Lynn Karl qualifie de "paradoxe de l'abondance" dans son ouvrage *The Paradox of Plenty.* En effet l'exploitation de ces ressources est souvent associée à une mauvaise gestion budgétaire, de la corruption et de faibles performances économiques. Pour l'exemple du Nigéria, Sala-i-Martin et Subramanian (2003) considèrent que la médiocre performance du pays provient en grande partie d'une mauvaise gestion des revenus pétroliers. Parmi les différentes thèses expliquant cette malédiction, Frankel (2012) met en avant que les ressources naturelles peuvent être épuisées trop rapidement, lorsque le rythme d'extraction s'avère trop soutenu. Ces difficultés économiques sont également évoqués à travers le concept du "syndrome hollandais". Selon cette approche, des exportations massives de matières premires entrainent une appréciation du taux de change réel, ce qui ralentit la croissance de la productivité dans les autres secteurs de l'économie. La compétitivité s'en trouve alors amoindrie, freinant la diversification et la soutenabilité de l'économie. Il s'agit dès lors de voir comment cette notion de "soutenabilité" a émergé dans de débat public et de comprendre les problématiques qui en découlent.

1.2.2 Les enjeux d'une croissance soutenable

Le rapport Meadows (1972), intitulé "Halte à la croissance" (*"Limits to Growth"*) a mis en avant l'épuisement des ressources naturelles et ses conséquences sur l'activité économique. Après une prise de conscience des problèmes liés à l'environnement dans les années 1970, la notion de développement durable émerge ainsi dans les années 1980. Selon le rapport Brudtland (1987), *"le développement soutenable est un développement qui répond aux besoins du présent sans compromettre la capacité des générations futures à répondre aux leurs".* Les interprétations économiques qui suivirent donnèrent naissance à deux concepts de soutenabilité. La première approche, dite soutenabilité faible, d'inspiration néoclassique, ne prend en compte que la dimension économique. Elle permet la substitution entre le capital naturel (les ressources naturelles) et le capital physique, la diminution de l'un pouvant ainsi être compensée par l'accroissement de l'autre type de capital. Néanmoins, les opposants à cette soutenabilité faible ont souligné les limites de cette substituabilité des facteurs de production. La seconde approche, dite soutenabilité forte, intègre au contraire une dimension écologique. Elle préconise de maintenir constant le stock de capital naturel, au détriment de la croissance économique. Il existe une asymétrie entre le capital physique, qui peut être augmenté ou diminué volontairement, alors que le capital naturel est vu comme irréversible. L'élasticité de substitution entre le capital naturel et physique est donc nulle. Les partisans de la soutenabilité forte pronent une vision conservationniste, associée au principe de complémentarité des facteurs.

1.2.3 Les modèles de croissance exogène et endogène

Après avoir rappelé les enjeux de soutenabilité de la croissance, il s'agit dans cette section de montrer comment les économistes ont modélisé le concept de croissance et comment leurs modèles se sont enrichis au cours du temps, en particulier en intégrant les ressources naturelles comme facteur de production. Les théories classiques de la croissance du XVIIIe et XIXe siècle sont plutôt pessimistes, en estimant que l'économie atteint un état stationnaire, où la production n'augmente plus (Ricardo, Malthus, Mill). Le modèle de Solow de 1956 rejoint cette idée des Classiques, selon laquelle l'économie converge vers un état stationnaire, mais précise que l'économie peut éviter cet état et continuer de croître grâce à un progrès technique "exogène", c'est-à-dire indépendant du comportement des agents. Pour palier à cette limite, des économistes (Lucas, Romer, Barro) ont développé des modèles de croissance "endogène", dans lesquels les actions des agents ont un role à jouer. Ainsi Lucas (1984) a mis en avant le role du capital humain. En effet, plus les individus se forment, plus ils acquièrent des compétences, plus ils sont aptes à innover. De ce fait, l'innovation, l'investissement public, la recherche et développement sont autant d'éléments favorables à la croissance économique d'un pays. Avec l'émergence des problèmes environnementaux, la littérature économique a peu à peu pris en compte les ressources naturelles comme facteur de production.

Ainsi face au rapport Meadows et aux tenants de la croissance zéro, des économistes tels que Stiglitz, Solow, Dasgupta et Heal ont publié en 1974 dans la revue *Review of*

Economic Studies des articles contribuant à enrichir de manière significative l'économie des ressources naturelles. Ils réaffirment l'idée que l'économie tend naturellement vers un sentier de croissance équilibrée sur le long-terme. Ils proposent ainsi des modèles de croissance optimale, où les ressources naturelles sont incorporées dans la fonction de production, avec le capital physique et le travail. Une des questions fondamentales de ces études est de savoir quelles sont les conditions nécessaires pour éviter la baisse du niveau de consommation par tête dans le long-terme malgré le déclin inévitable de ces ressources naturelles épuisables. Stiglitz (1974) soutient que, dans le cadre d'une fonction Cobb Douglas, une augmentation de la consommation par tête, est non seulement possible, mais optimale à condition que le rapport entre le taux de croissance du progrès technique et la part de la ressource naturelle dans la production soit suffisamment élevé. La croissance est donc soutenable puisqu'elle permet de maintenir sur le long-terme la consommation par tête malgré l'épuisement des ressources. Pour Solow (1974), le progrès technique permet également d'éviter l'effondrement de l'économie sur le long-terme. L'auteur promeut l'objectif de garantir l'équité intergénérationnelle. Pour Dasgupta and Heal (1974), c'est la découverte d'un substitut de la ressource épuisable, véritable percée technologique, qui permet de maintenir un niveau de consommation soutenable dans le long-terme. Ils ont une approche différente du progrès technique, qui n'est pas vu comme un processus graduel, mais comme la découverte majeure d'un facteur de substitution (*backstop technology*). L'énergie solaire ou éolienne comme substitut de l'énergie fossile en serait une illustration. La date de découverte est néanmoins complètement inconnue.

D'autres articles ont ensuite complété ces modèles de croissance avec des ressources naturelles en introduisant un progrès technologique endogène. Parmi ces modèles de croissance endogène, Barbier (1999) a proposé un modèle Romer-Stiglitz, où le progrès technique endogène permet de dépasser la pénurie des ressources. Grimaud et Rougé (2003) étudient l'effet d'instruments d'intervention sur le rythme d'extraction des ressources naturelles et sur le taux de croissance dans un modèle schumpetérien.

Néanmoins, la plupart de ces modèles de croissance optimale avec des ressources naturelles épuisables se concentrent sur des économies fermées, alors même que les faits stylisés montrent bien que ces pays riches en ressources naturelles sont des économies ouvertes, souvent avec une dette extérieure, comme le prennent en compte les différents chapitres de cette thèse. Il s'agit désormais de prendre en compte ces questions d'endettement dans cette analyse.

1.3 Des enjeux de dettes de plus en plus présents face à la volatilité des prix des ressources naturelles

1.3.1 Des niveaux de dette croissants aggravés par la chute des prix du pétrole: vers un risque de défaut souverain accru ?

Si la littérature empirique s'est beaucoup penchée sur le "syndrome hollandais", les études sur la dette externe des pays exportateurs de pétrole sont peu nombreuses. Les pays riches en ressources naturelles font pourtant face à des niveaux de dette non négligeables. La récente chute des prix du pétrole, qui a perdu 75% de sa valeur sur 18 mois à partir de l'été 2014, n'a fait qu'accentuer ce phénomène. Le Brésil ou la Russie ont vu leur dette externe s'accroitre et ont dû faire face à une récession en 2015. Certains pays sont même confrontés au risque de défaut souverain. C'est le cas du Venezuela, qui détient pourtant les plus larges réserves de pétrole. L'agence de notation Fitch a ainsi dégradé le 18 décembre 2014 de deux crans sa note à long terme, passée de B à CCC, catégorie désignant les pays pour lesquels un défaut de paiement devient "une réelle possibilité". Plus récemment, de nombreux pétroliers ont vu leurs notes être dégradées par lagence de notation Standard & Poors. Ansi la note du Kazakhstan et d'Oman est passée BBB-, et Bahrein est passée en catgorie spéculative BB.

La littérature sur le risque de défaut souverain est abondante d'un point de vue théorique, avec comme article fondateur Eaton et Gerzovitz (1981). Ces derniers ont ainsi modélisé les décisions d'une petite économie ouverte, qui accède aux marchés financiers internationaux, tout en lissant sa consommation dans le temps. Le pays emprunte sur ces marchés en emmettant des titres de créances et les créditeurs, achetant ces titres, sont supposés avoir une aversion au risque neutre. Le souverain a alors le choix de rembourser ses dettes, avec comme utilité $V_R(b, y)$ qui dépend de sa dette b et de son niveau de production y. S'il décide de ne pas rembourser, son utilité est $V_D(y)$. Il maximise ainsi son utilité en comparant les deux situations:

$$V(b, y) = max(V_D(y); V_R(b, y))$$

Le défaut est alors optimal si:

$$V_D(y) > V_R(b, y)$$

En répudiant sa dette, le pays se retrouve en situation de défaut, et s'expose à être banni des marchés des capitaux dans le futur pour une période indéterminée. De plus, le pays est confronté à un niveau de production de défaut moins élevé. Bulow and Rogoff (1989) insistent sur les sanctions directes que peuvent encourir les pays faisant défaut. Ils montrent ainsi que si les contrats de dette souveraine présentent des coûts directs à faire défaut, que pourraient imposer les créditeurs, et non pas seulement des coûts de réputation, alors les prêts pourraient être remboursés. Comme le souligne Eaton, Gerzovitz et Stiglitz (1986), le problème essentiel de la théorie du défaut est l'application du contrat, s'assurant que chaque partie adhère au contrat et le respecte, que l'emprunteur rembourse ses dettes et que le créditeur puisse le pénaliser s'il ne le fait pas. Néanmoins, ce modèle de base apparait inconsistent avec les données sur l'emprunt international des pays émergents. Ce modèle a ensuite été prolongé, en particulier par Arellano (2008), qui montre que le niveau d'emprunt souverain et les taux d'intérêt fixés pour ces emprunts apparaissaient trop petits. Arellano (2008) parvient à améliorer les prédictions du modèle en accroissant les coûts du défaut, c'est à dire en diminuant la probabilité de revenir sur les marchés des capitaux et en augmentant le coût de production lors d'un défaut.

Une autre partie de la littérature a abordé le risque de défaut d'un point de vue empirique. Pour cela, le risque de défaut est mesuré par le spread, construit comme la différence entre le taux d'intérêt du pays et le taux d'intérêt des Etats-Unis. Edwards (1986) a ainsi analysé le marché des titres de dettes souveraines de pays en développement, en étudiant les différents déterminants macroéconomiques (comme le ratio des réserves de change et PIB, ratio de dette et PIB, investissement) des spreads souverains de 1976 à 1980. Il confirme empiriquement les implications des modèles d'accès à l'emprunt étranger, en particulier l'effet positif de plus grands ratios de dette sur le risque premium. Cependant, Edwards (1986) disposait de peu de données (167 observations pour 13 pays), du fait d'un marché des titres souverains pour les pays en développement encore embryonnaire. Eichengreen et Mody (1998) complètent cette analyse en montrant que l'état du marché (*market sentiment*) influence également les variations de spreads souverains, et non pas seulement les fondamentaux macroéconomiques.

Cependant cette littérature, aussi bien théorique qu'empirique, occulte la dimension des ressources naturelles des pays exportateurs de pétrole. C'est pourquoi les deux derniers chapitres de cette thèse contribue à la littérature en intégrant la dépendance de ces économies aux ressources naturelles dans l'étude du risque de défaut. Une autre dimension importante à prendre en compte dans cette analyse est la question de la volatilité des prix des ressources naturelles, qui joue un rôle non négligeable dans l'endettement de ces pays producteurs.

1.3.2 La volatilité des prix des ressources naturelles et l'accès aux marchés financiers internationaux

Il s'agit ici de comprendre comment cette volatilité des prix peut se répercuter sur la contrainte budgétaire des pays riches en ressources naturelles. Selon Van der Ploeg and Poelhekke (2008), la malédiction des ressources naturelles est avant tout un problème de volatilité des prix. La forte volatilité des prix mondiaux des ressources naturelles provoque la volatilité de la croissance du produit par tête dans les pays, qui dépendent en grande partie du revenu de ces ressources, ayant ainsi un effet négatif sur la croissance de long-terme. Les tensions sociales et ethniques, qui peuvent émerger de cette richesse naturelle, et les resctrictions s'appliquant au compte courant ont tendance à aggraver d'autant plus cette volatilité. Manzano et Rigobon (2011) confirment également cet argument selon lequel ce n'est pas tant la présence de ressources naturelles qui pose problème, mais bien plus la volatilité des prix des matières premières et les imperfections du marché du crédit. Ainsi ces pays ont profité de la hausse des prix des ressources dans les années 1970 pour emprunter, et ultiliser ces ressources comme collatéral, mais ce sont retrouvés dans des situations de surendettement losque les prix se sont effondrés dans les années 1980. En effet, une hausse des prix permet de relacher la contrainte budgétaire de ces pays, qui augmentent leur niveau de dette. En période de baisse des prix, ils doivent rembourser ces dettes alors même que leurs revenus baissent, et ne peuvent plus emprunter. Ils doivent finalement mettre en oeuvre des restrictions budgétaires, des dévaluations, ce qui se répercute bien souvent de manière négative sur la croissance. Ce cycle de "boom-bust" du prix des ressources naturelles s'apparenterait ainsi selon Manzano et Rigobon (2011) à une bulle sur les marchés financiers. De plus, Gelos, Sahay et Sandleris (2011) montrent que plus une économie est vulnérable aux chocs macroéconomiques, plus il sera difficile pour elle d'emprunter. Néanmoins, si le pays se voit contraint à faire défaut, sa capacité d'emprunt sur les marchés financiers sera maintenue si le défaut est résolu rapidement. Ainsi la possibilité d'accéder aux marchés ne dépendrait pas tant de la fréquence des défauts souverains, mais bien plutôt de la manière dont le défaut est géré. Pourtant, dans les faits certains pays exportateurs de pétrole et gaz décident de ne pas se financer sur les marchés, soit parce qu'ils n'en ont pas besoin soit parce que les coûts d'emprunt s'avèrent trop élevés. Pour la première catégorie de pays, il s'agit d'économies ayant accumulé d'énormes réserves de change, avec des excédents budgétaires qui leur permettent de financer leurs projets. Ces pays, comme l'Arabie Saoudite ou le Koweit, ont de plus tendance à privilégier l'emprunt domestique sur l'emprunt international. L'autre catégorie correspond à des pays qui n'ont pas la notation nécessaire pour se financer sur les marchés internationaux, comme la République du Congo (Brazzaville) ou la Guinée Equatoriale. Le Ghana a ainsi renoncé à émettre de la dette sur ces marchés en 2015 face à des coûts d'emprunt trop élevés. Cependant, face à une chute des revenus pétroliers et des prix restant bas, ces pays tendent à modifier leurs modes de financement sur les marchés des capitaux.

1.3.3 Des moyens de financement en évolution pour assurer la soutenabilité des finances publiques

Face à la récente chute des prix du pétrole, de nombreux exportateurs ont vu leurs revenus s'effondrer, leurs réserves de change fortement diminuer et ont ainsi creusé leur déficit. Pour la première fois de son histoire, l'Arabie Saoudite a émis de la dette sur son marché domestique, mais pourrait avoir recours en 2016 aux marchés financiers internationaux pour se financer. Le Royaume envisage également de vendre une part de ses titres du Trésor américains afin d'honorer ses obligations budgétaires, et même de mettre en Bourse la compagnie pétrolière nationale Saudi Aramco.

Cette chute des revenus pétroliers peut néanmoins représenter une réelle opportunité pour ces pays fortement dépendants des ressources fossiles afin de mener à bien des réformes structurelles. Des pays ont ainsi commencé à modifier leur système de subventions, souvent inefficace et qui ne profite en réalité pas aux plus pauvres. A la fin de l'année 2015, l'Arabie saoudite a ainsi réduit jusqu'à 80% les subventions sur les produits pétroliers. Il faut savoir que rien que pour l'année 2015 les subventions dans le secteur de l'énergie ont coûté 61 milliards de dollars au Royaume. L'Algérie et le Nigéria les ont également fortement réduites.

Si la dimension budgétaire est majeure dans l'analyse économique de ces pays, la dimension institutionnelle joue également un role non négligeable.

1.4 Les institutions comme clé du développement des pays riches en ressources naturelles?

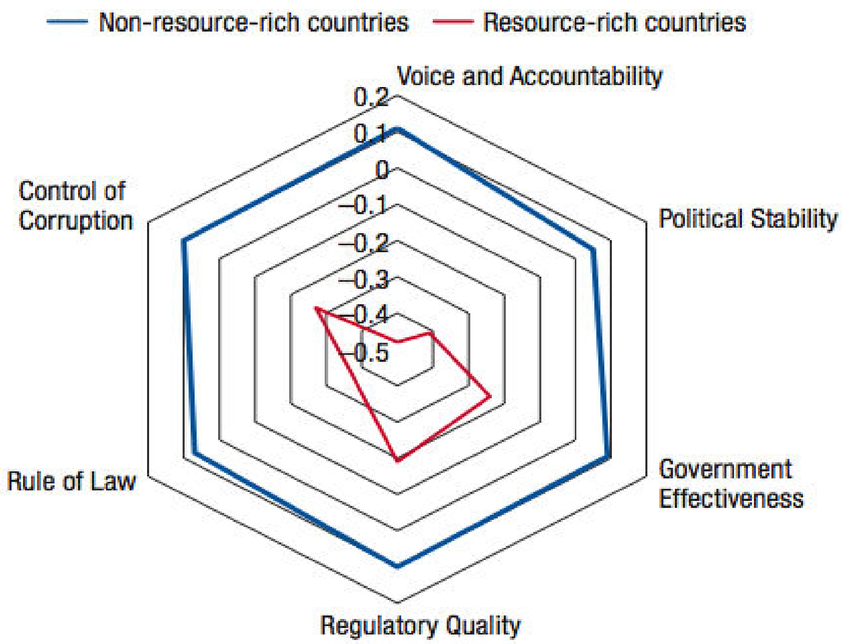
1.4.1 Une qualité institutionnelle souvent faible

Les pays riches en ressources naturelles affichent souvent des résultats assez faibles en termes de gouvernance institutionnelle. Comme on peut le voir sur la Figure 1.1, leurs scores en termes de stabilité politique, qualité de l'état de droit, de droits politiques, civils, d'efficacité des pouvoirs publics, sont bien plus faibles que ceux des pays dépourvus de ressources naturelles. Ils sont confrontés à des niveaux de corruption élevés, comme le montrent les scores de l'Index de Perception de la Corruption de Transparency International (*Transparency International Corruption Perception Index*), qui varient sur une échelle de 1 (pour les pays très corrompus) à 10 (pour les pays non touchés par le clientélisme). Pour les principaux exportateurs pétroliers, comme le Nigéria, l'Algérie, l'Angola, les scores ne dépassent pas 5. En effet, Arezki et Bruckner (2009), Bhattacharyya et Hodler (2009) trouvent que les rentes pétrolières sont souvent associées à un niveau de corruption plus élevé.

De plus, Ross (2001) montre que la démocratie tend à s'étioler dans les pays pétroliers. Jansen et Wantchekon (2004) mettent en évidence une corrélation entre l'abondance de ressources naturelles et les régimes autocratiques en Afrique. Selon Tsui (2010), découvrir 100 milliards de barils de pétrole (ce qui correspond à la dotation initiale de l'Irak) correspond à diminuer de 20% le niveau de démocratie du pays.

Ces pays doivent souvent faire face à une instabilité politique. En effet, selon Collier et Hoeffler (2004, 2009) l'exploitation de matières premières présente un risque accru de guerre civile. Lujala (2010) fait le constat que c'est la localisation des gisements de pétrole qui accroit le risque de conflits. Ainsi le pétrole à terre (*onshore*) est plus susceptible de mener à des conflits, alors que ce n'est pas le cas du pétrole en mer (*offshore*), dont les installations sont plus difficilement accessibles lors d'attaques violentes par des fractions rebelles. Néanmoins, la littérature plus récente met en doute la relation entre ressources

Figure 1.1: Institutional quality in natural resource-rich countries



Source: Worldwide Governance Indicators (World Bank) for 1996 - 2014 and IMF

naturelles et qualité institutionnelle. Tsui et Cotet (2010) montrent ainsi qu'en contrôlant les effets fixes de pays, la relation statistique entre les réserves de pétrole et la guerre civile disparait. De même, il n'y aurait pas de lien statistique entre coup d'état et richesse pétrolière. Alexeev et Conrad (2009) affirment que les ressources naturelles n'auraient pas d'effet sur le niveau de démocratie du pays. Le deuxième chapitre de cette thèse contribue à cette littérature, en montrant que la qualité institutionnelle du pays ne semble pas jouer un rôle déterminant dans la réduction des coûts d'emprunt des pays exportateurs de pétrole et gaz, lorsque les effets fixes de pays et d'années sont pris en compte.

1.4.2 L'importance de la qualité institutionnelle sur la gestion économique des ressources naturelles

Robinson, Torvik, Verdier (2006) montrent que les gouvernements ont tendance à privilégier un rythme d'extraction des ressources naturelles supérieur au rythme optimal, du fait de leur forte préférence pour le présent. Les booms de ressources naturelles, en accroissant la valeur d'être au pouvoir et donnant plus d'influence aux dirigeants politiques, risquent d'aboutir à une mauvaise allocation des ressources dans le reste de l'économie. Néanmoins, l'effet final dépend de la qualité institutionnelle du pays. De ce fait, les pays promouvant une forte transparence de la gestion des rentes pourront mieux profiter de ces booms économiques, en évitant les tentations de corruption. C'est ce que confirment McSharry (2006) et Melhum, Moene et Torvik (2006), en affirmant que c'est la qualité des institutions qui permet à ces pays d'éviter la malédiction des ressources naturelles et de tirer pleinement avantage de leurs ressources. Arezki, Hamilton et Kasimov confirment également que l'effet de la manne des ressources naturelles sur la stabilité macroéconomique et la croissance dépendant de la qualité institutionnelle. De même selon Gelos, Sahay et Sandleris (2011), la qualité des politiques économiques et des institutions auraient une influence positive sur la possibilité des gouvernements de recourir à l'emprunt international. Arezki et Bruckner (2012) ont ainsi montré qu'une augmentation de 1% du prix des matières premières (*commodities*) menait à une réduction de $1,6\%$ du niveau de dette externe dans les pays démocratiques, mais pas dans les autocraties. De ces constats émergent des recommandations économiques afin de mener à bien les mesures propices à la croissance économique.

1.4.3 Des pistes de réforme pour améliorer la gouvernance institutionnelle

La question de la gestion financière des rentes demeure plus que jamais d'actualité, en particulier à l'heure de nouvelles découvertes de pétrole et gaz dans plusieurs pays (l'Ouganda va bientôt produire du pétrole, le Ghana a commencé en extraire, le Mozambique exporte depuis peu du charbon et vient de découvrir des gisements de gaz naturel). Pour éviter cette malédiction des ressources naturelles, différents paramètres sont à prendre en compte pour une affectation optimale des recettes : le stade de développement économique, la force des institutions publiques, l'impact du volume des actifs pétroliers sur l'économie réelle, le modèle de gouvernance.

Des mesures pour tenter de lutter contre la corruption ont été mises en place dans certains pays, comme mieux former et augmenter les salaires des fonctionnaires. L'Initiative pour la Transparence dans les Industries Extractives (*Extractive Industries Transparency Initiative*), lancée en 2002, promeut le principe du "Publiez ce que vous payez" (*"Publish what you pay"*), selon lequel les compagnies pétrolières s'engagent à publier ce qu'elles versent aux gouvernements en termes de revenus pétroliers. Cette norme mondiale vise à promouvoir la transparence des revenus provenant de l'extraction des ressources naturelles, ainsi qu'une gestion ouverte au public et responsable de celles-ci. Si ces mesures ne sont qu'une première étape dans le processus réformateur, elles jouent un role clé pour les générations futures, qui ne pourront plus se reposer sur l'accumulation de rentes face à l'épuisement des ressources.

1.5 Comment assurer une croissance durable et un niveau de dette soutenable pour les générations futures avec des ressources non renouvelables ?

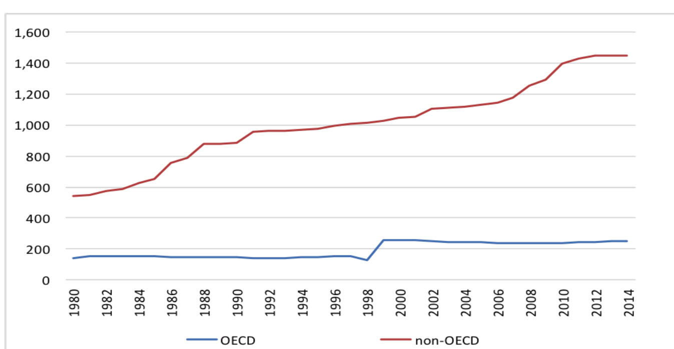
1.5.1 Des réserves de pétrole et gaz vouées à disparaitre...

Cette section fait un état des lieux des stocks de ressources naturelles fossiles, comme le pétrole et le gaz. Différents types de réserves existent, mais cette thèse se concentre sur l'étude des réserves "prouvées" de pétrole et de gaz. Selon la définition de l'Administration d'Information de l'Energie des Etats-Unis, elles correspondent aux "quantités de pétrole et de gaz, qui selon les analyses de géoscience et les données d'ingénieur, peuvent être estimées avec une certitude raisonnable d'être mises en production de manière économique à partir d'une date donnée, des réservoirs connus, et sous les conditions économiques, méthodes d'opération et régulations gouvernementales existantes" (*"quantities of oil and gas, which,* *by analysis of geoscience and engineering data, can be estimated with reasonable certainty to be economically producible from a given date forward, from known reservoirs, and under existing economic conditions, operating methods, and government regulations."*) Elles sont donc différentes des réserves probables et possibles.

Le Venezuela détient les réserves prouvées de pétrole les plus larges au monde, juste après l'Arabie Saoudite. La Russie, suivie par l'Iran, possède les plus grandes réserves prouvées de gaz naturel.

Or ces réserves prouvées ont fortement augmenté ces dernières années dans les pays non OCDE, comme le montre la Figure 1.2. En effet, les grandes découvertes de ces dernires années ont été faites surtout dans les pays émergents. Le Brésil a ainsi multiplié les découvertes de pétrole off-shore au cours de la dernière décennie. Cependant, ces énergies fossiles sont de plus ne plus difficiles à extraire, souvent en eaux profondes, à forte température et forte pression. Le nombre de découvertes est bien inférieure à celles faites dans les années 1970. Les pays n'ayant ainsi pas fait de nouvelles découvertes et avec un rythme d'extraction élevé, ont vu leur stock d'énergies fossiles, c'est-à-dire leurs réserves, décliner. C'est le cas de l'Indonésie ou de l'Argentine, devenus des importateurs nets de pétrole. Au contraire, ceux qui ont découvert de grands gisements pétroliers, comme le Brésil, ont vu leurs réserves augmenter.

Figure 1.2: Proven oil reserves in OECD and non OECD countries (in thousand million barrels)



Source: BP

1.5.2 ...qui posent la question de la diversification des ces pays

Cette partie vise à étudier les différentes stratégies financières pronées par la théorie économique et celles adoptées par les pays riches en ressources naturelles, qui ont réussi à diversifier leur économie. Les pièges à éviter pour ces pays sont principalement la mauvaise discipline budgétaire (l'enjeu étant de transformer des revenus exceptionnels en revenus permanents) et le sous-investissement dans les secteurs autres que celui des ressources naturelles (secteur financier, industrie manufacturière, éducation, santé), plus connu sous le nom de "syndrome hollandais". Les préconisations d'économistes ont ainsi mis en lumière la possibilité d'obtenir une croissance durable associée à une gestion financière saine des ressources naturelles. Hartwick (1977) a montré qu'en appliquant une règle simple (investir toute la rente dans d'autres actifs), il est possible d'obtenir un développement durable avec des ressources épuisables. C'est ce que Solow (1986) a qualifié de "règle empirique pour le développement durable". Il s'agit dès lors de veiller à ce que les recettes tirées des ressources naturelles soient investies à bon escient. Une autre option est la création d'un fonds souverain, sur le modèle norvégien ou même celui du Qatar. Le fonds permet de lisser les revenus et ainsi faire face aux fluctuations des prix des matières premières, tout en prenant en compte les générations futures, en particulier lors de la période suivant l'épuisement des ressources. Dans leur article *"The elephant in the ground"*, Van den Bremer, van der Ploeg, et Wills (2016) préconisent de coordonner les deux types d'actifs que représentent la ressource dans le sol et son fonds souverain. La consommation de ces pays exportateurs devraient représenter une part constante de la richesse totale des ressources et du fonds, ce qui stabiliserait les dépenses, tout en remplaçant peu à peu les réserves de ressources naturelles par des actifs financiers.

D'autres pays, comme le Chili, ont mis en place une règle fiscale pour mieux faire face à la volatilité des prix. Van der Ploeg and Poelhekke (2008) préconisent plus d'ouverture au commerce international, plus de développement financier, et moins de resctrictions s'appliquant au compte courant.

Les exemples de l'Indonésie, de la Malaisie, du Botswana ou même de Dubai peuvent être instructifs. Ils ont réussi à se développer en diversifiant leurs secteurs économiques et leurs exportations, à travers une gestion macroéconomique prudente et une ouverture commerciale extérieure. L'Indonésie a ainsi modernisé son secteur agricole et industriel. Il a contenu les dépenses publiques afin d'accumuler des réserves, et a fait en sorte que le taux de change ne s'apprécie pas trop pour que les exportations non pétrolières restent compétitives. Le pays est ainsi parvenu à réduire son taux de pauvreté et sa dépendance au pétrole.

1.6 Présentation des chapitres de la thèse

1.6.1 Chapitre 1

Le premier chapitre de cette thèse présente un modèle de croissance exogène avec des ressources naturelles non renouvelables. La littérature théorique dans le domaine (Sitglitz, 1974, Solow, 1974, Dasgupta et Heal, 1974) se concentre en grande partie sur des économies fermées, alors que les faits montrent bien qu'en réalité ces pays exportateurs de ressources naturelles, sont des économies ouvertes, avec des niveaux de dettes externes plus ou moins élevés. Il s'agit donc ici d'étudier une petite économie ouverte, dont les ressources sont épuisables. La question posée est de voir si le fait d'emprunter sur les marchés financiers internationaux lui permet de dépasser la pénurie de ces ressources, et ainsi d'obtenir une croissance soutenable dans le long-terme. Le chapitre présente un modèle à la Ramsey, où le gouvernement maximise son utilité sous trois contraintes. La première est une contrainte d'accumulation du capital physique, où l'investissement se déprécie au cours du temps. La seconde est une contrainte sur le stock des ressources naturelles, qui décroit au rythme d'extraction des ressources. La troisième est la contrainte budgétaire du gouvernment, qui perçoit des revenus des exportations des ressources naturelles, et qui peut s'endetter à un taux d'intérêt donné. Le gouvernement n'exporte pas toutes ses ressources naturelles, mais en conserve une partie pour son marché domestique. Le modèle est composé de deux parties:

une où le taux d'intéret est constant, et une seconde où le taux d'intéret varie en fonction du niveau de dette du pays. Dans cette première partie à taux d'intérêt constant, un premier cas sans progrès technique est étudié. Comme les ressources naturelles sont épuisables, le taux d'extraction des ressources R tend asymptotiquement vers zéro dans le long terme. Or le ratio K/R du capital et des ressources naturelles est constant d'après les conditions du second ordre, ce qui implique que le niveau de capital décroit également vers zéro de manière asymptotique. On peut en déduire par la forme de la fonction de production, qui dépend du capital et des ressources, que la prodution tend asymptotiquement vers zéro, ce qui signifie que l'économie est en voie d'extinction. Ajouter des ressources naturelles non renouvelables à une petite économie ouverte mène à des résultats contrefactuels de non-croissance et non-production, différents des modèles de Ramsey en économie ouverte sans ressources, où la vitesse de convergence du capital et de la production est infinie. Une trajectoire de croissance équilibrée est alors définie, en tant que sentier où les quantités de production, de consommation et de capital varient à des taux proportionnels constants. Après la résolution des équations, tout en prenant en compte les conditions de transversalité, toutes les variables (production, consommation, ressources naturelles, investissement, niveau de dette) croissent au même taux sur ce sentier de croissance équilibrée. Ainsi les résulats trouvés ici confirment ceux de Stiglitz (1974), selon lesquels il n'y a pas de croissance soutenable sans progrès technique. Un second cas est alors analysé toujours dans cette première partie, en introduisant du progrès technologique, qui croit à un taux d'intérêt constant. Les résultats sont assez similaires au premier cas, puisque toutes les variables tendent asymptotiquement vers zéro, à la différence que cette fois les ressources naturelles ne croissent pas au même taux que la production, le capital, l'investissement, la dette et la consommation. Cela diffère donc de Stiglitz (1974), où la soutenabilité de la croissance est faisable dans une économie fermée avec des ressources non renouvelables, si le ratio du progrès technique et du taux de croissance démographique est supérieur à la part des ressources naturelles dans la production. Ainsi, dans une économie ouverte possédant des ressources naturelles épuisables, le progrès technique ne permet pas de dépasser l'épuisement des ressources et d'obtenir une croissance soutenable dans le long terme.

Dans la seconde partie du modèle, le taux d'intérêt dépend désormais du niveau de dette du pays, ce qui est une hypothèse plus réaliste. L'économie doit faire face à des restrictions d'accès aux marchés financiers, car plus sa dette externe augmente plus le taux d'intérêt du pays pour emprunter sera élevé. Un premier cas, où les prix des ressources naturelles sont constants, est étudié. En se référant à Schmitt-Grohe et Uribe (2003), une prime de risque est intégrée dans l'expression du taux d'intérêt, qui prend une forme exponentielle. Après résolution des équations et en les regroupant dans une équation différentielle autonome, le niveau de dette optimal s'avère décroitre avec le temps. La politique économique recommandée ici est donc de payer ses dettes avant tout, et de ne pas prendre de risque. Le ratio du capital et des ressources naturelles, qui dépend du niveau de dette, approche asymptotiquement zéro. De ce fait, le capital et la production tendent également asymptotiquement vers zéro. Mais il est intéressant de noter que cette fois le taux de croissance de la consommation dépend de la dette externe, losque le taux d'intérêt est endogène au niveau de dette. Il est constaté que ce taux de croissance de la consommation est positif pendant de la transition dynamique, sous la condition qu'une expression dépendant du taux d'intérêt soit supérieure au taux de préférence pour le présent. La consommation peut donc croitre jusqu'à un certain point, mais finit par décroitre dans le long terme. Un second cas est analysé, où le prix des ressources naturelles est croissant. Il s'agit de voir si le fait que les prix des ressources augmentent, assurant de meilleurs revenus à ces pays exportateurs de ressources naturelles, permet d'avoir une croissance soutenable dans le long-terme. Le prix de la ressource prend donc une forme exponentielle. Cette fois on peut regrouper les différentes conditions sous une équation différentielle non autonome. Dans le court terme, le niveau de dette augmente ainsi que la consommation sous des conditions posées sur les paramètres constants. Cependant, dans le plus long terme la consommation décroit de nouveau, ne permettant pas d'assurer la soutenabilité de l'économie.

Le résultat principal de ce chapitre est que l'accès aux marchés financiers internationaux ne permet pas d'avoir une croissance soutenable quand le taux d'intéret est constant. En effet, même l'introduction de progrès technique dans cette partie du modèle n'aboutit pas à résoudre le problème de soutenabilité, contrairement à Stiglitz (1974). Néanmoins, le taux de croissance de la consommation peut être positif avant de décroitre sur le long-terme, lorsque le taux d'intéret est endogène au niveau de dette du pays. C'est également le cas lorsque des prix croissants des ressources naturelles sont introduits dans cette seconde partie du modèle. Ce chapitre pourrait être prolongé en endogénéisant la part des ressources naturelles qui est exportée à l'étranger.

1.6.2 Chapitre 2

Le second chapitre examine si les réserves de pétrole et de gaz peuvent réduire les coûts d'emprunt de pays émergents exportateurs de pétrole et gaz. Cette question est d'autant plus d'actualité que de nombreux pays pétroliers doivent faire face à la chute des prix du pétrole, faisant fondre leurs revenus. Contraints par des budgets de plus en plus serrés, ces pays se tournent de plus en plus vers l'émission de dette sur les marchés financiers internationaux. Ce phnomène encore récent chez les pays émergents limitent donc dans le temps les données disponibles. Les données de spreads souverains, en particulier l'index EMBIG composé des spreads souverains des pays émergents, commencent ainsi qu'à partir de 1994, voire plus tard pour certains pays. La période d'étude est donc de 1994 à 2014. L'échantillon est composé de 10 pays: Algérie, Nigéria, Argentine, Brésil, Mexique, Venezuela, Equateur, Indonésie, Malaisie, et Russie. Il est à souligner que l'analyse ne porte que sur les pays émergents possédant des réserves de pétrole, gaz et émettant sur les marchés financiers, c'est-à-dire les pays pétroliers et gaziers où il existe des données sur les spreads souverains. Certains pays pourtant avec d'importantes ressources naturelles sont donc exclus de l'échantillon, parce qu'ils n'empruntent pas sur les marchés de crédit internationaux, comme l'Arabie Saoudite, le Qatar ou le Congo. Concernant la méthodologie, un modèle à effets fixes temporels et de pays est utilisé avec des données annuelles de panel. Les effets fixes de temps et pays permettent de contrôler pour des chocs communs à l'échelle mondiale et des facteurs ne variant pas dans le temps, comme la localisation géographique, les déterminants culturels et historiques. Des variables de controle sont insérées dans les régressions afin de prendre en compte les déterminants macroéconomiques, mobilisés dans la littérature empirique. Parmi ces facteurs, le ratio de dette externe et du Revenu National Brut, le ratio des réserves de change et du Produit Intérieur Brut. Etre en défaut pendant la période étudiée est également un élément à ne pas négliger. L'inflation, qui représente la stabilité macroéconomique du pays, et le spread régional pour prendre en compte le risque de contagion, puisqu'un pays est souvent dépendant de la stabilité financière de ses voisins.

Un des résultats principaux est que ces réserves ont un impact significatif sur les spreads souverains, contrairement aux exportations et à la production de pétrole et gaz. En effet, ces flux n'ont pas d'effet statistiquement significatif sur le risque souverain. Les marchés financiers privilégieraient les réserves, c'est-à-dire les stocks, symboles de richesse future, sur les flux comme la production et les exportations, richesse du présent. Cependant, la qualité institutionnelle ne semble pas jouer un rôle déterminant dans la diminution du coût d'emprunt de ces pays, en contrôlant pour les effets fixes de temps et de pays. Les marchés financiers ne donneraient pas de premium pour les réserves de pétrole ou de gaz des pays plus démocratiques ou moins corrompus. Pour prolonger ce travail, la méthodologie du bootsrap permettrait de remédier au petit échantillon de pays.

1.6.3 Chapitre 3

Le troisième chapitre analyse les effets des rendements du prix du pétrole sur les spreads des Credit Default Swaps (CDS) pour deux pays exportateurs de pétrole, la Russie et le Venezuela. Très peu d'études existent sur ces deux pays, fortement dépendants des revenus pétroliers, et dont la récente chute des prix du pétrole a eu un effet dramatique sur leur économie. En effet, le Venezuela tire 96% de ses recettes des exportations des hydrocarbures. La question posée dans ce chapitre est de savoir si les rendements du prix du pétrole peuvent accroitre le risque de défaut souverain pour des économies aussi peu diversifiées. L'intuition économique est que cette chute des prix a augmenté l'instabilité des CDS souverains. Face aux nombreuses "ruptures" dans les données, un modèle non linéaire est utilisé, reprenant la méthodologie du cadre théorique de Hamilton (1989). Cela nous permet d'étudier deux types de régimes, un régime "calme" et un régime "turbulent". Il s'agit d'un modèle de Markov Switching avec des probabilités de transition variant dans le temps, où ces dernières dépendent de la volatilité des prix du pétrole. Des données journalières des CDS souverains de 2008 à 2015 sont utilisées, ce qui donne la possibilité d'obtenir des estimations plus précises des spreads.

Les principaux résultats de cette étude sont que les rendements du prix du pétrole expliquent de manière significative les spreads des CDS du Venezuela, mais pas ceux de la Russie. Le prix du pétrole aurait un effet indirect sur les spreads des CDS russes à travers le canal du taux de change. En effet, les deux pays ont un système de change différent, la Russie a un taux de change flexible alors que le Venezuela a un taux de change fixe. Ce chapitre étudie également l'effet des indices boursiers sur les CDS souverains dans ces pays riches en ressources naturelles, puisque la stabilité financière joue un role clé sur les marchés des CDS. D'autres facteurs plus globaux sont pris en compte, comme l'indice boursier américain le S&P 500, le VIX qui représente la volatilité induite du S&P 500 et l'OVX qui est l'indice de volatilité du pétrole brut. Ces facteurs ont un impact significatif sur les spreads des CDS souverains des deux pays. Des recherches futures pourraient inclure une analyse du risque de contagion entre différents pays.

2 Chapter one

Sustainable growth and financial markets in a natural resource rich country

2.1 Introduction

Surprisingly, oil or gaz producers, even though they have important revenues due to their natural resources, are usually facing high level of debt. For instance, Angola, which is one of the first oil producer of Africa has to deal with an external debt of 36 billion of US dollar, and Brazil had a debt of 340 billion of US dollar in 2015. Nevertheless, the issue of external debt in natural resource rich countries has been neglected by economists so far.

In this paper, I develop one of the first analysis on this critical issue, investigating whether a natural resource dependent country with an external debt can achieve sustainable output and consumption growth rates, thanks to its access to international financial markets. The paper introduces international borrowing in an optimal exogenous growth model, with exhaustible natural resources, in which the country can borrow money at a constant interest rate and then at an endogenous interest rate. It is a one-sector model, in which the economy extracts and produces natural resources, that it can sell on the domestic market or export abroad. The choice was made not to explore a two-sector model, in order to focus on financial opening and not on trade opening. The main finding of the paper is that sustainability is not feasible when the interest rate is constant, even if there is technical progress, but when the economy faces a debt-elastic interest rate, consumption can grow for a while before decreasing in the long-run.

This paper is at the crossroads of two literatures and fills important gaps in each literature. The first stream of literature deals with sustainable growth with natural resources. The cornerstone of those studies is Stiglitz's (1974) neoclassical optimal growth model, where natural resources are essential for production. He points out that optimal growth and a sustainable per capita consumption is feasible with exhaustible natural resource in limited supply, if the ratio of the rate of technical change to the the rate of population growth is greater than or equal to the share of natural resources. Solow (1974) also uses a neoclassical growth model, where he applies the max-min principle to the intergenerational problem of optimal capital accumulation, in general and then in particular with scarce natural resources. Dasgupta and Heal (1974) have a different approach of technical change, they do not view it as a smooth gradual process, but as technological breaktrough. They thus introduce a "backstop technology", which represents a major discovery, a new substitute for the depletable resource. An example might be the substitution of fossil fuel energy by solar or wind energy. It should be emphasized that this date of discovering is completely unknown. Nevertheless, this substitution process is a way to overcome resource scarcity and avoid a falling level of per capita consumption. Dasgupta and Stiglitz (1976) and Heal (1978) follow this approach. More recently, Benchekroun and Withagen (2011) show that in a Dasgupta-Heal-Solow-Stiglitz based model, the initial consumption under a utilitarian criterion starts below the maximin rate of consumption if and only the resource is abundant enough. They underline the fact that the present generation does not necessarily benefits most from a windfall of resources. My paper contributes to this Dasgupta-Heal-Stiglitz-Solow (DHSS) literature by "opening" the economy. Indeed, in most of DHSS models, those natural resource rich economies are closed, and the country does not have access to debt. As a matter of fact, very few studies examine optimal exogenous growth models with resource extraction in an open economy. There are some exceptions, as Poelhekke and Van der Ploeg (2008), Van der Ploeg and Venables (2011) who have introduced international finance in their models of resource-rich countries, which focus more on managing resource windfalls. In addition, some articles decided to introduce endogenous growth with non renewable natural resources in this literature, as Schou (1996). In particular, Barbier (1999) proposed a "Romer-Stiglitz" model, where endogenous technical change can overcome resource scarcity. Grimaud and Rougé (2003) analyses the effect of intervention instruments on the rate of resource extraction and growth rate in a Schumpeterian model. Furthermore, Groth and Schou(2002) show in a one-sector optimal endogenous growth model, growth per capital consumption is unstable unless there is population growth. They adopt a "semi-endogenous" framework to allow a stable long-run growth. In this paper, I focus on an exogenous technological progress that delays the depletion of natural resources, as the main idea is to see if a resource dependent economy can have a sustainable growth rate thanks to international borrowing, while its main source of growth is bound to disappear. Technical progress is thus added in the model to see if it confirms the results. It is interesting to note that in my model technical change does not help overcome resource scarcity, contrary to Stiglitz (1974) and the rest of this literature.

The second body of literature embraces extensions of the Ramsey model to an open economy. It is shown that the open economy version of the Ramsey model leads to a number of paradoxical conclusions. Barro and Sala-i-Martin (2003) find that the speed of convergence for capital and output is infinite, so the economy jumps into the steady state. Moreover, consumption tends to zero, except for the most patient country. Nevertheless, Schmitt-Grohe and Uribe (2003) display that there are different alternatives to modify the standard small open economy model. Indeed, some attempts have been made to improve those counterfactual results, by introducing a constraint on international credit or adjustment costs. The infinite speed of convergence for capital and output does not apply to countries that are effectively constrained to borrow, and consumption does not decrease to zero. With adjustment costs for investments, capital and output are less instantaneous, even if capital markets are perfect. Oxborrow and Turnovsky (2015) chose an other approach to close the small open economy model, by replacing the infinitely-lived representative agent framework with a general demographic structure, assuming a survival function, which enables them to relax the knife-edge constraint. My paper fills the gap in this small open economy literature by adding exhaustible natural resources. The resources here are essential for production, non renewable, and can apply to oil, gaz, shale gaz or to different minerals as copper, gold, diamonds.

In the next section, I set forth a general Ramsey model in a small open economy, with exhaustible natural resources. In section 3, I focus on a particular case where the interest rate r is constant. A resource-augmenting technical progress, that helps raise the efficiency of resource use, is then introduced. In section 4, the model is generalized with an interest rate, which is increasing in the level of debt. I then try to see if the results are different when natural resource prices are increasing.

2.2 Theorethical framework

A simple neoclassical growth model with natural resources is considered. It is a small open economy with borrowing capacities.

Output is produced with a constant-returns-to-scale technology, using a Cobb-Douglas production function:

$$Y = F(K,R) = K^{\alpha}((1-\gamma)R)^{1-\alpha}, 0 < \alpha < 1 \tag{1}$$

where K is the stock of man-made capital, R a non renewable natural resource, and γ the share of the country's natural resources that are exported abroad. Labor is supposed to be constant.

According to diminishing returns to the accumulation of capital,
$F'(K) = F_K > 0$ and $F''(K) < 0$.

I(t) is the investment function, s(t) the saving function, and i(t) the financial contribution, that the government can use, when the production of natural resource is low: $I(t) = s(t) + i(t) = Y(t) - C(t) + i(t)$

The man-made capital depreciates at rate δ:

$$\dot{K}(t) = I(t) - \delta K(t) = Y(t) - C(t) + i(t) - \delta K(t), \delta \in [0,1] \tag{2}$$

2.2.1 Natural resources

Let S(t) be the stock of non-renewable resources available at time t, and R(t) the rate of extraction of this resource at time t. The economy has an initial stock of natural resources S(0).

The stock decreases over time with the rate of extraction:

$$\dot{S}(t) = -R(t) \tag{3}$$

with R(t) a continuous function of time, $K(0) > 0$ and $S(0) > 0$.

2.2.2 The government

The economy is centralized and administered by the government, which controls the management of natural resources through a monopoly. The government has constant relative risk aversion preferences. The intertemporal utility function is:

$$\int_0^\infty e^{-\rho t} U(C(t)) \mathrm{d}t \tag{4}$$

with U(C(t)) = $\frac{C^{1-\eta}-1}{1-\eta}$ for $\eta \neq 1$, $\eta > 0$
and U(C(t)) = ln(C(t)) for $\eta = 1$

The variable C(t) denotes consumption at time t, and η is the coefficient of relative risk aversion. The discount rate ρ is assumed to be strictly positive.

The government has access to international capital markets, and can borrow or lend at an interest rate r, which is exogenous and which depends on the level of the country's debt B(t) at time t. One part of the country's resources γR is exported abroad, and the rest (1-γ)R is sold on the domestic market.

The government's dynamic budget constraint is:

$$\dot{B}(t) = C(t) + r(B(t))B(t) + I(t) - Y(t) - \gamma pR(t) = r(B(t))B(t) + i(t) - \gamma pR(t) \qquad (5)$$

where p is the price of the natural resources sold aborad, and thus $\gamma pR(t)$ is the natural resources revenue received by the government from exports.

The government maximises its lifetime utility on an infinite horizon, subject to the capital accumulation equation (2), to the natural resources stock constraint equation (3) and the budget consraint equation (5).

The problem to be solved is thus:

$$max_{\{C,I,R\}} \int_0^\infty e^{-\rho t} U(C(t))\mathrm{d}t$$

s.t.

$$\dot{K}(t) = I(t) - \delta K(t)$$

$$\dot{S}(t) = -R(t)$$

$$\dot{B}(t) = C(t) + r(B(t))B(t) + I(t) - Y(t) - \gamma pR(t)$$

$$K(0) > 0, S(0) > 0$$

There are three state variables S(t), B(t), and K(t). Three control variables C(t), I(t) and R(t) to be chosen.

The current value Hamiltonian is :

H (C, R, I, λ_1, λ_2, λ_3, t) = U(C(t)) + $\lambda_1(t)(I(t) - \delta K(t))$ - $\lambda_2(t)R(t)$ + $\lambda_3(C(t) + r(B(t))B(t) + I(t) - Y(t) - \gamma p(t)R(t))$

The co-states $\lambda_1(t)$, $\lambda_2(t)$, $\lambda_3(t)$ represent respectively the shadow price of accumulated capital, of the resource stock and the shadow price of debt.

The optimality conditions are given by:

$$U'(C(t)) = -\lambda_3(t) \tag{6}$$

$$-\lambda_3(t)(F'_R + \gamma p) = \lambda_2(t) \tag{7}$$

$$-\lambda_3(t) = \lambda_1(t) \tag{8}$$

$$\dot{\lambda_1}(t) = \lambda_1(t)(\delta + \rho) + \lambda_3(t)F'_K \tag{9}$$

$$\dot{\lambda_2}(t) = \rho\lambda_2(t) \tag{10}$$

$$\dot{\lambda_3}(t) = \lambda_3(t)(\rho - r'(B(t))B(t) + r(B(t))) \tag{11}$$

At the optimum rate, the rate of return is the same at all points in time, being equal to the social discount rate (equation 10): $\frac{\dot{\lambda_2}(t)}{\lambda_2(t)} = \rho$

As the Hotelling rule goes, the shadow price of the resource in the ground, also called the scarcity rent, grows at the discount rate.

The transversality conditions are:

$$\lim_{t\to\infty} e^{-\rho t}\lambda_1(t)K(t) = 0$$

$$\lim_{t\to\infty} e^{-\rho t}\lambda_2(t)S(t) = 0$$

$$\lim_{t\to\infty} e^{-\rho t}\lambda_3(t)B(t) = 0$$

It is not possible to accumulate capital and debt indefinitely. As in the long run, the natural resource will be exhausted, the country cannot extract those resources indefinitely.

2.3 Model with a constant interest rate

The economy has unrestricted access to a perfect world capital market.

2.3.1 Model without technical progress

It is now assumed that the interest rate equals a constant r and that r $\leq \rho$ applies, because if not the economy would eventually accumulate enough assets to violate the small-country assumption that we made.

With an interest rate r constant, the government's dynamic budget constraint becomes:

$$\dot{B}(t) = C(t) + rB(t) + I(t) - Y(t) - \gamma p R(t) \tag{12}$$

The optimality conditions remain the same as in the general model, except for equation (11) that becomes:

$$\dot{\lambda_3}(t) = \lambda_3(t)(\rho - r) \tag{13}$$

Using (8) and (11) yields that the marginal productivity of capital is equal to the depreciation rate plus the interest rate:

$$F_K = \delta + r \tag{14}$$

Besides, using the production function and equation (14), the marginal productivity of capital can be reexpressed as:

$$F_K = \alpha(\frac{K}{(1-\gamma)R})^{\alpha-1} = \delta + r$$

It leads to a ratio capital natural resource $\frac{K}{(1-\gamma)R}$ which is constant, when the interest rate r is constant:

$$\frac{K}{(1-\gamma)R} = (\frac{\delta + r}{\alpha})^{\frac{1}{\alpha-1}}$$

From (9) and (11), the marginal productivity of natural resources depends on the price of those resources and on the interest rate:

$$F_R + \gamma p = -\frac{\lambda_2(0)}{\lambda_3(0)} e^{rt} \tag{15}$$

As one can note, there is an incompatibility between equation (15), which grows exponentially, and the marginal productivity of the natural resources derived from the production function, $F_R + \gamma p = (1-\alpha)(\frac{K}{(1-\gamma)R})^{\alpha} + \gamma p$, which is constant.

We have to distinguish two cases: - If the country does not export its natural resources, then $\gamma = 0$, the model does not work. Equation (15) becomes:

$$F_R = \ -\frac{\lambda_2(0)}{\lambda_3(0)} e^{rt},$$

which is not possible as F_R is constant.

- If the country exports its natural resources, equation (15) holds if and only if prices increase at a rate r. Therefore, prices can be reexpressed as:

$$p(t) = p(0)e^{rt}$$

Using equations (14) and (15) boils down to a new Solow-Stiglitz condition:

$$\frac{\dot{F_R} + \gamma \dot{p}}{F_R + \gamma p} = F_K - \delta = r \tag{16}$$

It is shown that along the optimal path, the growth rate of the marginal productivity of the natural resources plus the growth rate of the prices have to be equal to the interest rate.

Proposition: *The optimal rate of consumption is given by*

$$g_C = \frac{\dot{C}}{C} = \frac{r-\rho}{\eta}, \eta > 1 \tag{17}$$

If $\eta = 1$, $\frac{\dot{C}}{C} = r - \rho$

Proof: This is straightforward from equations (6) and (11), which give the Keynes-Ramsey rule.

As $r \leq \rho$, the rate of consumtion is negative, therefore consumption decreases asymptotically towards zero. This result confirms what has been shown in the literature extending the Ramsey model to an open economy with international borrowing, where consumption also tended to zero.

I shall see now what are the implications of a constant ratio capital natural resource on output.

Proposition: *The optimal path of output and stock of capital approach zero.*

Proof: As the natural resources are exhaustible, therefore the rate of extraction of those resources tends towards zero: $\lim_{t\to+\infty} R = 0$

Since the ratio $\frac{K}{R}$ is constant, this implies that the accumulation of capital also approaches zero

$$\lim_{t\to+\infty} K = 0$$

As K and R are falling to zero, therefore output also decreases towards zero:

$$\lim_{t\to+\infty} Y = 0$$

In other words, not just the growth rate but even the level of output will vanish.

In addition, from equation (2), the level of investment is also approaching zero:

$$\lim_{t \to +\infty} I = 0$$

Those no-output and no-growth results appear to be counterfactual. Especially, the fact that production also falls towards zero leads to an economy on the way to extinction.

Adding exhaustible natural resources to an open economy version of the Ramsey model leads thus to different results from those models with no natural resources, where the speed of convergence for capital and output is infinite.

A balanced growth path (BGP) is defined as a path along which the quantities Y, C and K change at constant proportionate rates. Let g_x denote the growth rate of the variable $x > 0$, that is $g_x = \frac{\dot{x}}{x}$.

Proposition: *Along a BGP,* $g_Y = g_K = g_I = g_C = g_R$

Proof: Let reexpress the production function in growth rate, such as $g_x = \frac{\dot{x}}{x}$:

$$Y = (\frac{K}{(1-\gamma)R})^{\alpha} R$$

Then,

$$g_Y = \alpha g_{\frac{K}{(1-\gamma)R}} + g_R$$

As the ratio $\frac{K}{(1-\gamma)R}$ is constant, its growth rate equals zero.

Therefore, $g_K = g_R$ and $g_Y = g_R$

Then, $g_Y = g_K = g_I = g_R = g_C = \frac{r-\rho}{\eta} \leq 0$, $\eta > 1$

Concerning the debt path, the budget constraint need to be considered:
$\dot{B}(t) = C(t) + rB(t) + I(t) - Y(t) - \gamma pR(t)$:

$$B(t) = b_1 e^{rt} + b_2 e^{\frac{r-\rho}{\eta}t} + b_3 e^{(\frac{r-\rho}{\eta}+r)t}$$

Solving this, with the transversality condition $\lim_{t\to\infty} e^{-\rho t}\lambda_3(t)B(t) = 0$ and the corresponding solution $\lambda_3(t) = \lambda_3(0)e^{(\rho-r)t}$ yields:

$$\lim_{t\to+\infty} \lambda_3(0)(b_1 e^{rt} + b_2 e^{\frac{r-\rho}{\eta}t} + b_3 e^{(\frac{r-\rho}{\eta}+r)t})e^{-rt} = 0$$

$$\lambda_3(0) \lim_{t\to+\infty} (b_1 + b_2 e^{(\frac{r-\rho}{\eta}-r)t} + b_3 e^{\frac{r-\rho}{\eta}t}) = 0$$

From the transversality condition, it is shown that $b_1 = 0$ and as r $\leq \rho$, $\lim_{t\to+\infty} B(t) = 0$.

This induces that

$$max g_B = \frac{r-\rho}{\eta}$$

In conclusion, in a small open economy with exhaustible natural resources when there is no technical progress and a constant interest rate, all the variables output, capital, consumption, natural resources, the level of debt grow at the same rate along the BGP and decline asymptotically towards zero.

Therefore, as in the literature of sustainable growth with natural resources, such as

Stiglitz (1974) or Dasgupta and Heal (1974), sustainability is not feasible without technical progress.

2.3.2 Model with technical progress

A resource-augmenting technical progress is now introduced in the model. This assumption can be supported by the fact that technological change can lead to the discovery of new natural resources (like the discovery of oil fields in Brazil), or allow the exploitation of resources previously thought not to be economically accessible (as offshore high pressure - high temperature wells for example). Different types of technical changes have been developed in the literature. Technical change can be seen as a gradual process, or like a major discovery. Dasgupta and Heal (1974) view it like a backstop technology that can appear at a discrete time. Endogenous technical change have also been introduced in the literature, especially by Grimaud and Rougé (2003), Lafforgue (2008). This paper focuses on an exogenous technical change, which can delay the depletion of natural resources but which is not a susbtitute to those resouces.

The new Cobb-Douglas production function is:

$$Y = K^{\alpha}(A(1-\gamma)R)^{1-\alpha}, 0 < \alpha < 1$$

with A the resource-saving technological change. A is growing at some constant exogenous rate $\tau > 0$, so that $A = e^{\tau t}$

Prices and the interest rate are assumed to be constant.

The optimality conditions are the same as in the benchmark model, except that this time the marginal productivity of capital and the marginal productivity of the resource can be rexpressed as:

$$F_K = \alpha(\frac{K}{A(1-\gamma)R})^{\alpha-1} \tag{18}$$

$$F_R = (1-\alpha)(\frac{K}{A(1-\gamma)R})^{\alpha} A \tag{19}$$

From equation (14), yields:

$$F_K = \delta + r$$

This implies that the ratio $\frac{K}{A(1-\gamma)R}$ is constant:

$$\frac{K}{A(1-\gamma)R} = (\frac{\delta + r}{\alpha})^{\frac{1}{\alpha-1}} \tag{20}$$

Moreover, the modified Solow-Stiglitz efficiency condition still holds:

$$\frac{F_R \dot{+} \gamma p}{F_R + \gamma p} = F_K - \delta = r$$

In other words, along the optimal path the interest has to be equal to the growth rate of the marginal productivity of the resource plus the government's revenue of exported resources.

Using this last efficiency condition and equation (23) yields:

$$\frac{\dot{F_R}}{F_R} = \alpha(\frac{\frac{\dot{K}}{A(1-\gamma)R}}{\frac{K}{A(1-\gamma)R}}) + \frac{\dot{A}}{A} \tag{21}$$

$$\frac{F_R \dot{+} \gamma p}{F_R + \gamma p} = \frac{(\alpha(\frac{\frac{\dot{K}}{A(1-\gamma)R}}{\frac{K}{A(1-\gamma)R}}) + \frac{\dot{A}}{A})F_R}{F_R + \gamma p}$$

As the ratio $\frac{K}{A(1-\gamma)R}$ is constant, therefore its growth rate $g_{\frac{K}{AR}} = \frac{\frac{\dot{K}}{A(1-\gamma)R}}{\frac{K}{A(1-\gamma)R}}$ is equal to zero. Equation (25) can thus be reexpressed as:

$$\frac{F_R \dot{+} \gamma p}{F_R + \gamma p} = \frac{\tau F_R}{(1-\alpha)(\frac{K}{A(1-\gamma)R})^{\alpha} A + \gamma p}$$

Proposition: *The optimal growth rate of consumption is given by:*

$$g_C = \frac{\dot{C}}{C} = \frac{r - \rho}{\eta}$$

Proof: This is straightforward from equations (6) and (11), which give the Keynes-Ramsey rule. Therefore, the consumption growth rate is negative, as $r \leq \rho$. Consumption cannot be sustainable in the long run.

This result is thus different from Stiglitz (1974), where thanks to techincal progress there is sustainability in a closed economy with exhaustible natural resources, if the ratio of the rate of technical change to population gowth rate is higher or equal than the share of natural resource in production.

Proposition: *Along a BGP,* $g_Y = g_K = g_I = g_C$ *and* $g_R < 0$

Proof:

$$g_{A(1-\gamma)R} = g_A + g_{(1-\gamma)R} = g_A$$

It is assumed that $g_R < 0$

As the ratio $\frac{K}{A(1-\gamma)R}$ is constant, by differenciating logarithmically:

$$g_{\frac{K}{A(1-\gamma)R}} = g_K - g_{A(1-\gamma)R} = 0$$

and $g_{A(1-\gamma)R} = g_A + g_{(1-\gamma)R} = g_A + g_R$, as γ constant

This implies that:

$$g_K = g_A + g_R$$

Furthermore, as $g_K = g_C$, we have: $g_R = g_C - g_A$

Then,

$$g_R = \frac{r - \rho}{\eta} - \tau$$

As $g_R < 0$, therefore $g_C = \frac{r-\rho}{\eta} < \tau$

Concerning the debt path, the budget constraint is considered, knowing that Y, I and R tend asymptotically towards zero, with constant prices:

$$B(t) = b_1 e^{rt} + b_2 e^{\frac{r-\rho}{\eta} t}$$

Solving this, with the transversality condition $\lim_{t \to \infty} e^{-\rho t} \lambda_3(t) B(t) = 0$ and the corresponding solution $\lambda_3(t) = \lambda_3(0) e^{(\rho - r)t}$ yields:

$$\lim_{t \to +\infty} \lambda_3(0)(b_1 e^{rt} + b_2 e^{\frac{r-\rho}{\eta} t}) e^{-rt} = 0$$

$$\lambda_3(0) \lim_{t \to +\infty} (b_1 + b_2 e^{(\frac{r-\rho}{\eta} - r)t}) = 0$$

From the transversality condition, it leads to $b_1 = 0$ and as r $\leq \rho$, then $\lim_{t \to +\infty} B(t) = 0$.

This implies that

$$\max g_B = \frac{r - \rho}{\eta} - r$$

In conclusion, in a small open economy with exhaustible natural resources when there is technical progress and a constant interest rate, all the variables output, capital, consumption, natural resources, level of debt decline towards zero. Moreover, along the BGP those variables do not grow at the same rate.

Surprisingly, technical progress cannot overcome resource scarcity, as the interest rate is exogenous and constant Therefore, contrary to Stiglitz (1974) positive growth rates for output and consumption cannot be sustained in the long run.

2.4 Model with a debt-elastic interest rate

The economy faces now limitations in its access to the world financial markets. It is indeed more realistic than a country that can borrow as much as it wants at a fixed rate.

2.4.1 Case with constant prices

The interest rate r(B) depends now on the level of debt. It is thus assumed that r(B) is increasing in the aggregate level of foreign debt.

Proposition: *The optimal level of debt decreases and output falls to zero in the long-run.*

Proof: Using the optimality conditions of the general model, especially equations (8), (9) and (11), the marginal productivity of the capital depends on the interest rate:

$$F_K = \delta + r'(B).B + r(B) \tag{22}$$

As $F_K = \alpha(\frac{K}{(1-\gamma)R})^{\alpha-1}$, we can find the ratio $\frac{K}{(1-\gamma)R}$:

$$\frac{K}{(1-\gamma)R} = (\frac{\delta + r'(B).B + r(B)}{\alpha})^{\frac{1}{\alpha-1}} \tag{23}$$

From equations (7), (10), (11) and (17), the marginal productivity of the natural resources is given by:

$$\frac{\dot{F_R + \gamma p}}{F_R + \gamma p} = F_K - \delta = r'(B).B + r(B) \tag{24}$$

This relation corresponds to the new Solow-Stiglitz efficiency condition in an open economy with a debt-elastic interest rate.

But F_R can be also written as: $F_R = (1-\alpha)(\frac{K}{(1-\gamma)R})^{\alpha}$

Therefore,

$$\frac{\dot{F_R}}{F_R} = \alpha(\frac{\frac{\dot{K}}{(1-\gamma)R}}{\frac{K}{(1-\gamma)R}})$$

Using (18), yields:

$$\frac{\dot{F_R + \gamma p}}{F_R + \gamma p} = \frac{1}{\alpha} * G(B).r'(B) * \dot{B}$$

with

$$G(B) = \alpha \frac{\frac{1}{\alpha - 1}(r'(B).B + r(B) + \delta)^{(}\frac{1}{\alpha-1} - 1)}{(r'(B).B + r(B) + \delta)^{(}\frac{1}{\alpha-1}) + \gamma p}$$

And thus with (20), it leads to a function of B, r(B), r'(B), $G(B) < 0$:

$$\frac{1}{\alpha} * G(B).r'(B) * \dot{B} = r'(B).B + r(B)$$

This condition can be reexpressed as the following autonomous differential equation:

$$\dot{B} = H(B)$$

with $H(B) = (r'(B).B + r(B)) * \frac{\alpha}{G(B) * r'(B)}$

As $B > 0$, $r(B) > 0$ and $r'(B) > 0$, and $G(B) < 0$, $H(B) = \dot{B}$ is thus negative.

Therefore, the optimal level of debt B is decreasing with time. This is quite a paradoxical result, as the economic policy recommanded here is to pay off its debt from the beginning and thus not to take any risks.

As in the literature it is more common to use an exponential interest rate, this last formulation will be used to see if the result is still robust.

I refer to Schmitt-Grohe and Uribe (2003) debt-elastic interest-rate premium. It can be expressed as:

$$r(B) = r^* + \psi(e^{B-D} - 1),$$

where $\psi(e^{B-D} - 1)$ is the country-specific interest rate premium, r^* is the world interest rate, D is the steady-state level of foreign debt. r^*, D and ψ are constant and positive parameters. Therefore, when the level of debt reaches its steady-state, ie B = D, it implies that the interest rate equals the international interest rate: $r(B) = r^*$

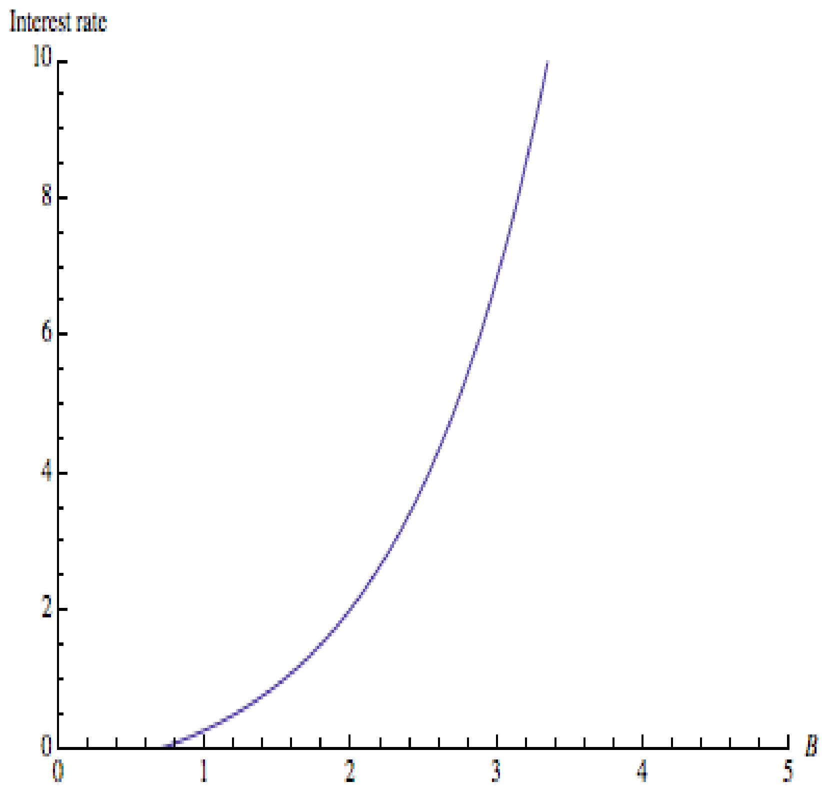
Proposition: *When the interest rate is exponential, the optimal level of debt decreases and output falls to zero in the long-run.*

Proof: The formulation of the interest rate implies $r(B) > 0$ and $r'(B) = \psi e^{B-D} > 0$. G(B) is still negative, thus $\dot{B} < 0$. Debt is thus still decreasing with time.

As the level of debt is falling to zero, the ratio $\frac{K}{(1-\gamma)R}$ also approaches asymptotically a constant:

$$\frac{K}{(1-\gamma)R} = (\frac{\psi e^{B-D}.B + r^* + \psi(e^{B-D} - 1) + \delta}{\alpha})^{\frac{1}{\alpha - 1}}$$

Figure 2.3: Exponential interest rate r(B) in function of the level of debt



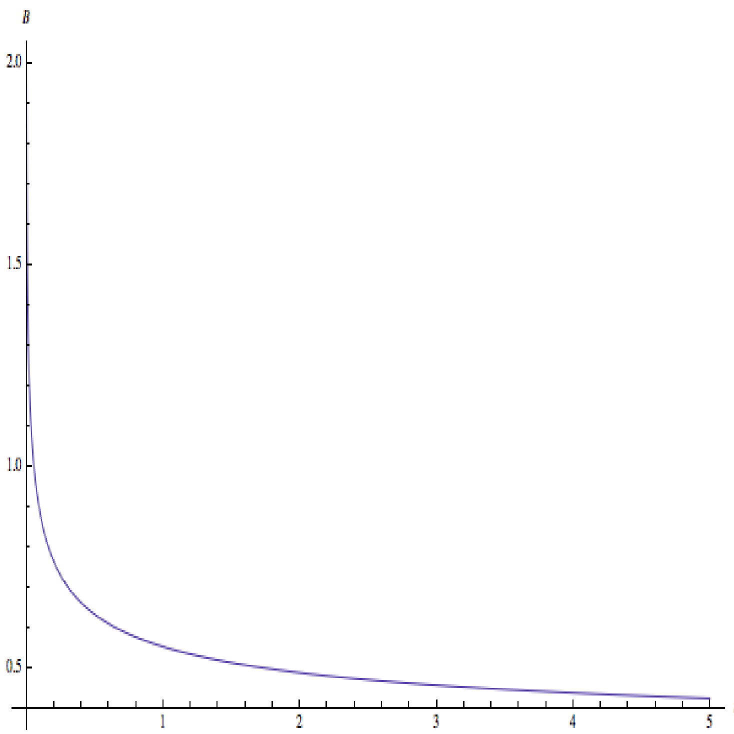
A numerical example is provided to illustrate the debt pattern in function of time when the interest rate is exponential (Figure 2.4). More precisely, I set $\alpha = 0,32$, $\delta = 0,1$, $p = 1$, $\gamma = 0,5$, $r* = 0,04$, $D = 0,7442$ and $\psi = 0,8$, and plot the optimal debt path in function of time.

In fact, despite the form of interest rate chosen, the level of debt B is still decreasing towards zero and the ratio $\frac{K}{(1-\gamma)R}$ tends asymptotically towards a constant.

I thus find the same counterfactual results from the benchmark model with a constant

Figure 2.4: Debt path in function of time

With an exponential interest rate r(B)



interest rate r concerning the accumulation of capital, the level of investment, and output that decrease asymptotically towards zero.

Proposition: *The optimal rate of consumption is given by:*

$$\frac{\dot{C}}{C} = \frac{F_K - \delta - \rho}{\eta} = \frac{r'(B).B + r(B) - \rho}{\eta}, \eta > 1 \tag{25}$$

Proof: This is straightforward from equations (6) and (11). Consumption accumulates at a rate equal to the difference between the net marginal product of capital $F_K - \delta$ and the discount rate ρ.

Nevertheless this time the consumption growth rate g_C is depending on the level of debt B_t, contrary to the benchmark model.

In fact during the transitional dynamics, the consumption growth rate is first positive: $g_C \geq 0$ when $r'(B).B + r(B) \geq \rho$

In the long-run, as the level of debt B tends asymptotically towards zero, this growth rate becomes negative, thus $g_C \leq 0$, and consumption decreases.

To illustrate the consumption growth rate in function of time when the interest rate is exponential (Figure 2.5), I set $\alpha = 0,32$, $\delta = 0,1$, $p = 1$, $\gamma = 0,5$, $r* = 0,04$, $D = 0,7442$ and $\psi = 0,8$.

It can be seen that the consumption growth rate is first positive, and then declines in the long-run. Therefore, when the interest rate is endogenized, consumption can grow for a while before decreasing.

2.4.2 Case with increasing prices

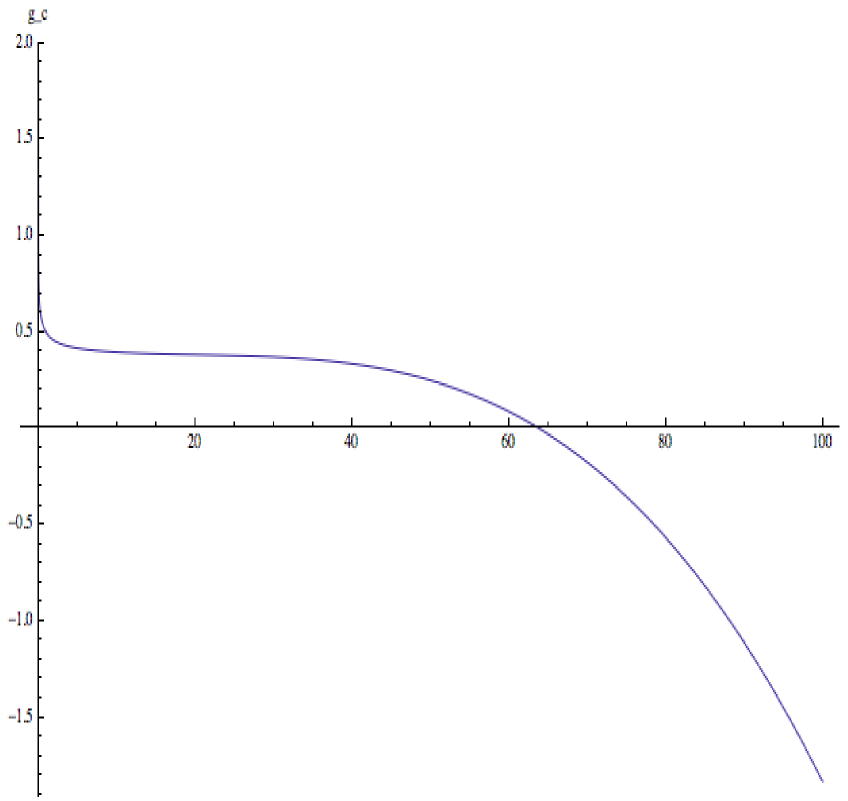
From now on, prices have been taken as constant. They are now assumed to increase at a rate θ, with: $p(t) = p(0)e^{\theta t}$. The idea is to see if increasing prices, like in 2002-2008 where the oil price went from 20$ to 140$, can help have a sustainable growth.

The equation (20) becomes:

$$\frac{\dot{F_R} + \gamma \dot{p}}{F_R + \gamma p} = \frac{G(B).r'(B) * \dot{B} + \gamma \dot{p}}{\alpha}$$

Figure 2.5: Consumption growth rate in function of time

With an exponential interest rate r(B)



$$\frac{G(B).r'(B) * \dot{B} + \gamma \dot{p}}{\alpha} = r'(B).B + r(B)$$

This condition can be reexpressed as the following non autonomous differential equation, as p depends now on time:

$$\dot{B} = H_2(B)$$

with $H_2(B) = \frac{\alpha(r'(B).B+r(B))-\gamma\dot{p}}{G(B)*r'(B)}$

As it is known from below $r(B) > 0$, $r'(B) > 0$, and $G(B) < 0$.

Moreover, $\gamma > 0$ and $\dot{p} > 0$. Therefore, when $\alpha(r'(B).B + r(B)) < \gamma\dot{p}$, then $\dot{B} > 0$. Let us apply this condition in the case where B(0) takes the value of zero and when the interest rate is exponential, this condition becomes: $\alpha(r^* + \psi(e^{-D} - 1)) < \gamma \dot{p(0)}$. As p(0) is assumed to be equal to one, then $\dot{p(0)} = \theta$. This inequality is thus verified when $\psi(e^{-D} - 1) < \frac{\gamma\theta}{\alpha} - r^*$. In that case, the country increases its level of debt. In the short-run, it is interesting to see that as debt is growing, consumption grows.

But when $\alpha(r'(B).B + r(B)) > \gamma\dot{p}$, then $H_2(B) = \dot{B} < 0$, the optimal level of debt is still decreasing, even though prices are increasing. Indeed when B(0) takes the value of zero and when the interest rate is exponential, this condition becomes: $\psi(e^{-D} - 1) > \frac{\gamma\theta}{\alpha} - r^*$. This means that even in a period of relative prosperity, when the price of the natural resource is increasing, thus when the country earns more money then it used to do, the government ought to pay off its debt in priority. In the long-run, it confirms the results from the case with a debt-elastic interest rate and constant prices, which is quite similar to what was found in the benchmark model, where consumption declines.

2.5 Conclusion

This paper has developed an exogenous optimal growth model of a resource-rich open economy, where natural resources are essential for production and non-renewable.

The main finding is that sustainability is not feasible when the interest rate is constant, even if there is technical progress, but when the economy faces a debt-elastic interest rate, consumption can grow for a while before decreasing in the long-run.

First, it was shown that when the interest rate is assumed constant, this economy is faced to decreasing consumption and production. This leads to some counterfactual no-growth results, as all the variables approach asymptotically zero and grow at the same rate on a balanced growth path. When technical progress is added, results are quite similar to this first case except that natural resources and output, consumption do no longer grow at the same rate. Contrary to Stiglitz (1974), resource augmenting technical progress does not overcome resource scarcity. In the literature extending Ramsey models to an open economy, borrowing constraints with a collateral or adjustment costs are usually added in order to found less paradoxical results, but my approach is different. I introduce an interest rate that increases in the aggregate level of debt. It is a more realistic assumption, as countries usually face a risk premium. Second, when the interest rate is endogenized, the optimal level of debt asymptotically declines, and so do the output, capital and investment. Therefore, the country ought to reduce its debt. Nevertheless, the growth rate of consumption is positive during the transitional dynamics before declining.

This paper can be considered as a contribution to the optimal growth models with exhaustible natural resources, that focused mainly on closed economies. One way to extend this paper would be to optimize the model according to γ the share of the country's natural resources exported abroad. Another extension would be to introduce a constraint on international credit, where natural resources could be used as collateral.

3 Chapter two

Oil and Gas, which is the Belle of the Ball ?

The Impact of Oil and Gas Reserves on Sovereign Risk

3.1 Introduction

Many oil countries use their oil reserves in order to borrow on international financial markets. Oil is usually seen by credit rating agencies as a good collateral, as they view it as a liquid asset and its stock is more or less known. This practice, called asset-backed securitization of future-flow receivables, flourished after the Mexican crisis in 1994-95, especially in Latin Americas countries such as Mexico, Brazil, Argentina, Venezuela. For Ketkar and Ratha (2001), "Nearly one-half of the dollar amounts raised via future flow transactions are backed by oil and gas export receivables." Nevertheless, this financial method has some drawbacks. For example, the presence of proven oil reserves gave Nigeria a credit-rating far higher than its macroeconomic fundamentals would have otherwise justified, and the country had to struggle with a huge debt for years. For most of emerging oil economies, which are usually not very diversified, the current deep drop of oil prices represents a dramatic fall of oil revenues. Therefore, the issue of debt overhang can become even more critical, and the risk of a sovereign default could be looming. It could be the case of Venezuela, which is currently strangled by its debt, or Russia that fears a deep recession. This risk can be represented by sovereign bond spreads, that abruptly rise when financial markets fear a sovereign default. Despite the prevalence of the practice, economists have not studied its impact on borrowing costs.

This article fills this gap and examines the effects of oil and gas reserves on sovereign spreads and investigates whether those reserves alleviate the borrowing constraint of emerging oil and gas exporting countries. According to the U.S Energy Information Administration, oil and gas proved reserves are defined as "quantities of oil and gas, which, by analysis of geoscience and engineering data, can be estimated with reasonable certainty to be economically producible from a given date forward, from known reservoirs, and under existing economic conditions, operating methods, and government regulations." This analysis is at the crossroads of two literatures, international finance and resource economics. First, it contributes to a literature on the macroeconomic impacts of oil and gas. The international finance literature mainly focuses on international finance issues in oil importing developped economies (usually the United States and European economies) or in emerging countries. Some papers have brought to the fore the determinants of sovereign spreads in emerging countries. For example, Hilscher and Nosbusch (2010) investigate the effects of macroeconomic fundamentals on emerging market sovereign credit spreads. Akitoby and Stratmann (2008) study the impact of fiscal policy on sovereign risk spreads, and the relation between political institutions and fiscal indicators. They show that the composition of fiscal policy matters. Indeed, revenue-based adjustments lower spreads more than spending-based adjustments, and cuts in current spending decrease spreads more than cuts in investment. There is a more recent literature on international finance and natural resource. Kretzmann and Nooruddin (2005) examine the relationship between oil and debt and find that increasing oil production is associated with increasing debt. Van der Ploeg and Venables (2010) study optimal policies for resource-rich developing countries, which often face high domestic interest rate. They provide empirical evidence on the interest rate those economies have to pay, and find that the ratio of resource exports to GDP is not statistically significant. Van den Bremer, van der Ploeg, and Wills (2016) examine how commodity exporters can coordinate the management of two types of national assets under uncertainty: the asset in the ground (the natural resource) and the sovereign fund above it. They show that the rate of oil extraction should be faster than the one provided by the Hotelling rule if oil prices are pro-cyclical, which would generate a risk premium on oil wealth. Moreover, some authors have empazised the role of the oil price in the risk of default. Sharma and Thuraisamy (2013) find that oil price uncertainty predicts the change in Credit Deafult Swaps (CDS) spreads of some Asian countries. Alexandre and Benoist (2011) show that oil prices influence the government bond risk premium, and that an increase in oil prices is expected to decrease the CDS spreads of emerging markets. Nonetheless, this sovereign risk literature usually limits its analysis to macroeconomic and financial variables, at the local and global level, but does not take into account geological variables. Therefore, this article contributes to the empirical literature by introducing oil and gas reserves as determinants of sovereign default risk, by studying a panel of emerging oil and gas exporting countries between 1994 and 2014. The other contribution is to study different natural resources, like gas, and not just examine oil itself as many articles do. The second type of literature emphazises on the relationship between natural resource wealth and institutional quality. A negative correlation between natural resources and the level of democracy in Africa has been brought to the fore by Jensen and Wantchekon (2004). Tsui (2011), as well as Arezki and Bruckner (2012) have confirmed those results. Moreover, many articles find that oil production often leads to civil war (Collier and Hoeffler, 2002, Ross, 2006) and more corruption (Bhattacharyya and Hodler, 2009). Nonetheless, a more recent literature casts a doubt on this negative relationship between natural resource endowment and better institutions. Alexeev and Conrad (2009) provide strong support that there is no clear evidence that natural resources have an impact on democracy. Tsui and Cotet (2010) control for country fixed effects and show that the relationship between democracy and oil vanish. Haber and Menaldo (2011), who use historical data from 1800 to 2006, even find a positive impact of natural resource on democracy, by addressing the issue of omitted variable bias, contrary to studies that face this risk of bias by comparing resource-rich and resource-poor countries. Some institutional variables are thus introduced in this analysis, such as corruption, political stability, democracy, in order to investigate whether the interaction between oil, gas reserves and institutional quality can affect spreads.

The main results of this study is that there is no clear evidence that institutional quality plays a key role in alleviating the credit constraint and decreasing spreads, when controlling for country and time fixed effects. Indeed, the negative relationship between sovereign spreads and the interaction between oil reserves and institutional quality, ie financial markets give a premium to oil reserves in countries stable politically and not corrupt, is not significant. Moreover, financial markets seem to view differently oil reserves and gas reserves, as gas reserves tend to decrease borrowing costs, even when no institutional variables are taken into account.

The paper is organized as follows. Section 2 presents some stylized facts and the theoretical background. Section 3 discusses the econometric framework. Section 4 reports the empirical findings.

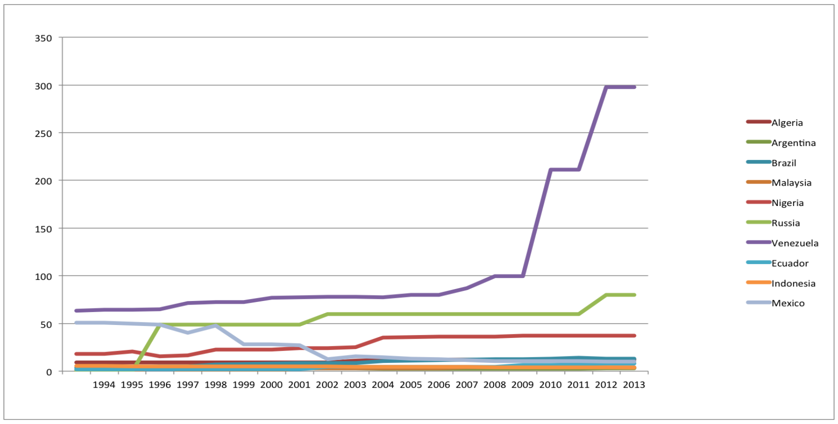
3.2 Sovereign bonds in emerging oil and gas countries

3.2.1 Sovereign bonds and giant discoveries in emerging oil and gas countries

Among recent defaults by Mexico (1982), Russia (1998), Ecuador (1999) and Argentina (2001, 2014), and the current debt crises of Greece, it is worth to underline that many of them are oil and gas exporting countries. Surprisingly, their level of debt was not that high. In fact, Mexico's 1982 debt crisis occurred at a ratio of debt to GNP of 47 percent, and Argentinas 2001 crisis at a ratio slightly above 50 percent. Thus, oil and gas reserves do not seem to prevent from sovereign risk, but it will be interesting to see how those reserves can in fact be viewed by financial markets, when oil and gaz exporting countries tap international markets.

Oil reserves evolve during time, as it can been seen on Figure 3.6. If Venezuela's reserves have risen quite shraply during the last twenty years, they have increased at a much lower pace for Nigeria and Russia. For some oil exporting countries, as Mexico or Indonesia, they have even decreased.

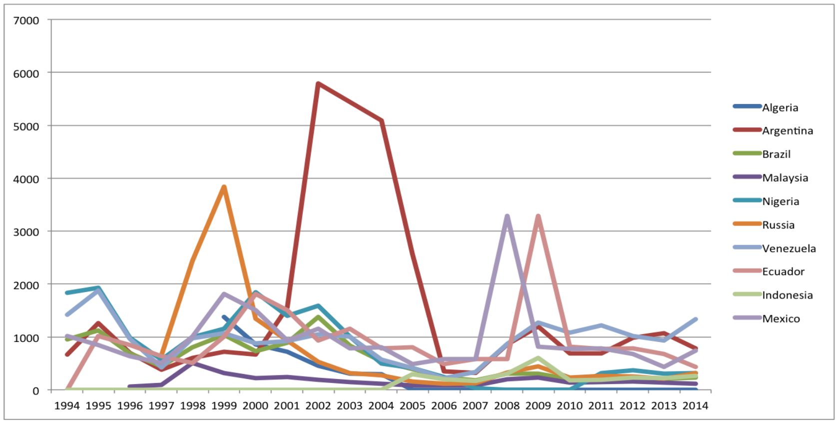
Figure 3.6: Oil reserves in billion barrels from 1994 to 2014



Those oil exporting countries have used their oil and gas reserves as a collateral to borrow money, especially under bilateral loan contracts with China for example. Those last years, they have tried to diversify their means of funding. In that sense, more and more emerging countries issue their debt on global markets, even though it is still a recent phenomenon, that rose sharply in the 1990s. Spreads, defined here as the difference between the yield on a country's bond issue and the yield on a comparable bond issued by the United States, represent the borrowing costs of a country. They depend on macroeconomic determinants but also on the market sentiment (Eichengreen and Mody, 1998). Figure 3.7 shows that after a major event spreads can dramatically increase, like the Russian spread after its default in 1998 or the Argentinian spread that reached 5000 basis points after the country's 2001 default.

If an event analysis is made country by country, it is interesting to see that sovereign spread in emerging oil and gas countries seem to be affected by events occuring in the oil and gas industry, such as the announcement of an oil field discovery. Indeed, according to Arezki, Ramey and Sheng (2014) giant oil discoveries, seen as news shocks, can have a significant impact on the current account, especially on saving and investment. To understand the impact of those event on the borrowing costs of countries issuing debt on international capital markets, the dataset on giant oil and gas discoveries by Mike Horn has been used.

Figure 3.7: Sovereign spreads in basis points from 1994 to 2014



The data contain information on the main discoveries made by countries, the year of the discovery, the field names and the volume of oil and gas discovered that can be ultimately recovered in million barrel of oil equivalent. Taking the case of Venezuela, its sovereign spread is systematically decreasing the following year of an oil or gas giant discovery, as it happened in 1999, 2002 and 2009. In 2007, the spread inceases sharply, which could be explained by the financial crisis, but maybe also by the fact that some private oil fields were nationalised by the president H. Chavez that same year. Concerning Russia, spreads are also decreasing the following year of a giant discovery in 2000, 2004 and 2005, but not in 2007, 2008 which is probably due to the financial crisis. Nevertheless, for countries who discovered many oil fields, like Brazil which made 14 giant discoveries during the period 1996-2012, not only the event of a giant discovery seems to be critical, but also the size of the discovery seems to matter. Indeed, when the volume discovered were relatively small (around 650-700 million barrels of oil equivalent in 1998 and 1999), the spread tends to increase, whereas when the country faces a supergiant oil discovery like in 2011, with the oil field Libra that represents 13500 million barrels of oil equivalent, the spreads declines until 2012. The economic intuition is that those discoveries tend to increase quite significantly oil and gas reserves, and so its net wealth. Those reserves should thus lower the country's borrowing costs and allow it to borrow more. But this correlation is not clear for all countries, as for example in Nigeria.

To complete this event analysis, panel data on emerging oil and gas countries have been used to see if empirically the date of the discovery has an impact on the sovereign spread. By examining the press releases of national or international oil companies, I used the month of the discovery. Nevertheless, the exact day was not always available for all the oil and gas fields disovered, so monthly data were used for the following regression. A dummy variable equals one when a discovery is made during the time period December 1993 to February 2015. Table 3.1 shows that it is not the fact of doing a giant discovery (more than 500 million barrels of oil equivalent) which is the most important for investors, but the volume of oil or gas discoverd. The volume of oil or gas discovered has a significant and negative impact on the sovereign spread. Indeed, the bigger is the volume of the discovery made, the more it will represent future wealth for the country, and thus decreases its borrowing costs. As usually offshore discoveries induce higher drilling costs, it is more expensive to extract oil at high temperature and high pressure, but the effect of doing an offshore discovery is not statistically significant in Table 3.1.

As many macroeconomic determinants play a key role in the evolution of sovereign spreads, control variables will have to be taken into account while examining the impact of those oil and gas reserves on sovereign spreads

3.2.2 Theoretical background

The framework refers to Edwards' model (1984, 1986). It is assumed that lenders are risk-neutral. The equilibrium condition is:

$$(1 - r^*) = pB + (1 - p)(1 + r)$$

with r^* the world interest rate, p the probability of default, r the lending rate and B the debt-output ratio.

From this condition, the country's risk represented by the spread s is given by:

Table 3.1 Effect of Giant Oil and Gas Discoveries on Spreads

Oil or gas discovery	0.0779
	(0.197)
Volume of oil or gas discovered	-0.0001**
	(0.000)
Offshore discovery	0.1462
	(0.354)
Constant	5.7434***
	(0.397)
Observations	2017
R^2	0.160

Standard errors are in parentheses.
***, **, * indicate statistical significance at the 1%, 5% and 10% level.
Countries included in the sample are: Algeria, Argentina, Ecuador, Brazil, Indonesia, Malaysia, Mexico, Nigeria, and Venezuela.
The volume discovered is in million barrels of oil equivalent.
The time period is December 1993 to February 2015 (monthly data).
Month and country fixed effects are included.

$$s = \frac{p(1 + r^* - B)}{1 - p}$$

Following the literature on sovereign risk theory, the probability of default can be expressed as:

$$p = \frac{exp(\sum_{i=1}^{n} \psi_i W_i)}{1 + exp(\sum_{i=1}^{n} \psi_i W_i)}$$

with W_i the determinants of the probability of default, that can be macroeconomic variables, like the foreign exchange reserves to output ratio.

By using the previous equations, and transforming it with a logarithmic function, it leads to:

$$log(s) = log(1 + r^*) + \sum_{i=1}^{n} \psi_i W_i$$

When some time and fixed effects are added, the estimation of the model is given by:

$$log(s_{it}) = \alpha_i + \psi W_{it} + \mu_t + \epsilon_{it}$$

with ϵ_{it} the random disturbance.

3.3 The empirical specification

3.3.1 The variables

As there are many macroeconomic determinants of spreads in the literature, we took the same control variables as Akitoby and Stratmann (2008), which are the variables the more widely used in the literature: the ratio of external debt to Growth National Income (GNI), the history of default, the regional spread index, the ratio of foreign exchange reserves to Growth Domestic Product (GDP), inflation (Consumer Price Index), and the output gap. External debt is a fundamental determinant of sovereign spread, and it is expected to have a positive sign. The history of default is a dummy variable, which reveals if the country is in default or not for the year studied. As Reinhart and Rogoff (2009) emphazise, Venezuela can be seen as a "modern-day sovereign default champion" as it has defaulted 10 times since 1830. The regional spread index gives a good idea of the risk of contagion in the region, as usually those countries have tight ties with their commercial neighbours. For example, the Argentinian 2001 crisis had an impact on the Brazilian economy. Foreign exchange reserves is also a major determinant of spreads, as is represents the capacity of a country to pay back its debt, it should have a negative sign and thus lower spreads. Oil and gas countries usually accumulate huge amounts of foreign reserves. Inflation reveals the macroeconomic stability of the economy, so if inflation is low it shoud be positively vewed by financial markets. Output gap gives more information than the economic growth, as it takes into account potential growth.

Oil and gas reserves, which are considered as stocks and represent natural resource wealth, are added to those variables. This analysis is aware of the risk of measurement error coming from the use of those reserves, as the literature has highlighted it. Production and exports variables, which are seen as flows, are also taken into account.

3.3.2 Testing the impact of oil and gas reserves on spreads

The following formulation is used for the baseline model:

$$Logspread = \alpha_i + \delta debt_{it} + \sum \beta' C_{it} + \gamma_1 OilReserve_{it} + \gamma_2 GasReserve_{it} + \mu_t + \epsilon_{it} \quad (26)$$

where $debt_{it}$ is the ratio of external debt to Gross National Income, C_{it} is a vector of control variables, $OilReserve_{it}$ is the proved oil reserves, $GasReserve_{it}$ the proved gas reserves, α_i a country fixed effect, μ_t the time fixed effect and ϵ_{it} are the error terms. I used as control variables the history of default, the regional spread index, the ratio of foreign exchange reserves to GDP, inflation, and the output gap.

3.3.3 Testing the interactions between oil and gas reserves and institutional quality

The specification for testing the interactions between oil and gas reserves and institutional variables is:

$$Logspread = \alpha_i + \delta debt_{it} + \sum \beta' C_{it} + \sum \gamma' R_{it} + \lambda Instit_{it} + \sum \phi(R_{it} Instit_{it}) + \mu_t + \epsilon_{it} \quad (27)$$

where $Instit_{it}$ represents institutional variables, such as the level of corruption, political stability, democracy; R_{it} stands for oil and gas reserves, $R_{it} Instit_{it}$ is the interaction between oil and gas reserves and those institutional variables.

3.4 Data and Results

3.4.1 Data description

The analysis is based upon data recorded at an annual frequency, over the 1994 - 2014 period, in ten emerging oil exporting countries: Algeria, Nigeria, Argentina, Brazil, Ecuador, Mexico, Venezuela, Indonesia, Malaysia and Russia. This study is limited to a small sample, as only oil and gas emerging countries that issue debt on financial markets are taken into account in the analysis. Therefore, oil and gas exporting countries like Saudi Arabia or Qatar are not part of the sample, as they do not tap international markets (those countries display thus no data on sovereign spreads). They usually have critical level of foreign exchange reserves or refer to domestic credit in order to finance their fiscal needs. With the recent fall of oil prices, some of them might have to use more and more the option of foreign borrowing, as Saudi Arabia has announced it. Moreover, other oil producing countries that do not have the macroeconomic determinants to access international markets, and thus the credit rating, as it is the case of the Republic of Congo (Brazzaville) or Equatorial Guinea, are also not included in the sample.

The dependent variable is the annual mean spread, which is obtained from the JP Morgan Emerging Markets Bond Index Global (EMBI Global). This index includes U.S. dollar denominated Brady bonds, Eurobonds, traded loans, and local market debt instruments issued by sovereign and quasi-sovereign entities. It considers only emerging markets issues over US dollar 500 million and with a maturity of at least two years and a half. The measures of financial variables are extracted from the Datastream. The data avaibility for this index starts only in 1994, which explains the time period.

Macroeconomic variables are obtained from the World Bank indicator and the International Monetary Fund. Institutional variables are from the World Bank Governance Index.

Oil and gas reserves are expressed in million barrels of oil equivalent and come from the US Energy Information Agency (EIA). Oil reserves are crude oil proved reserves, and gas reserves are natural gas proved reserves. The oil price is represented by the West Texas Intermediate (WTI) and expressed in dollars. The gas price is from a natural gas futures contract in dollars per million British thermal units (Btu).

3.4.2 Impact on spreads

As shown in Table 3.3, some of the control variables, as the debt to GNI ratio, regional spread, the foreign exchange reserves to GDP ratio, are all significant and have the expected sign. The ratio of the foreign exchange reserves to GDP is negative, as it enables a country to service its debt and thus decreases the risk of default. The coefficients of the debt to GNI ratio, regional spread, and the history of default are on the contrary positive. Nevertheless, the output gap and inflation are not significant.

Oil reserves and gas reserves are significant, but have opposite signs. Oil variables tend to increase spreads, therefore financial markets penalize oil countries, whereas gas reserves tend to decrease spreads, as if markets give a premium to countries detaining gas. Those results could be explained by the fact that the gas exporting countries in the sample (especially Algeria, Russia) are "leaders" on gas markets, representing more guarantee for the buyers, compared to the oil exporting countries, which have less market shares on the global oil market. Oil can also be seen as more volatile, sold on spot markets, at short-term and at a global price. Volatility hampers economic growth, and a sudden fall of oil price can stop confortable revenues and jeopardize public investments. On the contrary, gas is traded in the form of long-term supply contracts, and often through bilateral relations, which ensure the producing country a steady flow of revenues. It also secures the high capital investment necessary to develop and transport gas. For financial markets, gas reserves would thus mean more stability. Moreover, oil can also be perceived as an energy of the past, becoming less popular than gas, which tends to pollute less (by reducing the emission of CO2) and could represent a bridge to a renewable energy future.

The impact of oil exports, oil production, gas exports, gas production on spreads were also tested, but they all appear to be not significant. As they are flows, high natural resource production and export represent current wealth. But those current revenues could vanish rapidly if the country has no natural resource reserves, which embody future wealth. This could explain why they are not taken into account by financial markets. Oil and gas rents were also used as explanatory variables. Expressed as a ratio of the GDP, those rents come from the World Banks Adjusted Saving Project, defined as the difference between the value of crude oil/gas production at world prices and total costs of production. As for production and export variables, they were insignificant. A country with important oil and gas rents, but with no major oil and gas reserves is bound to see its revenues decrease (especially for not diversified economies), and thus face more difficulty to pay its debt in the future. Therefore, financial markets value more the future, represented by the oil and gas reserves, than the present.

3.4.3 Interactions between oil and gas variables and institutional quality

The introduction of institutional variables in the model is justified by the literature on oil and institutions. Studies on natural resource and conflict show that natural resources are associated with social tensions (Auty and Gelb, 2001). When an interaction between oil and gas reserves is introduced with political stability, Table 3.4 shows that the impact of those reserves on spreads differ whether the country is affected by conflicts or not. The political stability index scores from -2,5 when the country is plagued by violent activities to 2,5 when it is stable. The coefficient of oil reserves remains significant, with the same sign. When the country is politically stable, spreads decrease, but if the country is plagued by unstability and tensions, then borrowing costs increase. On the contrary, the estimate of the interaction term between gas reserves and political stability is positive and significant. Political stability does not seem to relax the credit constraint for countries with gas reserves.

Moreover, oil extraction is usually associated with more corruption (Bhattacharyya and Hodler, 2009). I thus added in the regression a variable standing for corruption, measured by the Transparency International Corruption Perception Index, that scores between 1 for high corruption and 10 for not corrupt countries. I kept the same control variables, to see the impact of the interaction between oil reserves and corruption, with the level of corruption itself, on spread. The coefficient of oil reserves continues to be significant and positive. The estimate of the interaction term between oil reserves and corruption is negative. The less a country is corrupted, the more the spread decreases. Therefore, when oil reserves increase, the borrowing costs of countries plagued by sleaze increase, whereas they lower for not corrupt countries. The coefficient of the interaction term is nevertheless not significant with time fixed-effects. Concerning gas reserves, the coefficient is still negative and significant.

As democracy and oil wealth are usually linked (Tsui, 2011, Arezki and Bruckner, 2012), a political score standing for democracy was added to examine the impact of an interaction between democracy and oil, gas reserves, but the coefficient appear not to be significant. The more the country is democratic, the more the borrowing costs of the country decreases. The coefficients on the levels of the political institution variables are not reported as none of them are significant. With time fixed-effects, they might not be estimated precisely, due to the low variations in the scores of those variables. The occurence of legislative and executive elections did not change the results.

Interactions with government effectiveness, rule of law, regulatory quality (that come from the Worldwide Governance Indicators project supported by the World Bank) and political, civil rights (that are from Freedom of House) were also examined. For most of those variables, the estimates are insignificant and thus not reported. It is interesting though to highlight that regulatory quality has a significant impact on spreads, but oil and gas reserves are no longer significant.

3.5 Robustness checks

Different sensitivity checks were performed. A range of econometric methods was used and the results were still significant with Ordinary Least Squares (OLS) and random effects. The use of different estimators (such as a least squares dummy variable (LSDV) estimator, a within estimator and a first difference estimator) also confirms our results. A dynamic model was used, with some lagged variables. The impact of the lagged value of the dependent variable was significant at the 1 percent level. The results were still significant when a Generalized Method of Moments (GMM) estimation was used. I also checked for stationarity with the Augmented Dickey Fuller (ADF) test. All the variables were stationary, except oil price, so the first difference of oil price was used. As the sample size and the time period are quite small, the estimators may not be completely precise. A bootstap analysis could thus complete the robustness checks.

The issue of the endogeneity of oil and gas reserves can be discussed, as one can argue that discoveries depend on the cost of drilling and the demand for natural resources. If the literature on natural resources tend to consider resource endowments as exogenous, the recent study by Arezki, van der Ploeg, Toscani (2016) questions this commonly held view, as they show that countries discover more natural resources after the adoption of market-based institutions.

The occurence of a currency crisis did not affect the results. Alternative measures of solvency were used, which gave similar results. When controlling for regional effects, the fact of being part of the region MENA increases the impact of gas reserves on sovereign spreads, and the effect is significant. I also tested the impact of global risk factors, like the VIX. This estimate is higly statistically significant, and the results on the oil and gas variables still hold. Moreover, removing large producers of both oil and gas from the sample, like Algeria or Russia, increases the impact of oil and gas reserves on sovereign spreads. Their estimates remain significant and keep the same sign. When controlling for the existence of a sovereign wealth fund, the effect of oil and gas reserves on sovereign spreads are still significant. The results still hold as well when I control for the impact of a nationalisation in the oil and gas sector (which represents a form of expropriation of a private firm by the local government), as it happened in 2000 in Russia, 2007 in Venezuela and 2012 in Argentina with Repsol.

3.6 Conclusion

In this paper, the impact of oil and gas variables on sovereign spreads is examined, using annual panel data in emerging oil ans gas exporting countries. It is shown that institutional quality does not seem to play a key role in alleviating the borrowing constraint of those countries. The fact that oil reserves tighten the credit constraint when the country is plagued by vested interests and political turmoil, by increasing spreads, is not statistically significant. The evidence suggests that financial markets tend to view differently oil and gas. Indeed, I find that financial markets give a premium to gas reserves, that lower spreads, and penalize on the contrary oil reserves, that increase them. One interpretation could be that gas tends to ensure constant revenues thanks to its long-term supply contracts, usually through bilateral relations, at a regional level. On the contrary, oil is much more exposed to volatility as it is traded at short-term on spots markets at a global level.

Those results suggest policy implications for those economies. First, promoting efficiency in the use of oil rents could help oil and gas exporting countries to decrease their borrowing costs. Second, establishing a fiscal rule for natural resources could help stabilize volatile revenues, and enhance fiscal sustainability, and thus relax their credit constraint. Moreover, reducing gas flaring could also be beneficial. Indeed, those countries usually burn off the gas that is produced along with oil, as gas is much more costly in terms of infrastructures and transport than oil. Taking actions to end flaring would reduce their CO2 emissions and represent a good opportunity to trade their gas, even though it is a costly investment. It would nevertheless be worth it, as they could secure other source of revenues through long-term supply contracts.

As future work concerning the methodology, a bootstrap technique should help overcome the small size of the sample. In order to reduce measurement error, an option could be to control for oil and gas quality. Further research could include data on the decision to invest in production projects, confirming if the oil discoveries are profitable and synonymous of future wealth. It would also be interesting to see if the refinery capacity of those oil and gas countries can play a role, as some major oil producers and exporters of crude oil have to import refined petroleum, because of their low refinery capacity, which is the case of Nigeria for example.

Table 3.2 Descriptive Statistics

	Mean	Standard Deviation	Min	Max
Log of annual mean spread	6.308	0.908	3.237	8.664
External debt to gni	42.773	28.129	2.063	210.334
To be in default	0.220	0.415	0	1
Regional spread	458.275	261.959	133.391	2046.636
Foreign exghange reserves to gdp	19.224	19.742	1.221	113.045
Log inflation	2.317	1.083	-2.748	7.639
Log oil reserve	9.331	1.230	7.359	12.604
Log gas reserve	9.468	1.477	5.771	12.685

Table 3.3 Effect of Oil and Gas Reserves on Spreads

(Dependent variable: annual mean spread)

	Fixed Effects (1)	Fixed Effects (2)
External debt to gni	0.015***	0.017***
	(0.003)	(0.002)
To be in default	0.408**	0.370*
	(0.165)	(0.184)
Regional spread	0.001***	0.001*
	(0.000)	(0.000)
Foreign exghange reserves to gdp	-0.040***	-0.032***
	(0.008)	(0.008)
Log inflation	0.038	0.117*
	(0.074)	(0.056)
Log oil reserve		0.334***
		(0.061)
Log gas reserve		-0.441**
		(0.130))
Constant	4.537***	5.220***
	(0.222)	(1.350)
Observations	141	141
R^2	0.778	0.805

Robust standard errors are in parentheses. All columns include year and country fixed effects.
***, **, * indicate statistical significance at the 1%, 5% and 10% level.
The list of the 10 countries included in the sample is as follows: Algeria, Argentina, Brazil Ecuador, Indonesia, Malaysia, Mexico, Nigeria, Russia, and Venezuela
The time period is 1994-2014.

Table 3.4 Effect of Oil and Gas Reserves on Spreads, with Interaction with Institutional quality (Dependent variable: annual mean spread)

	Corruption	Political Stability	Democracy
External debt to gni	0.017***	0.016***	0.017***
	(0.002)	(0.002)	(0.003)
To be in default	0.357	0.555**	0.355
	(0.190)	(0.156)	(0.198)
Regional spread	0.001**	0.001*	0.001*
	(0.000)	(0.000)	(0.000)
Foreign exghange reserves to gdp	-0.036***	-0.036***	-0.029**
	(0.007)	(0.006)	(0.008)
Log inflation	0.094	0.119	0.105
	(0.045)	(0.059)	(0.048)
Log oil reserve	0.757**	0.319**	0.403***
	(0.232)	(0.084)	(0.084)
Log gas reserve	-0.525*	-0.283	-0.247
	(0.230)	(0.135)	(0.272)
Log oil reserve × Corruption	-0.142		
	(0.076)		
Log gas reserve × Corruption	0.098		
	(0.062)		
Log oil reserve × Political Stability		-0.233	
		(0.123)	
Log gas reserve × Political Stability		0.325**	
		(0.097)	
Log oil reserve × Democracy			- 0.001
			(0.013)
Log gas reserve × Democracy			-0.036
			(0.035)
Constant	1.134	3.812***	2.761
	(1.887)	(0.597)	(2.448)
Observations	136	113	141
R^2	0.824	0.712	0.812

Robust standard errors are in parentheses. All columns include year and country fixed effects.

***, **, * indicate statistical significance at the 1%, 5% and 10% level.

The list of the 10 countries included in the sample is as follows: Algeria, Argentina, Brazil, Ecuador Indonesia, Malaysia, Mexico, Nigeria, Russia, and Venezuela. The time period is 1994-2014.

4 Chapter 3

Is sovereign default looming for oil exporting countries? The case of Russia and Venezuela

4.1 Introduction

The recent oil price collapse has brought to the fore that a debt crisis could also reach oil exporting countries. Not so long ago, they were viewed as financially sound, accumulating huge amount of petro-dollars and showing relatively good ratings by credit rating agencies. Nevertheless, those countries have recently seen their level of debt rise dramatically, leading to increasing credit default swap (CDS) spreads and thus raising the issue of a potential default. For illustration, as a result of tumbling oil prices Venezuela's 5-year credit default swap (CDS) has spiked from less than 2000 basis points (bps) on January 2014 to more than 5000 bps on January 2015. CDS are often seen as financial instruments that can potentially affect financial stability, even though there are controversial debates concerning their use and utility. Nevertheless, the appearance of those financial instruments usually acts as a prelude to a debt restructuring. Sovereign credit risk is more than ever a critical issue, since the Greek crisis and the European bailout, but the question of credit default risk in oil exporting countries has been overlooked by economists so far.

We present one of the first analysis to investigate how oil prices returns and financial factors impact the changes of CDS spreads in two emerging oil exporting economies, Venezuela and Russia, on a daily basis. A critical question is whether oil price returns can increase the risk of default, through a rise of sovereign CDS. Our intuition is that the fall of crude oil prices and its high volatility at the end of 2014 has increased the instability of sovereign CDS. Indeed, as the countries studied are highly dependent on oil revenues, financial markets can doubt their ability to honor their debts. This is why understanding the role of oil price returns in oil exporting countries CDS market is essential for investors and policy makers to better understand those solvability issues. Since data on financial indicators are available at higher frequencies than macroeconomic indicators, using financial indicators provides additional variations in the data, which helps identifying the determination process of sovereign credit spreads in a short time period, such as a fall of commodity prices. Indeed, the impact of oil price on sovereign CDS spreads has not been really examined in the literature, and its effect is usually ambiguous in oil exporting countries. On the one hand, oil can be seen as a secure source of revenue for those economies and is viewed as a liquid asset by credit rating agencies. Even though its price is volatile, it enables natural resource rich countries to accumulate enough foreign exchange reserves to pay their debts. Therefore, the volatility of oil price should not undermine sovereign CDS. On the other hand, oil can also be seen as a malediction, fueling conflicts, corruption, and mismanagement of natural resources,with negative macroeconomic consequences, as a shrinking manufacturing sector in an undiversified economy. This last thesis is put forward by the "natural resource curse" and the "dutch disease" literature (Corden and Neary, 1982). To address this question, we study the determinants of sovereign CDS spreads in Venezuela and Russia from 10/10/2008 to 07/02/2015. We use daily sovereign 5-year CDS, which are more liquid than the market sovereign bond, and thus enable us to obtain more accurate estimates of credit spreads. We compare a Time Varying Transition Probabilities Markov Switching model to other standard models, such as a linear and a Markov Switching models. As a lot of breaks can be seen in the data, a non linear model should appear more relevant. Moreover, policy changes during the sample period are also important potential sources of regime switching. For instance, Russia's economy has been largely impacted by wars and Arab spring in Libya. Regime switching in the sovereign CDS market could result from those political events. Finally, countries with high levels of sovereign debt are vulnerable to speculative attacks. If the probability of default is high, the demand for sovereign CDS increases. For all those reasons, linear regression models, by not taking into account those disruptions, could produce misleading results when regime switching exists. We therefore use a test developed by Carrasco (2014) and find evidence of regime switching in our sample. It will enable us to study two kinds of regimes, one "calm regime" and one "turbulent regime". We thus refer to a Time Varying Transition Probabilities Markov Switching model of Filardo (1998) and Kim (2008), where the transition probabilities are driven by the oil prices volatility index changes.

We show that oil price returns impact directly the changes of Venezuela CDS spreads. In the case of Russia, monetary interventions lead to a depreciation of the ruble to compensate the fall of oil prices. We take also in consideration the oil price volatility. We find that the volatility perceived by the market plays a major role in the determination of CDS spreads. In this paper, we make the assumption that oil price volatility does not affect directly the daily pricing of CDS spreads but the state of the economy. Indeed, if oil prices become more volatile, practitioners can interpret it as a bad signal of the state of the economy. Thus, determinants of sovereign CDS spread will not have the same impact in time of crisis than in calm periods. Investors will be more vigilant to a downturn of global and local factors. We also study the impact of stock markets on sovereign CDS in those natural resource rich countries, as financial stability is known to play a key role in the CDS market. The main results of the article can be summarized as follows: first, we show that crude oil price returns is a critical determinant of Venezuela CDS spreads. However, concerning Russia, the real exchange rate plays a key role, as the latter one is directly impacted by commodity prices. Secondly, in both countries oil price volatility has an impact on the state of the economy. The more oil price returns are volatile, the more the probability to be in a high volatility regime increases. Thirdly, global factors impact both countries in the same way. For example, if the US stock market (S&P500) rises, sovereign CDS spreads from Russia and Venezuela decline. Last but not least, we show that the Venezuelan stock market index (IBVC) does not impact Venezuelan CDS spreads, whereas the Russian stock market impacts Russian CDS.

This article contributes to the existing literature by focusing on sovereign CDS in two emerging natural resource rich countries, Venezuela and Russia. Indeed, most empirical studies have concentrated on developed countries, especially in the Eurozone since the Greek crisis, or on emerging countries without taking into account one of their major characteristics, price commodities. We choose to focus on those two major oil producers, Venezuela and Russia, as they have seen their CDS rise those last years, facing financial turmoil as oil price tumbled. There are very few studies examining those two countries, even though oil price has had a dramatic impact on their economy. Our study is at the crossroads of two literatures, the literature on the determinants of CDS and more broadly on sovereign risk, and the literature on natural resources, especially oil. In the past years, the literature on Credit Default Swaps has been flourishing. Many articles highlight the importance of global factors as determinants of CDS spreads. Longstaff (2011) show that global risk factors, such as U.S. equity, volatility, and bond market risk premia, explain CDS spreads. Pan (2008) have also pointed out the predominance of such factors, by developing a theoretical pricing model that decomposes spreads into expected losses from default and a risk premium. The risk premia of the sovereign CDS spreads co-move strongly over time and are related to global risk factors. Moreover, Augustin (2014) shows that expected growth and consumption volatility in the U.S impact components in the term structure of CDS spreads for a geographically dispersed panel of 38 countries. Further evidence that shocks from the United States influence sovereign CDS spreads in emerging markets is provided by Dooley (2009). Finally, Wang (2012) finds that the CDS markets of both developed and emerging countries are highly correlated during the US subprime crisis and mainly driven by the US economy. Moreover, some authors using financial indicators as determinants of sovereign CDS spreads, Fontana (2016) and Fender (2012) distinguish the pricing behaviors between normal times and crisis times. Other studies also emphasize the role of local factors on sovereign risk. For example, Alexander (2008) find a time-sensitive relationship between CDS and local stock markets and Eyssell (2013) include the Chinese stock market as a determinant of Chinese sovereign CDS changes. Remolona (2008) find that country-specific fundamentals determine sovereign risk in emerging countries, and that global investors' risk aversion drives time variation in the risk premia. Our results are consitent with this literature, as we also find that our global risk factors (the S&P 500 and the VIX) and local factors (local stock market) explain CDS changes. A second body of literature focuses on natural resources, and more precisely on the "dutch disease". Among this literature, it has been shown that higher oil prices lead to a real exchange rate appreciation (Corden and Neary, 1982; Corden, 1984). If different studies attempted to see if Russia contracted the "dutch disease" (Mironov and Petronevich, 2015), in our paper we find that the exchange rate seems to play the same role on CDS spreads than oil price returns. As Rautava (2004) highlights it, the exchange rate in Russia could be influenced by oil prices, even though he does not demonstrates a clear relationship between them. For that reason, we decided to use separately those two variables to better assess their respective impact on CDS in the case of Russia. Moreover, few articles have shed light on the relationship between oil price and CDS. Among them, Sharma (2013) show, by using daily time series data over eight Asian countries, that oil price uncertainty can predict CDS spreads for three countries. We fill the gap in this literature by taking into account the impact of oil price returns and volatility on the changes of CDS spreads in emerging oil exporting countries.

The rest of the paper is organized as follows. Section 2 describes the Venezuelan and Russian economies. Section 3 presents the methodology. Results are given in Section 4. Section 5 concludes.

4.2 Oil price and sovereign CDS spreads in Venezuela and Russia

In this section, we give some stylized facts regarding the Venezuelan and Russian economies, that will enable us to explain some of our results. Table 4.5 provides some descriptive statistics for CDS spreads. We also provide a theoretical background for the determinants of sovereign CDS changes.

4.2.1 Structure of the Venezuelan and Russian Economies

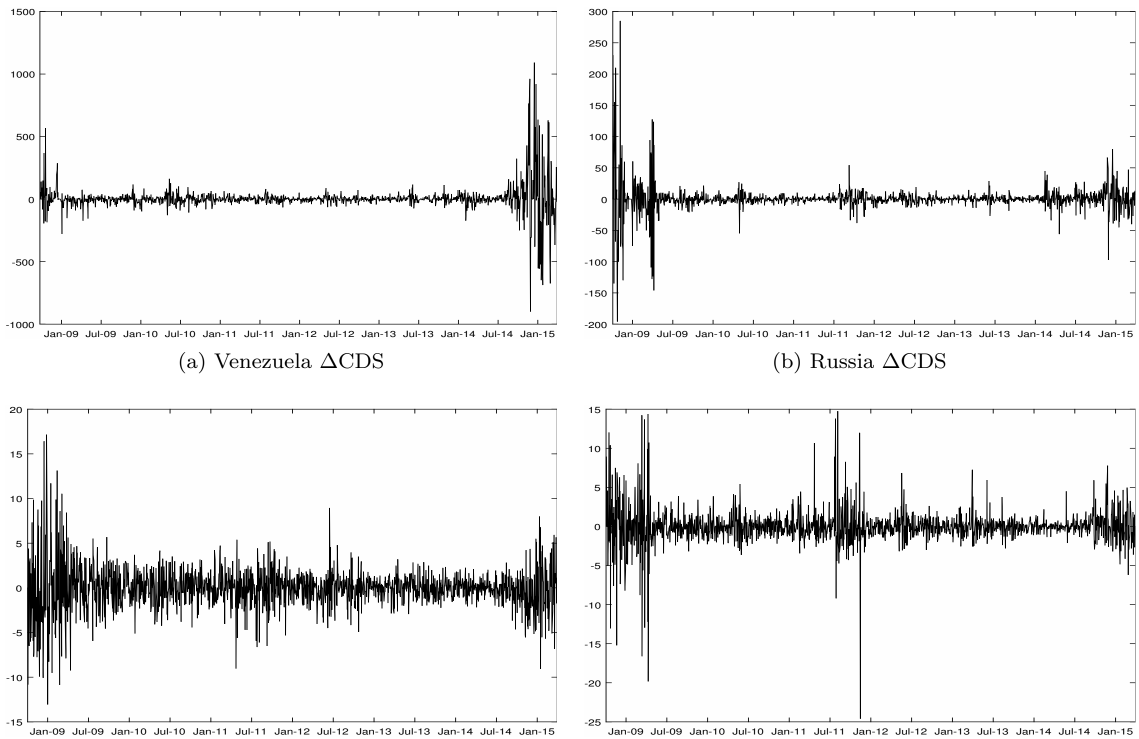
The Venezuelan economy As a founding member of the Organization of the Petroleum Exporting Countries (OPEC), Venezuela plays a key role in the global oil market. It has the largest reserves in the world, with nearly 300 billion barrels of proved oil reserves. Revenues from petroleum exports account for more than 50% of the country's GDP and roughly 95% of total exports. Venezuela is heavily dependent on oil extraction, as it has mostly extra heavy oil, harder and more costly to extract. Moreover, its economy lacks major investments to maintain oil production at its current level. Figure 4.8, which displays the variations of CDS spreads, WTI crude oil price returns and the changes of oil price volatility index (OVX), shows that concerning Venezuela, those series present turbulent periods in 2008 and at the end of 2014. More than the 2008 crisis, the country can also have afraid financial markets by some violent reforms negatively perceived by investors. Indeed, in 2007-2008 many nationalizations were engaged: nationalization of key energy and telecommunications companies, of household fuel distributors and petrol stations, of banks. Oil revenues were also shrinking following the oil slump at the end of 2008, which started to raise issues of concern related to fiscal matters. The Venezuelan economy might also have been impacted by the death of the president Hugo Chavez in March 2013. In February 2015, the government devalued currency, but its unstable political situation and its acute economic problems (undiversified economy, skyrocketing inflation) has led to rising CDS. The cost of insuring against losses on Venezuelan government debt is now one of the most expensive government debt to insure in the world. Nevertheless, Table 4.5 shows that Venezuelan CDS spreads are less volatile than Russian CDS spreads. Indeed, in the case of Russia it reveals a larger variance and excess of Kurtosis.

The Russian economy Russia is one of the world's largest producers of crude oil including lease condensate. According to the U.S. Energy Information Administration (EIA), Russia's proved oil reserves are estimated to 80 billion barrels. In 2014, Russia exported

Country	T	Min	Max	Mean	Variance	Skewness	Kurtosis
Venezuela	1701	-42.04	31.98	0.096	12.23	0.167	24.52
Russia	1687	-43.96	50.53	0.002	24.32	0.669	26.29

Table 4.5 Credit default swaps changes characteristics between the 10 October 2008 and the 2 july 2015.
Note: T is the number of observations.

roughly 7.3 million barrels per day of petroleum and other liquids. As shown in Figure 4.8, there are three main turbulent periods: in 2008, during 2011 and at the end of 2014 regarding Russian CDS. Russia was hit by the 2008 crisis, facing an economic recession and a steep decline in external demand. This was worsened by a negative perception of risks after the war with Georgia and by the oil price slump after its peak in July 2008. In 2011, oil prices became more volatile, that could be due to geopolitical reasons, like tensions caused by the Arab spring and the conflict in Libya. Both countries have had strong relationships since the cold war, thus the conflict may have impacted negatively Russia. The Russian economy experienced two shocks in 2014. The first one is a terms-of-trade shock, as oil prices more than halved between July and December 2014. The second shock, more idiosyncratic, was the economic sanctions in July 2014, following geopolitical tensions with the annexation of Crimea. This was followed by massive capital outflows and a depreciation of the ruble. Indeed, the currency was extremely volatile in 2014 (it lost 46 percent of its value against the U.S. dollar). In November 2014, Russia switched to a free-float exchange rate system. As oil price and the ruble tend to be linked, the exchange rate dynamics reflect the abrupt downward adjustment in oil prices. For Rautava (2004), the Russian economy is influenced significantly by fluctuations in oil prices and by the real exchange rate through both long-run equilibrium conditions and short-run direct impacts. Those tensions and events led to a sharp increase in the costs of external borrowing for Russia. As a result, spreads on Russian CDS peaked in 2014 at 284 basis points.



(a) Venezuela ΔCDS

(b) Russia ΔCDS

(c) WTI oil returns

(d) ΔOVX

Figure 4.8: Daily change of CDS spreads of Venezuela and Russia, WTI oil returns and change of OVX between the 10 October 2008 and the 2 July 2015.

4.2.2 Determinants of sovereign CDS spread for oil exporting countries

Following Eyssell (2013), we use a Merton-type theory to justify determinants of CDS spreads. This theory evaluates the firm credit risk. Merton (1974) characterizes a firm's default when, at the maturity of the debt, the value of the firm is below the value of outstanding debt. In Merton's model, the firm value is defined as a stochastic process. Gapen et al. (2008) extend this model to sovereign default. Sovereign CDS is an instrument to proxy the market views on a country's default risk and acts like an insurance against credit events. Credit spread changes should respond to changes of some global and local factors. The default is thus presented like a stochastic process directly linked to the structure of the economy. According to Merton (1974), bond and equity prices are correlated with default: high equity prices should induce low CDS prices. Spreads of a sovereign CDS should be determined by local stock market and its volatility index. If volatility is high, the sovereign CDS spread should increase. However, other country risk factors could also affect CDS spreads. As shown by Figure 4.8, changes of CDS spreads, WTI crude oil price returns and change of the oil price volatility index appear to be linked. At the end of 2008, we assist to an increase in the oil price volatility and Venezuelan CDS spreads volatility. We observe the same behavior at the end of 2014. Nevertheless, this correlation between oil price returns and CDS spread variations is not always respected. For example, in mid-2012 oil price plummeted from 125 dollars to 90 with an increase of the volatility, but it did not lead to an increase in CDS spread volatility. In fact, some other events may impact CDS spreads. Global factors have to be taken in consideration too. We thus select determinants following the literature on sovereign CDS: the local stock market is used to represent the country financial stability, the S&P 500 as a proxy of the financial globalization since it is considered as the main stock market. The VIX represents the implied volatility of the S&P 500 index and is commonly used as a proxy of global risk aversion. OVX is the Crude Oil Volatility Index. Of course, we take account of the asynchronicity issues, dealing with open and closing time on each markets. To conclude, we will use S&P500 returns, local stock market returns, VIX and OVX changes, WTI crude oil returns and the real exchange rate returns as determinants of CDS spread changes. [1]

4.3 Methodology

4.3.1 A general to specific approach in the linear framework

To model the dynamic of the CDS spread changes, we first start by a general-to-specific approach in a linear model to detect and eliminate statistically insignificant variables. The approach used is an automatic model selection, Autometrics, a recent third-generation algo-

[1] The dataset is described in the Appendix and can be available on demand.

rithm for computer-automated model selection developed by Doornik (2007). The algorithm is implemented by Doornik (2009) and is available on OxMetrics software. The method can handle some problems like outliers and structural breaks detection with the impulse-indicator saturation (IIS) and the Step-Indicator Saturation (SIS).[2] The idea is to include impulse and step dummies for all observations in a process. Impulse and step indicators are defined respectively by $1_{\{t=j\}} = 1$ for observation $t = j$ (zero otherwise) and $1_{\{t \leq j\}} = 1$ for observations up to j (zero otherwise). More details are given in the Appendix.

The economic mechanism that operates in the real world is represented by an unknown Data Generating Process (DGP). To approximate this DGP, we specify a General Unrestricted Model (GUM) based on institutional knowledge and informations:

$$\Delta CDS_t = f(x_t) + \varepsilon_t \tag{28}$$

where ΔCDS_t is the change of the log CDS spreads, f is a linear function of x_t a vector of explicative variables and ε_t the remainder. The vector x_t is composed by lags of CDS spread changes, by different explanatory variables[3] and their own lags: the local stock market returns (rSM), the S&P500 returns (rSP), the VIX change (ΔVIX), the WTI crude oil price returns ($rOIL$), the nominal exchange rate returns (rFX). The algorithm starts with five lags for all variables. The different stages of the algorithm can be found in the Appendix. Following this methodology, we obtain the final linear model which describes best the CDS changes: it contains all the relevant variables considered in the GUM and some impulse and step indicator variables.

4.3.2 Introducing nonlinearities

A linear model is often too restrictive to model daily long time series. Indeed, the dynamics of a financial variable may be dependent on the "well-being" of the economy. It follows

[2]Such methods have been largely studied in the literature with their asymptotic properties, see for example **Johansen (2008)** and **Castle (2011)**

[3]We consider log-returns since we are interested in relative changes.

that the dynamic is driven by an underlying latent state which can take a finite number of values. We analyze the determinants of the Credit Default Swaps (CDS) through a dynamic mixture autoregressive framework. Such model has been introduced by Hamilton (1989) with the Markov Switching Autoregressive (MS-AR) model and became very popular to model time series of macroeconomic and financial variables. For example, Ang (2002) show that a MS-AR model matches quite well the behavior of interest rates and Sims (2006) use a multivariate MS model to study monetary policy switches. This kind of model is particularly suitable to model sovereign CDS. As we said in Sections 1 and 2, both countries have been affected by external events. Moreover, Venezuela has been the target of speculative attacks, thus Markov Switching models regarding sovereign CDS spreads should be more relevant. It exists other non linear models of structural breaks. However, in most cases, they require a priori some information concerning the breaks. When many sources of regime switching exist, this type of model appears more appropriate, we then need to determine the number of regimes in the economy.

Markov Switching models depend on a latent state variable s_t. This variable indicates the nature of the world at time t. s_t follows a Markov chain with finite state spaces $S = 1, ..., k$, and a transition matrix P. The transition matrix P is given by

$$P = \begin{pmatrix} p_{11} & \cdots & p_{1k} \\ \vdots & \cdots & \vdots \\ p_{k1} & \cdots & p_{kk} \end{pmatrix}$$

with $p_{ij} = p(\Delta_t = j|\Delta_{t-1} = i)$ the probability to be in state j at time t given to be in the state i at the time $t-1$. The simple MS(k)-AR(p) process is defined if there exist ω_{s_t} and ϕ_{i,s_t}, $i = 1, \dots, p$ such that

$$y_t = \omega_{s_t} + \sum_{i=1}^{p} \phi_{i,s_t} y_{t-i} + \varepsilon_t \tag{29}$$

where ε_t is the error term. The model defined by Equation (29) can be generalized by adding the vector of explanatory variables x_t in the regression. Each variable can switch or not across regimes, thus, x_t can be decomposed in two vectors x_t^{ns} and x_t^s. x_t^s contains the variables which switch and x_t^{ns} the ones which do not switch. Let us define the Markov Switching Generalized model as

$$y_t = \sum_{i=1}^{l} \gamma_i x_{i,t}^{ns} + \sum_{i=1}^{m} \phi_{i,s_t} x_{i,t}^{s} + \varepsilon_t \tag{30}$$

with $\varepsilon_t \sim P(\zeta_{s_t})$ the assumed probability density function of the innovations, with its own set of parameters ζ. $\gamma = (\gamma_1, \ldots, \gamma_l)'$ and $\phi_{s_t} = (\phi_{1,s_t}, \ldots, \phi_{m,s_t})'$ are the vectors of parameters to estimate with l the number of non switching variables and m the number of switching variables.

Similarly to Filardo (1998) and Kim (2008), we introduce Time Varying Transition probabilities (TVTP), where the transition probabilities are time-varying and depend on some variables. The transition matrix becomes:

$$P_t = \begin{pmatrix} p_{11}(z_t) & \ldots & p_{1k}(z_t) \\ \vdots & \ldots & \vdots \\ p_{k1}(z_t) & \ldots & p_{kk}(z_t) \end{pmatrix}.$$

z_t is an explanatory variable which follows the conditions of Filardo (1998) and Kim (2008). The probabilities are defined by $p_{ij}(z_t) = \Phi(\theta_{ij} z_t)$; z_t is called the state variable vector and θ_{ij} are the parameters to be estimated. For $k = 2$, we only need to estimate θ_{11} and θ_{12}. The interpretation of these parameters is the following one. If θ_{11} is positive, the probability to stay in regime one increases if z_t is positive. In the same way, if θ_{12} is positive, the probability to switch from regime 2 to regime 1 increases if z_t is positive. $\Phi()$ is the cumulative normal distribution function. Even though the choice of the cumulative normal distribution function for the transition probabilities is common wisdom in the applied literature, any function that maps the transition parameter into the unit interval would be a valid choice for a well-defined log-likelihood function. The TVTP model is the main point of interest: it enables us to see which variables impact the probabilities of regime switch. Following the work of Hamilton (1989), this model can be estimated by maximum likelihood.[4]

4.4 Results

4.4.1 The linear model

Table 4.6 reports the estimates of the linear model. As expected, a rise in crude oil price returns decreases the change of the CDS spread for Venezuela, as oil accounts for more than 95% of Venezuela's export revenues. This impact is significant at the one percent level. When oil prices are high, it means more oil revenues for the government, which is well viewed by financial markets. Nevertheless, concerning Russia the Autometric selection method does not retain oil price returns as a determinant of CDS spreads. This finding is interesting since the Russian economy is largely dependent on oil exports. It could be explained by the fact that Russia has other important sources of revenues, like gas (Russia is the second-largest producer of gas in the world). Moreover, oil prices can impact CDS spreads through the exchange rate canal. The Russian authorities can let the ruble depreciate against the US Dollar to counter the fall of oil prices. There is a theoretical and empirical literature about this subject. For example, Ferraro (2015) show that commodity prices can predict commodity currencies exchange rates at a daily frequency. The two countries have indeed different exchange rate systems. Russia has moved to a floating exchange rate regime those last years, whereas Venezuela has a complex multi-layered exchange rate system and currency controls still exist, since their introduction in 2003 by the former President Hugo Chavez. Concerning the other determinants, the results confirm our intuition. When the change of VIX is positive (i.e. the VIX rises), thus the more the market's anxiety rises, the more CDS spreads also increase. Moreover, there is strong evidence for Venezuela that changes of CDS spread are significantly and negatively affected by the returns of the S&P 500. In the case of Russia, the S&P500 and the local stock market returns play both a

[4]See Perlin (2015) and Ding (2012) for more details.

significant role and have a negative sign. Nevertheless, financial stability tends to decrease CDS spreads more strongly in Russia, as the estimates are higher than those of Venezuela. However, this linear model is too restrictive to fully assess the impact of oil price returns on CDS spreads and thus the probability of default of these emerging countries.

	Venezuela	Russia
ΔCDS_{t-1}	0.105^{***} (0.01)	-
rSP_{t-1}	-0.140^{***} (0.03)	-0.329^{***} (0.04)
rSM_{t-1}	-	-0.629^{***} (0.03)
$rOIL_{t-1}$	-0.111^{***} (0.02)	-
ΔVIX_{t-1}	0.081^{***} (0.01)	0.201^{***} (0.06)
rFX_{t-1}	-	0.516^{***} (0.06)
σ	1.649 (−)	1.89 (−)
log-LL	-3147.79	-3361.03
Number of Impulse dummies	60	53
Number of Step dummies	140	136

Table 4.6 Linear models estimation of Venezuela and Russia CDS spreads from 10/10/2008 to 07/02/2015.
Note: Standard errors are in parentheses. ***, ** and * statistical significances at 1%, 5% and 10%. A '-' means that the concerning variable is eliminated by the selection process.

4.5 Evidence from the TVTP-MS model

Results from the TVTP-MS model are reported in Tables 4.7 and 4.8. Explanatory variables are selected independently from the linear model. We estimate four models for Venezuela. Model 1 reflects the impact of oil price returns on the change of CDS spread without other factors. In the second and third one, we include respectively local and global factors. The Model 4 includes both local and global factors. For Russia, we estimate six models. Models 1 and 2 are similar to those of the Venezuela. Models 3 and 4 are estimated with both oil price returns (Models 3.1 and 4.1) and real exchange rate returns (Models 3.2 and 4.2). To select which variables are switching across regimes, we perform a standard test. If the parameter in regime 1 is statistically different of the parameter in regime 2, we let the explanatory variable associated switch. Therefore, explanatory variables can be significant in only one regime. It can be justified by the fact that in turbulent periods, traders and operators are looking for some stabilization indicators and modify their behavior. Finally, we impose the unconditional variance to switch across regimes in order to define both regimes. The calm period is associated to the regime with the smallest variance (Regime 1), regime 2 is called the turbulent regime.

One practical issue is choosing valid information variables for the transition function. These variables have to be uncorrelated with contemporaneous state. The selection is done in two steps. Firstly, we test the null hypothesis of a standard MS model against a TVPMS model. This test is presented in the next section. Secondly, the parameters θ_{11} and/or θ_{12} need to be statistically significant. When several variables satisfy the tests, the final selection is made by considering information criteria. After testing different variables, we retain the OVX index to proxy the volatility of oil prices, as it represents the implied volatility of the crude oil stock market. This is fairly reasonable for many problems as long as $z_{t-1} = \Delta OVX_{t-1}$ the lagged transition variable is considered to be predetermined with respect to s_t the state. The interpretation of the coefficients associated to this variable is done in the following manner: for example, if θ_{11} is negative, it means that when the change of oil prices volatility is positive, probabilities to stay in regime one go down.

In this Markov Switching model, the first important result is the impact of oil prices and exchange rates on CDS spreads. Oil price returns are statistically significant only in turbulent periods for Venezuela, with a negative sign: negative returns (i.e. the oil price decreases) lead to an increase in CDS spreads, and thus in the probability of default. Investors keep a close look on oil price "news" when sovereign CDS appear to be in a turbulent period. In the case of Russia, oil price returns seem to have an impact on sovereign CDS spread changes in both regimes, however, this is true only in Models 1 and 2. When we add local and/or global factors, this impact decreases until it disappears in calm periods or in turbulent periods (respectively Models 3.1 and 4.1 in Table 3.4). As the literature (Rautava, 2004; Ferraro et al., 2015) does not offer clear evidence that the real exchange rate and oil prices are linked, but highlights that a relationship could exist especially on short-term horizons, we decided to use those two independent variables separately. We thus run the same regressions with real exchange rate returns instead of oil price returns. Exchange rate returns are positively significant in calm periods for Models 3.2 and 4.2 in Table 3.4. In the turbulent regime, exchange rate returns are near to be negatively significant. It means that when the ruble depreciates against the US Dollar (i.e. returns are positive), changes of sovereign CDS spread increase in calm periods and decrease in turbulent periods. Thus, a depreciation of the ruble increases the probability of default in calm periods. It plays the same role as the oil price returns. Secondly, Russian local stock market has a significant impact on Russia's CDS spread changes but only in turbulent periods since the parameter associated in calm periods is not significant. An increase in stock market returns during 'turbulent times' (regime 2) decreases the variation of CDS. For Venezuela, the variable is not significant. This result is probably due to the development level of the two stock markets. Capitalization to Growth Domestic Product for the Russian Federation is about 45% against 4% for Venezuela.[5]

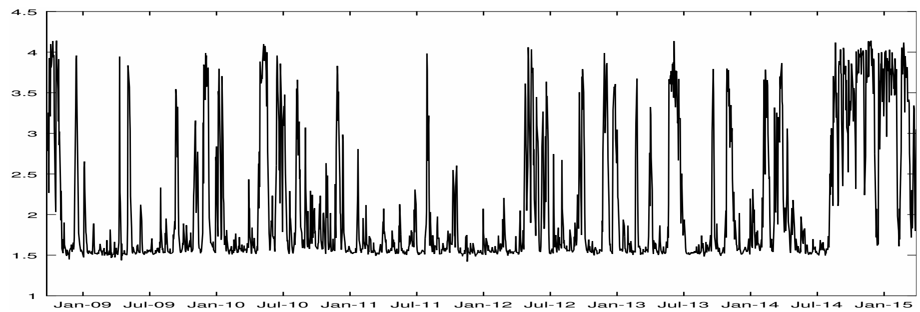
Concerning global factors, an increase in the US stock market returns during 'normal times' (regime 1) tends to lower the probability of default, and this impact is even sharper during turbulent times (regime 2). This empirical evidence is similar for both countries, showing their dependence to the global economy. The VIX also appears to be a major determinant of Russian and Venezeluan CDS (the coefficient is statistically significant at the one percent level), as a positive change of the implied volatility has a positive impact on the changes of CDS spreads. Those results are consistent with Longstaff et al. (2011), who find that global financial factors play a key role in determining sovereign CDS spreads.

Estimation results of the transition function are as we expected. In the case of Venezuela, when returns of the OVX decrease, the probability of switching from a turbulent state to

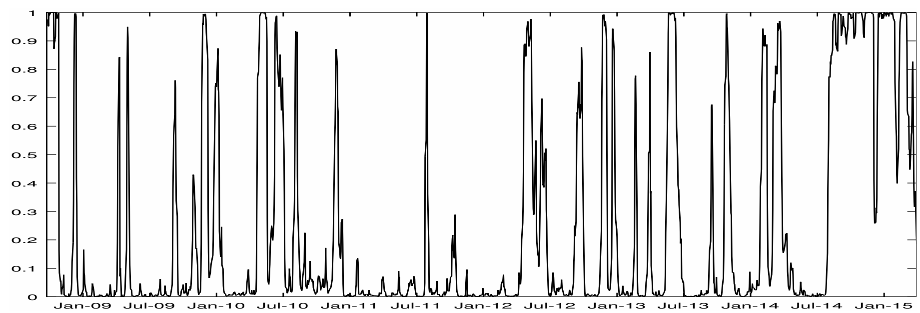
[5] Source FRED economic data

a "non-crisis" state increases. This is illustrated by the negative coefficient attached at ΔOVX_{t-1} variable in p_{12}. If the volatility rises, returns will be positive and this probability will decrease. Similarly, a lower volatility of oil prices tends to stabilize the financial economy of Venezuela. Contrary to Venezuela, it is the probability of remaining in a "calm" state which rises for Russia when the returns of the OVX are negative. Nevertheless, a higher oil price volatility increases the chance of moving from a turbulent state to a calm one for both countries, which confirms our intuitions.

Finally, Figures 4.9b and 4.10b present the smoothed probabilities to be in the high volatility regime. They point out that our model takes in consideration the last drop of crude oil prices and its impact on CDS spread changes at the end of 2014. Moreover, the MS model for Russia detects the period of instability caused by the war in Libya around July 2011. For Venezuela, there is also a high instability level around March 2013 caused probably by Chavez's death. We can also notice that low volatility periods for Russia are expected to last at least about 50 days, compared to only 35 days for the Venezuelan economy.



(a) Conditional standard deviation

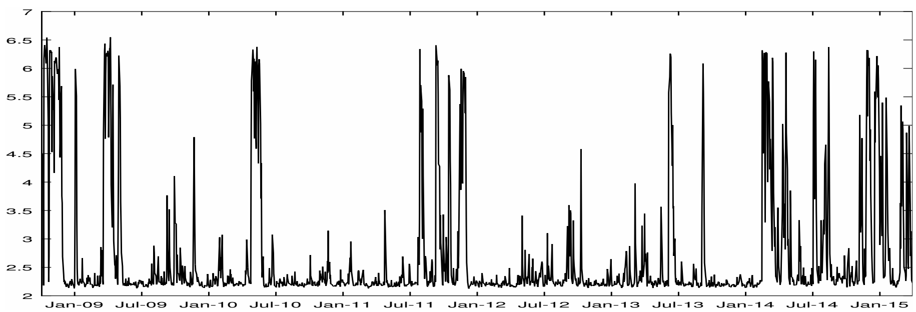


(b) Smoothed probability

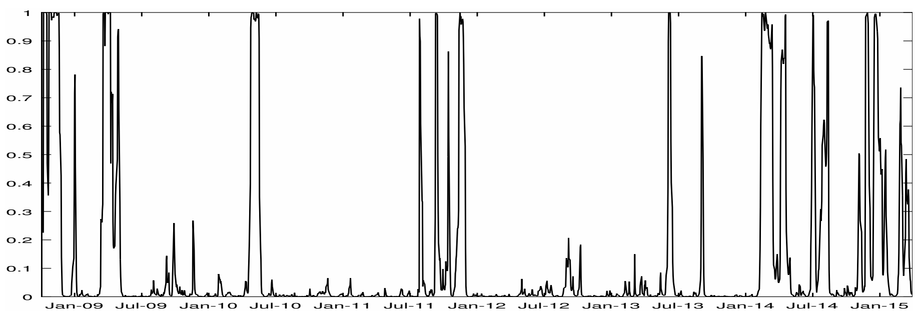
Figure 4.9: Venezuela. Standard deviation and smoothed probability of turbulent regime.

4.6 Model validation

We justify our TVTPMS model with some tests. Linear and TVTPMS models have a different and distinct structure. Thus, classical test procedures have to be used cautiously. In fact, we have to test the constancy of parameters. We assume that they are constant under the null hypothesis, whereas they are random and weakly dependent under the alternative. Testing the stability of coefficients is particularly challenging. The parameters that enter in the dynamic of the random coefficients are not identified under the null hypothesis. It is the well known nuisance parameters problem: the usual tests like the Likelihood Ratio (LR) test have a non standard distribution. To address this issue of MS models, Carrasco (2014) propose an optimal test for parameter stability. We apply this test to see if MS model is better than the linear model without the step and indicator variables. If we reject the null of



(a) Conditional standard deviation



(b) Smoothed probability

Figure 4.10: Russia. Standard deviation and smoothed probability of turbulent regime.

linearity for the MS model, it means that all the step and indicator variables represent in fact a stochastic regime switching model. This test has been used in recent empirical studies, for example Hu (2008), Dufrenot (2011) and Morley (2012). To validate the TVTPMS model, we use Kim (2008)'s approach. They use a LR statistic to test for endogenous switching. They propose a two-step maximum likelihood estimation procedure to deal with the problem of endogeneity in Markov-switching regression models. In this paper, size-adjusted critical values are used, taken from the Monte Carlo simulations generated with a model under the null. AIC and BIC are also reported for the three models.

Table 4.9 presents those results. The MS and the TVTPMS models tested are respectively Model 4 in Table 3.3 and Model 4.2 in Table 3.4. First, if we look at information criteria, the smallest corresponds to the TVTP-MS model. It can be underlined that they are very similar for the Venezuela between the TVTP-MS and the MS models. However, as shown by Chuffart (2015), these criteria are not always efficient in some special cases. But, all the tests reject the null at least at 10%. That means that for the Carrasco (2014) test, we reject the null of linearity and for the Kim (2008) test, we reject the null of no time varying transition probabilities. We can thus conclude that our final model, the TVTP-MS is preferred to the linear and the MS models on the basis of those tests.

4.7 Conclusion

In this paper, we compared a Time Varying Transition Probabilities Markov Switching model to a linear and a Markov Switching models, to assess the impact of oil price returns on sovereign default risk for two major oil producing countries. The Markov-Switching with Time Varying Transition Probabilities model outperforms the other standard models. We showed that crude oil price returns have a significant influence on Venezuela's CDS spreads, but does not explain significantly Russian CDS spreads changes. Our interpretation is that oil prices impact Russian CDS spread through the exchange rate canal, as Russia has a flexible exchange rate system. On the contrary Venezuela has fixed exchange rates, so oil price changes impact directly Venezuelan CDS spreads. The evidence also suggests that the Russian local stock market returns have a significant and negative impact on Russia's CDS spreads, whereas Venezuela's CDS spreads are not related to its local stock market. This study suggests a number of policy implications for those economies. First, in order to better face oil price volatility they should more than ever diversify their economy. Some countries have managed to move from a natural resource oriented economy to an economy open to financial services (like Dubaï) or to tourism (Indonesia). Second, this oil price collapse should be seen as an opportunity for those countries to reduce their oil subsidies, which usually represents a huge expense in the government budget. Further research could take into account contagion risk between countries.

	Model 1		Model 2		Model 3		Model 4	
	R1	R2	R1	R2	R1	R2	R1	R2
Parameters								
cst	-0.087^{*} (0.05)	0.397 (0.27)	-0.085 (0.05)	0.389 (0.27)	-0.076 (0.05)	0.351 (0.25)	-0.043 (0.05)	0.286 (0.25)
ΔCDS_{t-1}	0.199^{***} (0.02)	-	0.199^{***} (0.02)	-	0.179 (0.02)	-	0.168^{***} (0.02)	-
$rOIL_{t-1}$	-0.016 (0.03)	-0.187^{*} (0.10)	-0.021 (0.02)	0.389^{***} (0.28)	0.000 (0.03)	-0.223^{**} (0.10)	-0.016 (0.01)	-0.186^{*} (0.1)
rSM_{t-1}	-	-	-0.005 (0.04)	0.037 (0.12)	-	-	-0.020 (0.04)	0.034 (0.11)
rSP_{t-1}	-	-	-	-	-0.099 (0.06)	-0.770^{**} (0.22)	-0.123^{***} (0.05)	-0.694^{***} (0.16)
ΔVIX_{t-1}	-	-	-	-	0.000 (0.01)	-0.052 (0.04)	0.091^{***} (0.01)	0.198^{***} (0.03)
σ^2	2.139^{***} (0.15)	17.906^{***} (2.33)	2.141^{***} (0.15)	17.848^{***} (2.35)	2.079^{***} (0.15)	16.662^{***} (2.12)	2.010^{***} (0.14)	17.241^{***} (2.08)
dof	4.339^{***} (0.57)	-	4.342^{***} (0.57)	-	4.329^{***} (0.57)	-	5.277^{***} (0.80)	-
Trans. funct.								
p_{11}								
cst_{11}	1.980^{***} (0.12)		1.980^{***} (0.12)		1.957^{***} (0.12)		1.942^{***} (0.12)	
ΔOVX_{t-1}	-0.011 (0.05)		-0.011 (0.06)		-0.009 (0.05)		-0.027 (0.02)	
p_{12}								
cst_{12}	-1.512^{***} (0.17)		-1.512^{***} (0.18)		-1.514^{***} (0.17)		-1.494^{***} (0.162)	
ΔOVX_{t-1}	-0.086^{*} (0.05)		-0.087^{*} (0.05)		-0.083^{*} (0.05)		-0.095^{**} (0.05)	
Model validation								
Log-LL	-3992.66		-3992.63		-3984.41		-3895.469	
E(R1)	41.63		41.70		39.52		36.87	
E(R2)	12.66		12.65		12.83		11.92	
LM-Autocorr(5)	5.304 (0.38)		5.394 (0.37)		5.036 (0.41)		5.109 (0.40)	

Table 4.7 TVTP-MS models estimation of Venezuela sovereign CDS spread between the 10 October 2008 and the 2 July 2015. Note: Standard errors in parentheses. ***, ** and * statistical significances at 1%, 5% and 10%. R1 and R2 are respectively regime 1 and regime 2. A '-' means that the concerning variable is eliminated by the selection process and/or that it is not switching across regimes. σ^2 is the unconditional variance, dof is the degree of freedom. Log-LL is the log likelihood. E(R1) and E(R2) are respectively the expected duration of regime 1 and regime 2. LM-Autocorr(5) is an heteroskedasticity consistent serial correlation test with 5 lags.

	Model 1		Model 2		Model 3.1		Model 3.2		Model 4.1		Model 4.2	
	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2
Parameters												
cst	-0.055 (0.07)	0.192 (0.685)	-0.073 (0.070)	0.310 (0.67)	-0.032 (0.06)	0.310 (0.52)	-0.035 (0.06)	0.281 (0.62)	-0.020 (0.07)	0.147 (0.66)	-0.036 (0.07)	0.384 (0.51)
ΔCDS_{t-1}	0.103^{***} (0.02)	-0.134 (0.09)	0.104^{***} (0.03)	-0.397^{***} (0.06)	0.037 (0.02)	-0.110^{**} (0.04)	-0.004 (0.02)	-0.158^{***} (0.05)	0.043^{*} (0.03)	-0.431^{***} (0.06)	0.027 (0.03)	-0.427^{***} (0.00)
$rOIL_{t-1}$	-0.138^{***} (0.02)	-1.077^{***} (0.31)	-0.125^{***} (0.03)	-0.780^{***} (0.20)	-0.042 (0.03)	-0.314^{**} (0.18)	-	-	-0.052^{*} (0.03)	-0.289 (0.20)	-	-
rFX_{t-1}	-	-	-	-	-	-	0.362^{***} (0.08)	-	-	-	0.440^{***} (0.09)	-0.491 (0.37)
rSM_{t-1}	-	-	0.002 (0.04)	-1.160^{***} (0.18)	-	-	-	-	0.003 (0.04)	-0.868^{***} (0.17)	0.071 (0.05)	-0.962^{***} (0.30)
rSP_{t-1}	-	-	-	-	-0.530^{***} (0.06)	-1.465^{***} (0.26)	-0.518^{***} (0.06)	-1.717^{***} (0.26)	-0.540^{***} (0.07)	-1.478^{***} (0.31)	-0.522^{***} (0.07)	-1.693^{***} (0.28)
ΔVIX_{t-1}	-	-	-	-	0.146^{***} (0.01)	0.402^{***} (0.05)	0.150^{***} (0.01)	0.426^{***} (0.06)	0.150^{***} (0.01)	0.444^{***} (0.07)	0.150^{***} (0.01)	0.473^{***} (0.07)
σ^2	4.934^{***} (0.40)	72.369^{***} (18.05)	4.795^{***} (0.31)	55.254^{***} (7.72)	4.009^{***} (0.27)	34.066^{***} (4.50)	4.169^{***} (0.27)	43.839^{***} (6.16)	4.473^{***} (0.293)	48.708^{***} (6.849)	4.366^{***} (0.34)	47.648^{***} (9.68)
dof	4.453 (0.71)	-	4.837 (0.75)	-	4.622^{***} (0.64)	-	5.004^{***} (0.74)	-	5.947^{***} (1.10)	-	5.926^{***} (1.14)	-
Trans. funct.												
p_{11}												
cst_{11}	2.453^{***} (0.22)		2.297^{***} (0.16)		2.310^{***} (0.16)		2.272^{***} (0.15)		2.194^{***} (0.14)		2.173^{***} (0.14)	
ΔOVX_{t-1}	-0.083^{***} (0.03)		0.066^{**} (0.03)		-0.066^{***} (0.02)		$-0.060{**}$ (0.02)		-0.056^{**} (0.02)		-0.056^{***} (0.02)	
p_{12}												
cst_{12}	-1.283^{***} (0.19)		-1.332^{***} (0.15)		-1.412^{***} (0.15)		-1.291^{***} (0.16)		-1.168^{***} (0.15)		-1.159^{***} (0.17)	
ΔOVX_{t-1}	0.014 (0.03)		0.003 (0.03)		-0.005 (0.04)		-0.0148 (0.02)		-0.015 (0.02)		-0.018 (0.02)	
Log-LL	-4437.213		-4429.553		-4289.992		-4283.591		-4285.550		-4276.513	
E(R1)	79.19		69.95		68.97		66.20		57.12		54.47	
E(R2)	9.98		10.93		12.64		10.10		8.19		8.05	
LM-Autocorr-5	3.406 (0.64)		4.994 (0.42)		5.649 (0.34)		5.250 (0.38)		3.406 (0.64)		3.560 (0.61)	

Table 4.8 TVTP-MS models estimation of Russia sovereign CDS spread between the 10 October 2008 and the 2 July 2015.
Note: see note of Table 3.3.

	Venezuela		Russia	
	AIC	BIC	AIC	BIC
MS	8003.0	8077.1	8594.6	8696.5
TVTP-MS	7980.8	8067.8	8591.0	8694.4e
Carrasco et al.	3.47^{*} (0.06)		5.37^{**} (0.04)	
Kim et al.	4.170^{*} (0.078)		6.42^{***} (0.02)	

Table 4.9 Information criteria and specification tests.
Note: Critical values have been simulated with 3000 simulations. ***, ** and * statistical significances at 1%, 5% and 10%. p-value in parentheses.

4.8 Appendix

Data and programs

All our variables come from Thomson-Reuters database. We use daily data from the 26 September 2008 to 2 July 2015. The period depends on the availability of the data since CDS spreads are new instruments. The dependent variable is the change of the log of CDS spreads at time t, and the independent variables are all expressed in terms of log-returns. We use variables from different parts of the world in the model thus, we had to synchronize the series, as the day-off and the holidays are not the same in each country. This can lead to missing information for some days. In order to deal with that, we decided to delete all the extra information contained in the independent variables. For example, if there is no quotation for the CDS spread and on contrary, there is a quotation available for the S&P 500 on the same day, we delete this observation. In the other case, when there is additional information for the dependent variable, we interpolate linearly the missing observation for the independent variables. The program to synchronize data is available upon demand to the authors. We compute then log returns of each variable. The estimations of the models are computed using the toolbox of Ding (2012). A main file to replicate the results and data are also available upon demand.

Autometrics

We give briefly the general idea of the three stages of the Autometrics algorithm (see Doornik (2007) and Doornik (2009)).

Stage 1: the general model and indicator saturation (IIS+SIS). The first stage is to estimate and evaluate the GUM defined in Section 4.3.1. It must have stationary regressors. It is an approximation of the Local DGP (LDGP) which is a reduction of the DGP for relevant variables, nested within it. The general model is estimated, and diagnostic statistics are calculated for it. If any of those diagnostic statistics are unsatisfactory, the modeler must decide between developing another GUM or continuing with the simplification procedure. Secondly, inclusion of impulse and step dummies for all observations is feasible. However, the number of variables will be larger than the number of observations. To deal with this issue, a block strategy is used. Autometrics performs block additions and searches of impulse dummies for all observations in a process known as indicator saturation (IS). Doing so generates a robust regression estimator and provides a check for parameter constancy. If these tests result in a statistically satisfactory reduction of the GUM, then the new model is the starting point for the next Stage. Otherwise, the general model itself is the starting point.

Stage 2: a multi-path encompassing search. At this stage of the algorithm, a multi-path search is implemented, starting from the model at the first stage. The searches filter for relevant variables using usual Student tests and Fisher tests. At each step, the congruence is checked through diagnostic tests. If some variables are statistically insignificant, then Autometrics tries to delete those variables to obtain a simpler model. A simplification could be rejected. In this case, the algorithm backtracks along that path to the most recent acceptable model and then tries a different path. A terminal model results if the model's diagnostic statistics are satisfactory and if no remaining regressors can be deleted. The algorithm pursues multiple simplification paths and we can obtain many terminal models. An union model from those terminal models is considered and the algorithm tests this union model against all the terminal models. Finally, an other union model is created wich nests all the surviving terminal models.

Stage 3: another multi-path encompassing search. Stage 3 repeats Stage 2, by applying the simplification procedures from Stage 2 to the union model obtained. The resulting model is the final model. If Stage 3 obtains more than one terminal model after applying encompassing tests, then the final model is selected by using the information criteria.

5 General conclusion

This thesis presents a theoretical and empirical analysis on sovereign debt and economic growth in natural resource rich economies. While those natural resource rich countries face a major challenge with the recent oil price slump (a lot of other natural resource have also seen their price fall): they have to overcome their dependence on raw exports, and attempt to meet their fiscal needs by adapting their economic structure. The present thesis contributes to the existing literature by formalizing a new growth model with exhaustible natural resource and investigating the impact of oil and gas on sovereign risk in those emerging exporting countries.

The literature on economic growth in countries endowed with exhaustible natural resource is well documented, and brings to the fore that the rate of technical progress needs to be high enough, in order to be sustainable in the long-run. Technological progress is seen either as a continuous process or like a backstop technology. Nonetheless, most of those articles focus on non open economies, assuming they do not refer to international borrowing. There is a real gap in this theoretical literature, that the first chapter tried to filled by studying a small open economy that could tap international financial markets. The model in chapter one suggests that economic growth can be sustained for a while when the interest rate depends on the country's level of debt, but no sustainability can be found when the interest rate is constant. A potential extension of the analysis proposed in this chapter would be to endogenize the rate of natural resource exported abroad, to see how the country could optimize the level of resource exported and the part of the resource sold on the domestic market.

Moreover, studies combining sovereign risk and natural resources are sparse. If the international finance literature has largely analysed theoretical models on sovereign risk default, it has set aside the natural resource characteristics of those emerging countries, which usually rely heavily on their exports of raw material. On the empirical side, macroeconomic determinants are usually taken into account, like the ratio level of external debt to GDP, financial variables, or the ratio of foreign exchange reserves to GDP. Nevertheless, the empirical literature on sovereign risk overlooks geological variables, that are part of those countries' wealth. Chapter two attempts to overcome this lack, by examining the determinants of borrowing costs for major oil and gas exporting countries that issue debt on international markets. The main motivation comes from the fact that some emerging countries use their natural resources as collateral in order to borrow money. The idea of this chapter was thus to investigate if this natural resource endowment, usually oil and gas, can enable them to borrow at a lower cost, and see if detaining oil and gas reserves could help relax the credit constraint of those emerging countries. The intuition is that when those countries make giant oil and gas discoveries, their oil and gas reserves increase, and therefore their net wealth, which should help them to borrow more. It is shown that it is more the size of the dicovery that matters than the fact of doing a discovery itself. Moreover, financial markets value more oil and gas reserves, which represent stocks and future wealth, then oil and gas production, exports and rents, which are current flows. Nevertheless, there is no clear evidence that the interaction between oil, gas reserves and intstitutional quality decreases borrowing costs. A bootstrap methodology will be a next step to address the issue of the sample size. Another path for further research would be to take into account the date of investment decision after a giant oil and gas discovery, to see if financial markets give their blessings to those countries after this date more than the annoucement date of the dicovery.

The third chapter analyses the impact of oil price returns, oil price volatility, and stock exchanges on sovereign CDS in two major oil exporting countries, Russia and Venezuela. A Markov-switching model is developed, with time-varying transition probabilities.The main results are that oil price returns explain significantly the variations of the Venezuelan sovereign risk, contrary to the Russian CDS. Indeed, the impact of oil price returns and oil price volatility on Russian CDS tend to go through the exchange rate channel. As Russia has a flexible exchange rate framework, oil price variations affect the Russain exchange rate, whereas Venezuela displays a fixed rate system. A possible extension of this chapter would be to introduce a contagion risk between emerging countries.

The macroeconomic challenges faced by commodity exporters are not new, but they take a new direction with the current oil price slump. A lot of them have already taken the path of economic reforms and thus try to adapt their economic model, by relying less on oil exports and better develop their other sectors (manufacturing, agriculture, tourism). Nonetheless, the road ahead leading to structural reforms and sound public finances is still long. As new discoveries are getting sparse and of smaller size, those countries know their "elephant in the ground" will soon turn into a "mouse" in the ground. Those questions of sustainable growth and external debt will thus be more than ever a critical issue for those natural resource rich countries.

References

Acharya, V. V., I. Drechsler, and P. Schnabl (2011), "A Pyrrhic Victory? - Bank Bailouts and Sovereign Credit Risk", NBER Working Papers 17136, National Bureau of Economic Research, Inc.

Alexander, C. and A. Kaeck (2008), Regime dependent determinants of credit default swap spreads, *Journal of Banking & Finance*, 32.6, pp. 10081021.

Alexandre, H. and A. de Benoist (2010), "Oil prices and government bond risk premiums", *Lahore Journal of Business*, vol.1(1), pp.1-21.

Alexeev, M., and Conrad, R. (2009), "The elusive curse of oil", *Rev. Econ. Stat.* 91 (3), pp. 586598.

Alter, A. and Y. S. Schler (2012). Credit spread interdependencies of European states and banks during the financial crisis, *Journal of Banking & Finance*, 36.12, pp. 3444 3468.

Akitoby, B. and T. Stratmann (2008), "Fiscal Policy and Financial Markets“, *Economic Journal*, vol. 111, pp.197185.

Ang, A. and G. Bekaert (2002), Regime Switches in Interest Rates, *Journal of Business Economic Statistics*, 20.2.

Ang, A. and F. A. Longstaff (2013), Systemic sovereign credit risk: Lessons from the U.S. and Europe, *Journal of Monetary Economics*, 60.5, pp. 493510.

Arellano, C. (2008), "Default Risk and Income Fluctuations in Emerging Economies", *American Economic Review*, 98:3, pp. 690-712.

Arezki, R. and Bruckner, M. (2012), "Commodity Windfalls, Democracy and External Debt", *Economic Journal* vol. 122, pp.848-866.

Arezki, R., Hamilton, K. et K. Kasimov, "Resource Windfalls, Macroeconomic Stability and Growth: The Role of Political Institutions", *IMF Working Paper*, WP/11/142.

Arezki, R., Ramey, V. and L. Sheng (2015), "News Shocks in Open Economies: Evidence from Giant Oil Discoveries", NBER Working Papers 20857, National Bureau of Economic Research, Inc.

Arezki, R., van der Ploeg, F. and F. Toscani (2016), "Shifting Frontiers in Global Resource Wealth: The role of policies and institutions", OxCarre Research Paper 180.

Augustin, P. and R. T edongap (2014), Real economic shocks and sovereign credit risk, *Journal of Financial and Quantitative Analysis (JFQA)*, Forthcoming.

Auty, R. and Gelb, A.H (2001) Political Economy of Resource-Abundant States, in R. M. Auty (ed.), Resource Abundance and Economic Development, Oxford University Press, Oxford.

Auty R. (2001), Resource Abundance and Economic Development, Oxford, Oxford University Press.

Barbier, E.B. (1999), "Endogenous Growth and Natural Resource Scarcity", Environmental and Resource Economics 14: 51-74.

Barro, R. and Sala-i-Martin,X. (2003), Economic Growth, Cambridge, Mass., The MIT Press.

Benchekroun, H. and Withagen C. (2011),"The optimal depletion of exhaustible resources: A complete characterization." Resource and Energy Economics 33(3): 612 - 636.

Bhattacharyya and Hodler (2009),Natural Resources, Democracy and Corruption, *European Economic Review*, vol. 54, pp.608-621.

Bulow, J. and K. Rogoff (1989), "Sovereign Debt: Is to Forgive to Forget?", *The American Economic Review*, 79(1), pp. 43-50.

Carrasco, M., L. Hu, and W. Ploberger (2014), Optimal Test for Markov Switching Parameters, *Econometrica* 82.2, pp. 765784.

Castle, J. L., J. A. Doornik, and D. F. Hendry (2011). Evaluating Automatic Model Selection, *Journal of Time Series Econometrics* 3.1, pp. 133.

Chuffart, T. (2015), Selection Criteria in Regime Switching Conditional Volatility Models, *Econometrics*, 3.2, pp. 289316.

Collier, P. and Hoeffler A. (1998), "On Economic Causes of Civil War", Oxford Economic Papers, N 50, pp. 563-573.

Collier, P. and A. Hoeffler (2002), "Data Issues in the Study of Conflict“, CSAE Econometric and Data Discussion Paper.

Corden and Neary (1984)

Cotet, A., and K. Tsui (2013), "Oil and Conflict: What Does the Cross Country Evidence Really Show?", *American Economic Journal: Macroeconomics*, 5(1), pp. 49-80.

Dasgupta, P. and Heal, G. (1974), "The optimal depletion of exhaustible resources", *Review of Economic Studies*, Symposium on the Economics of Exhaustible Resources, pp. 3-28.

Dooley, M. and M. Hutchison (2009), Transmission of the U.S. subprime crisis to emerging markets: Evidence on the decoupling-recoupling hypothesis, *Journal of International Money and Finance* 28.8, pp. 13311349.

Doornik, J. (2009), Autometrics, *The Methodology and Practice of Econometrics, A Festschrift in Honour of David F. Hendry*, Ed. by J. Castle and N. Shephard. Oxford: Oxford University Press.

Doornik, J. and D. F. Hendry (2007), *PcGive 12*. Ed. by T. C. Ltd. London: TimberlakeConsultants Ltd .

Dufrénot, G., V. Mignon, and A. Péguin-Feissolle (2011), The effects of the subprime crisis on the Latin American financial markets: An empirical assessment, *Economic Modelling* 28.5, pp. 234223.

Eaton, J. and M. Gersovitz (1981), "Debt with potential repudiation: Theoretical and empirical analysis", *Review of Economic Studies*, 48:2, pp. 289-309.

Edwards, S. (1984), "LDCs foreign borrowing and default risk: an empirical investigation", *American Economic Review*, vol. 74(4), pp. 726-34.

Edwards, S. (1986), "The pricing of bonds and bank loans in international markets: an empirical analysis of developing countries' foreign borrowing", *European Economic Review*, vol. 30(3), pp. 565-89.

Eichengreen, B. and A. Mody (1998), "What Explains Changing Spreads on Emerging-Market Debt: Fundamentals or Market Sentiment?", NBER Working Paper No. 6408.

Eyssell, T., H.-G. Fung, and G. Zhang (2013), Determinants and price discovery of China sovereign credit default swaps, *China Economic Review* 24.C, pp. 115.

Frankel J., (2012), The Natural Resource Curse: A Survey of Diagnoses and Some Prescriptions, Forthcoming in Commodity Price Volatility and Inclusive Growth in Low-Income Countries (Arezki, Quintyn, Pattillo and Zhu, eds) International Monetary Fund.

Ferraro, D., K. Rogoff, and B. Rossi (2015), Can oil prices forecast exchange rates? An empirical analysis of the relationship between commodity prices and exchange rates, *Journal of International Money and Finance* 54.C, pp. 116141.

Filardo, A. J. (1998), "Choosing information variables for transition probabilities in a time- varying transition probability Markov switching model", *Research Working Paper* 98-09. Federal Reserve Bank of Kansas City.

Gapen, M., D. Gray, C. H. Lim, and Y. Xiao (2008), Measuring and Analyzing Sovereign Risk with Contingent Claims, *IMF Staff Papers* 55.1, pp. 109148.

Gelos, R., Sahay R. et Sandleris G. (2011), "Sovereign borrowing by developping countries: What determines market access?", *Journal of International Economics* 83, pp. 243-254.

Gilbert, R.J., (1979), "Optimal Depletion of an Uncertain Stock", *Review of Economic Studies* 46, pp. 47-57.

Grimaud, A. and Rougé, L.(2003), "Non-renewable resources and growth with vertical innovations: optimum, equilibrium and economic policies", *Journal of Environmental Economics and Management* 45, pp. 433-453.

Groth, C. and Schou, P. (2002), "Can non-renewable resources alleviate the knife-edge character of endogenous growth?", *Oxford Economic Papers* 54, pp.386-411.

Haas, M., S. Mittnik, and M. S. Paolella (2004), A New Approach to Markov-Switching GARCH Models, *Journal of Financial Econometrics* 2.4, pp. 493530.

Haber, S., and Menaldo, V. (2011), "Do natural resources fuel authoritarianism? a reappraisal of the resource curse", *American Political Science Review*, 105 (1), pp. 126.

Hamilton, J. D. (1989), A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle, *Econometrica* 57.2, pp. 35784.

Hartwick, J.M. (1977), "Intergenerational equity and investing rents from exhaustible resources", *American Economic Review* 66, pp. 972974.

Heal, G. (1979), "Uncertainty and the Optimal Supply Policy for an Exhaustible Resource", *Advances in the Economics of Energy and Resources* 2.

Hilscher, J. and Y. Nosbusch (2010), "Determinants of Sovereign Risk: Macroeconomic Fundamentals and the Pricing of Sovereign Debt," *Review of Finance*, European Finance Association, vol. 14(2), pp. 235-262.

Hotelling, H. (1931), "The Economics of Exhaustible Resources", *Journal of Political Economy* 39, pp. 137-175.

International Monetary Fund (2015), "The Commodities roller coaster. A fiscal framework for uncertain times." *Fiscal Monitor*.

Jensen, N. and Wantchekon, L. (2004), "Resource Wealth and Political Regimes in Africa", *Comparative Political Studies*, vol. 37(7), pp. 816841.

Johansen, S. and B. Nielsen (2009), An analysis of the indicator saturation estimator as a robust regression estimator, *The Methodology and Practice of Econometrics, A Festschrift in Honour of David F. Hendry*, Ed. by J. Castle and N. Shephard. Oxford: Oxford University Press.

Karl, T.L. (1997), *The Paradox of Plenty: Oil Booms and Petro-States*, Berkeley, University of California Press.

Ketkar, S. and D. Ratha (2001), "Development Financing During a Crisis: Securitization of Future Receivables", *World Bank Publications*.

Kim, C.J., J. Piger, and R. Startz (2008). Estimation of Markov regime-switching regression models with endogenous switching, *Journal of Econometrics* 143.2, pp. 263273.

Kretzmann, S. and I. Nooruddin (2005), "Drilling into debt", Oil Change International.

Lafforgue, G. (2008) "Stochastic Technical Change, Exhaustible Resource and Optimal Sustainable Growth", *Resource and Energy Economics*, vol. 30(4), pp. 540554.

Loury, G. (1978),"The Optimal Exploitation of an Unknown Reserve", *Review of Economic Studies* 45, pp. 621-36.

Liang, H. and S. Yongcheol (2008), Optimal Test for Markov Switching GARCH Models, *Studies in Nonlinear Dynamics & Econometrics*12.3, pp. 127.

Longstaff, F. A., J. Pan, L. H. Pedersen, and K. J. Singleton (2011), How Sovereign Is Sovereign Credit Risk?, *American Economic Journal: Macroeconomics* 3.2, pp. 75 103.

Longstaff, F. A. and A. Rajan (2008), An Empirical Analysis of the Pricing of Collateralized Debt Obligations, *Journal of Finance* 63.2, pp. 529563.

Lu, X. and H. White (2014), Robustness checks and robustness tests in applied economics, *Journal of Econometrics* 178, pp. 194206.

Lujala, P. (2010), The spoils of nature: Armed civil conflict and rebel access to natural resources", *Journal of Peace Research*, 47(1), pp. 15-28.

Manzano, O., and R. Rigobon (2001), "Resource curse or debt overhang?", National Bureau of Economic Research, No. w8390.

McSherry, B. (2006), The Political Economy of Oil in Equatorial Guinea, *African Stud-*

ies Quarterly 8, pp. 23-45.

Meadows, D.H., Meadows D.L, Randers J. and W. W. Behrens Ill (1972), *"Limits to Growth"* .A Report for THE CLUB OF ROME'S Project on the Predicament of Mankind.

Melhum, H., Moene, K. and R. Torvik (2006), Institutions and the Resource Curse, *Economic Journal* 116, 508, pp. 1-20.

Merton, R. C. (1974), On the Pricing of Corporate Debt: The Risk Structure of Interest Rates, *Journal of Finance* 29.2, pp. 44970.

Mironov and Petronevich (2015), "Discovering the signs of Dutch disease in Russia", *Resources Policy*, 46, Part 2, pp. 97112.

Morley, J. and J. Piger (2012), The Asymmetric Business Cycle, *The Review of Economics and Statistics* 94.1, pp. 208221.

Oxborrow, D. and Turnovsky, S. J. (2015), "Closing the Small Open Economy Model: A demographic Approach", *University of Washington Working Paper.*

Pan, J. and K. J. Singleton (2008), "Default and Recovery Implicit in the Term Structure of Sovereign CDS Spreads", *Journal of Finance* 63.5, pp. 23452384.

Pindyck, R. (1978), "The Optimal Explorationand Production of Nonrenewable Resources", *Journal of Politial Economy* 86(5), pp. 841-861.

Poelhekke, S. and van der Ploeg, F. (2008), "Volatility, Financial Development and the

Natural Resource Curse," *OxCarre Working Papers 003*, Oxford Centre for the Analysis of Resource Rich Economies, University of Oxford.

Rautava, J. (2004), "The role of oil prices and the real exchange rate in Russias economya cointegration approach", *Journal of Comparative Economics* 32.2, pp. 315327.

Reinhart, C. and K. Rogoff (2009), *This Time Is Different: Eight Centuries of Financial Folly*, Princeton, New Jersey: Princeton University Press.

Remolona, E. M., M. Scatigna, and E. Wu (2008), "A ratings-based approach to measuring sovereign risk", *International Journal of Finance & Economics* 13.1, pp. 2639.

Report of the World Commission on Environment and Development (Brudtland Report), 1987.

Robinson, J., Torvik, R. and T. Verdier (2006), "Political Foundations of the Resource Curse", *Journal of Development Economics* 79, no. 2, pp. 446-68.

Ross, M. L. (2001), "Does Oil Hinder Democracy?" *World Politics* 53, no.3, pp. 325-61.

Ross, M. L. (2004), "What Do We Know About Natural Resources and Civil War? ", *Journal of Peace Research*, vol. 41(3), pp. 337-356.

Ross, M. L. (2006), "A Closer Look at Oil, Diamonds, and Civil War", *Annual Review of Political Science*, vol. 9, pp. 265-300.

Sachs, J., and A. Warner (1995),"Natural Resource Abundance and Economic Growth" in G. Meier and J. Rauch, eds., *Leading Issues in Economic Development*, New York: Oxford University Press.

Sachs, J., and A. Warner (2001),"The Curse of Natural Resources",*European Economic Review* (Elsevier), vol. 45(4-6), pp. 827-838.

Sala-i-Martin, X. and Subramanian A. (2003), "Addressing the Natural Resource Curse: An Illustration from Nigeria." IMF Working Paper WP/03/139.

Schmitt-Grohe, S. and Uribe, M. (2003),"Closing small open economies", *Journal of International Economics* 61, pp.163-185.

Schou, P. (1996), "A Growth Model with Technological Progress and Non- renewable Resources", Mimeo, University of Copenhagen (1996).

Sharma, S. and K. Thuraisamy (2013), "Oil Price Uncertainty and Sovereign Risk: Evidence from Asian Economies", *Journal of Asian Economics*, Elsevier, vol. 28(C), pp. 51-57.

Sims, C. A. and T. Zha (2006), Were There Regime Switches in U.S. Monetary Policy?, *American Economic Review* 96.1, pp. 5481.

Solow, R. (1974): "Intergenerational equity and exhaustible resources", *Review of Economic Studies*, Symposium on the Economics of Exhaustible Resources: 29-46.

Stiglitz, J. (1974): "Growth with exhaustible natural resources: Efficient and optimal growth paths", *Review of Economic Studies*, Symposium on the Economics of Exhaustible Resources, pp. 123-137.

Tsui, K. (2011), "More Oil, Less Democracy: Evidence from Worldwide Crude Oil Discoveries," *Economic Journal*, vol.121(551), pp. 89-115.

Van den Bremer, T.S, van der Ploeg, F. and S. Wills (2016), "The Elephant in the ground: managing oil and sovereign wealth", *European Economic Review*, 82, pp.113-131.

Van der Ploeg, F. (2010), "Aggressive oil extraction and precautionary saving: coping with volatility", *Journal of Public Economics*, 94, 5-6, pp. 421-433.

Van der Ploeg, F. (2011), "Natural resources: curse or blessing?", *Journal of Economic Literature*, 49, 2, pp. 366-420.

Van der Ploeg, F. and S. Poelhekke (2009), "Volatility and the Natural Resource Curse", *Oxford Economic Papers*, 61, 4, pp. 727-760.

Van der Ploeg, F. and Venables, A. (2011), "Harnessing Windfall Revenues: Optimal Policies for ResourceRich Developing Economies", *The Economic Journal* 551, pp. 1-30.

Van der Ploeg, F. and Venables, A. (2013), "Absorbing a windfall of foreign exchange: Dutch disease dynamics," *Journal of Development Economics*, Elsevier, vol. 103, pp. 229-243.

Wang, P. and T. Moore (2012), The integration of the credit default swap markets during the US subprime crisis: Dynamic correlation analysis, *Journal of International Financial Markets, Institutions and Money* 22.1, pp. 115.