Du besoin de financement à l'épargne de précaution : l'impact du risque sur les flux de capitaux et la croissance dans les pays émergents

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L'Impact du Risque sur les Flux de Capitaux et la Croissance dans les Pays Émergents

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Introduction Générale

Cette thèse traite de l'impact des risques de liquidité et de production sur le lien entre flux de capitaux et croissance d'une part, et entre politique de change et croissance d'autre part. Ainsi, nous proposons des explications à certains paradoxes de finance internationale : le paradoxe de l'allocation et le paradoxe du régime de change.

Le paradoxe de l'allocation fait référence à la relation "perverse" entre flux de capitaux et croissance. En effet, l'intégration financière est traditionnellement considérée comme une opportunité pour les pays en développement de croître plus vite en attirant les flux de capitaux du monde développé. Lorsque le rendement marginal du capital est plus élevé que le taux d'intérêt mondial, que ce soit à cause d'une faible dotation en capital ou de la croissance de la productivité globale des facteurs (PGF), les agents domestiques devraient emprunter auprès du reste du monde afin d'investir dans leur propre production. Cependant, cette vision des choses a été remise en cause par le fait que les flux de capitaux qui devraient égaliser les rendements marginaux n'ont pas lieu (Lucas, 1990). Les récents "déséquilibres mondiaux" ne font que renforcer ce paradoxe : au lieu de recevoir des flux de capitaux, les pays émergents investissent dans les pays industriels, en particulier aux Etats-Unis. Pour une partie de la littérature, ces déséquilibres sont dus à l'inefficacité des marchés financiers émergents, qui pousse les agents domestiques à se tourner vers les marchés financiers étrangers. Cette interprétation a contribué à renouveler la façon de considérer la relation des pays en développement aux marchés financiers mondiaux. Ces derniers ne sont pas seulement une source de financement externe, mais aussi des fournisseurs de services financiers. En particulier, lorsque le risque de production ou de liquidité ne peut être assuré au niveau local, les marchés financiers étrangers peuvent fournir des actifs liquides et sans risque qui servent à l'auto-assurance des investisseurs des pays en développement contre leur risque spécifique. Cette approche permet d'expliquer les déséquilibres mondiaux par l'épargne de précaution des pays émergents. Cependant, les implications de l'épargne de précaution sur les liens entre croissance et flux de capitaux sont encore peu étudiées. **L'objectif principal de cette thèse est donc de ré-examiner la relation entre flux de capitaux et croissance à travers la prise en compte de l'épargne de précaution.** Cette démarche implique de tenir compte du risque individuel des investisseurs et de l'incomplétude des marchés financiers domestiques. Considérer que les pays émergents sont à la recherche non seulement de financement externe, mais aussi d'actifs liquides et sans risque permet de mieux comprendre cette relation dans les faits. En particulier, dans les données, la croissance n'est pas associée à davantage d'entrée de capitaux, comme le prédirait la théorie standard, mais à davantage de sorties (Aizenman and Pinto, 2007; Prasad *et al.*, 2007; Gourinchas and Jeanne, 2007). Ces faits constituent le "paradoxe de l'allocation" et font l'objet d'une tentative d'explication dans les deux premiers chapitres de cette thèse.

Par ailleurs, les défaillances des systèmes financiers domestiques des pays émergents, notamment leur inefficacité dans l'assurance du risque de liquidité des entreprises, affecte la relation entre croissance et politique macroéconomique. Ces défaillances permettent d'expliquer en particulier le deuxième paradoxe, le paradoxe du régime de change. Ce paradoxe renvoie à l'absence de relation robuste dans la littérature empirique entre politique de change et croissance (Baxter and Stockman, 1989; Husain *et al.*, 2005; Dubas *et al.*, 2005; De Grauwe and Schnabl, 2005). Aghion *et al.* (2006a) proposent une explication de ce paradoxe. Ils montrent empiriquement que la stabilité du taux de change a un effet d'autant plus bénéfique sur la croissance que le développement financier est faible. L'argument théorique repose sur l'idée qu'en présence de contraintes de crédit, les fluctuations ont des effets asymétriques sur la capacité d'innovation des entreprises. Par conséquent, la volatilité a un impact négatif sur la capacité moyenne des firmes à innover. Or, la flexibilité du taux de change est une source de volatilité macroéconomique, comme le montrent Aghion *et al.* (2006a). Si ce résultat permet d'expliquer la "peur du change flottant" dans les pays émergents, il est incomplet. Notamment, il est nécessaire de prendre en compte la dollarisation de la dette pour expliquer cette peur. En effet, la dollarisation rend plus vulnérables les revenus des firmes aux fluctuations du taux de change. **Le second objectif de cette thèse est donc d'examiner l'impact de la flexibilité du taux de change sur la croissance, mais en se concentrant sur le rôle de la dollarisation de la dette.** Cette question est abordée dans le troisième chapitre.

Les deux premiers chapitres s'inscrivent dans la littérature étudiant l'impact de l'intégration financière sur la croissance. En particulier, ils abordent les liens entre croissance et flux de capitaux. Or, les flux de capitaux peuvent d'autant plus jouer un rôle dans le développement qu'ils complètent le système financier domestique, en particulier (i) en termes d'accès à l'épargne étrangère d'une part, (ii) de diversification des risques d'autre part. Nous faisons dans ce qui suit le bilan de la littérature sur ces deux canaux majeurs de l'impact de la libéralisation financière. Nous constaterons que, d'une part, (i) il n'existe pas encore de théorie expliquant les flux d'épargne Nord-Sud observés. Ces derniers constituent l'objet de notre étude. D'autre part, (ii) dans les faits, la diversification des risques est loin d'être effective, que ce soit au niveau domestique ou international. Cette constatation appuie la démarche adoptée dans cette thèse, qui consiste à considérer la libéralisation financière non comme une source supplémentaire de diversification, mais comme une source de titres liquides et sans risques. Dans ce cas, l'auto-assurance des agents domestiques passe non par le partage des risques, mais par l'épargne de précaution. C'est cette épargne qui permet alors d'expliquer les paradoxes des flux Nord-Sud.

Le troisième chapitre, quant à lui, se rattache à la littérature sur les effets de la volatilité sur la croissance et sur la ”peur du change flottant”. Nous montrons qu'il existe un seuil de dollarisation au-delà duquel une économie ouverte ne peut profiter des vertus des régimes de change flexible, au risque de nuire à la croissance.

Dans ce qui suit, nous analysons la littérature sur les liens entre intégration financière et croissance en la rattachant à nos travaux. Cet exposé est suivi d'un résumé des deux premiers chapitres de la thèse. Ensuite, nous abordons plus en détail la littérature sur le lien entre régime de change et croissance afin d'introduire le troisième chapitre, qui est alors résumé.

Le rôle du secteur financier dans le développement économique a fait l'objet d'un débat presque centenaire. Depuis que Schumpeter (1911) a mis en avant les effets bénéfiques des services financiers sur la croissance, deux courants ont émergé. Pour le premier (Robinson, 1952; Lucas, 1988), les marchés financiers sont un simple reflet de l'activité économique. Pour le second, même si la causalité n'est pas unilatérale, il est important d'étudier comment le développement financier affecte la croissance économique (Patrick, 1966; Goldsmith, 1969; McKinnon, 1973). Au regard des études empiriques, il est à présent clair que, même si le développement économique génère de lui-même les incitations à l'émergence d'un secteur financier, de bonnes institutions financières font partie des pré-requis à la croissance.[1] En offrant les services des marchés extérieurs là où péchent les marchés domestiques, la libéralisation permet-elle d'améliorer les performances économiques ? Afin de répondre, il est important de distinguer d'abord quelles sont les différentes fonctions des marchés financiers. Levine (2005) en définit cinq : 1) la production d'information sur les projets avant

[1] Dans les études économétriques, l'endogénéité du système financier a été traitée en utilisant des instruments, soit le niveau de développement des marchés financiers en début de période (King and Levine, 1993a; Levine and Zervos, 1998), soit par l'origine légale de La Porta *et al.* (1998) (Levine, 1998, 1999; Levine *et al.*, 2000; Beck *et al.*, 2000). Ces études établissent ainsi que la composante exogène du développement financier a bien un impact positif sur la croissance. D'autres études arrivent aux mêmes conclusions en utilisant la dimension temporelle, notamment par le test de causalité à la Granger (Arestis and Demetriades, 1997; Xu, 2000; Christopoulos and Tsionas, 2004) ou en utilisant des données désagrégées (Rajan and Zingales, 1998; Jayaratne and Strahan, 1996; Demirgüç-Kunt and Maksimovic, 1998).

investissement ; 2) la supervision de l'investissement ; 3) l'échange, la diversification et la gestion du risque ; 4) La mobilisation et la centralisation de l'épargne ; 5) La facilitation des échanges de biens et services. Ces cinq fonctions ont toutes fait l'objet d'une recherche abondante. Cependant, du point de vue de l'ouverture financière, elles n'ont pas toutes les mêmes implications.

En effet, l'ouverture financière ne permet pas toujours de combler certaines lacunes des systèmes financiers domestiques. En ce qui concerne les deux premières fonctions, à savoir la production d'information et la supervision des investissements, elles sont plus à même d'être remplies par le système financier local. En effet, ce dernier possède l'avantage de la proximité et de la familiarité avec les projets étudiés ou supervisés, de même qu'une connaissance plus approfondie de l'environnement où les projets sont menés et du système légal encadrant les modalités de supervision. Quant à la cinquième fonction, à savoir la facilitation des échanges de biens et services, elle désigne le rôle que joue la monnaie dans la fluidification des échanges. Hormis dans les cas de dollarisation monétaire, où l'adoption d'une monnaie étrangère permet de surmonter les problèmes de crédibilité du gouvernement et d'hyperinflation, la monnaie est en général émise par une institution centrale et spécifique au pays. L'ouverture financière, sauf dans les cas de crise, ne remet pas en cause le rôle de facilitation des échanges des institutions financières.

Au contraire, la troisième fonction, la diversification du risque, joue un rôle fondamental lors de la libéralisation financière. En effet, cette dernière offre des possibilités supplémentaires de diversification des risques et permet donc aux agents de s'engager dans des projets plus risqués et plus rentables. De même, l'intégration financière offre des perspectives de financement nouvelles pour les pays en développement en leur donnant la possibilité d'utiliser l'épargne des pays développés pour investir. Elle permet donc de pallier la difficulté des marchés financiers domestiques à remplir la quatrième fonction, à savoir mobiliser des capitaux.

Ainsi, c'est en permettant la mobilisation de l'épargne étrangère d'une part, et par une meilleure diversification du risque d'autre part que les flux de capitaux sont censés influencer la croissance. Quels en sont les mécanismes et qu'en est-il dans les faits ?

La mondialisation financière est a priori censée apporter aux pays en développement des flux de capitaux lui permettant de croître plus vite. En effet, les capitaux devraient affluer des pays riches vers les pays pauvres car ces derniers ont un niveau de capital par tête plus faible. Dans le cas d'une fonction de production néoclassique ayant pour seuls argument le capital et le travail, cela implique que le rendement marginal du capital est plus élevé dans les pays pauvres, et que ces derniers devraient donc attirer les capitaux des pays riches jusqu'à que les rendements s'égalisent. La mondialisation des flux de capitaux permettraient donc des gains à l'échange significatifs. Ainsi, d'après Eichengreen and Mussa (1998), "la libre circulation des capitaux permet une meilleure allocation globale de l'épargne et des ressources vers leurs usages les plus productifs". De même, Fischer (1998) affirme que "de manière abstraite, la libre circulation du capital facilite l'allocation efficiente de l'épargne et aide à acheminer les ressources vers leur usage le plus productif, et donc augmente la croissance économique et le bien-être". Or, ces rendements marginaux, tels qu'ils sont calculés du moins, ne s'égalisent pas (Lucas, 1990)[2].

Le paradoxe de Lucas peut s'expliquer notamment par la mauvaise spécification de la fonction de production : celle-ci aurait d'autres arguments, comme le capital humain, ou plus généralement la productivité globale des facteurs (PGF). Ainsi, les rendements marginaux du capital s'égalisent entre pays, sans que les niveaux de capital par tête ne convergent. Cette différence est expliquée par le fait que la production est plus efficace dans les pays riches que dans les pays pauvres.[3] Des

[2] Voir aussi Barro and Sala-i Martin (1995) et Manzocchi and Martin (1997)

[3] Hall and Jones (1999) montrent en effet que les écarts de production par tête entre pays sont surtout dus aux écarts de PGF, et non aux différences en termes de dotations de facteurs. Caselli (2004) résume les sources potentielles de ces écarts de PGF en niveau dans la littérature. Voir aussi Mankiw (1995), Jorgenson (1995) et Easterly and Levine (2001).

frictions peuvent également créer des rentes[4] qui affectent le rendement privé du capital domestique, l'empêchant ainsi d'égaler celui des pays industriels, ou alors imposent des contraintes de crédit [5]. Pour Gourinchas and Jeanne (2006), les gains à la libéralisation sont plus faibles que les gains potentiels d'une amélioration de la productivité domestique, ou encore de la diminution des distorsions sur le rendement du capital. En effet, si le niveau de capital par tête est faible dans les pays en développement, ce n'est pas parce qu'il est loin de son niveau de convergence, mais parce que le niveau de long-terme est lui-même faible. Le paradoxe de Lucas est en fait le paradoxe du faible investissement dans les pays en développement. Comprendre pourquoi cet investissement est faible (i.e. pourquoi le niveau de capital est faible) revient à comprendre pourquoi il n'y a pas de flux de capitaux. Les flux de capitaux n'ont pas lieu parce qu'ils n'ont justement pas lieu d'être, ce qui explique le paradoxe de Lucas.

Les récents phénomènes appelés ”déséquilibres mondiaux” et caractérisés par le creusement du déficit de la balance des paiements des Etats-Unis, ont renforcé le paradoxe des flux Nord-Sud. En effet, il s'agit d'une illustration du paradoxe de Lucas, puisque le déficit américain est financé en grande partie par des capitaux originaires des pays émergents, notamment de l'Asie. Ainsi, ces phénomènes ont pu être rapprochés de la “surabondance d'épargne” (*saving glut*) dans les pays asiatiques.[6] Les auteurs qui ont étudié les déséquilibres mondiaux de ce point de vue désignent en général comme responsable le faible développement financier des pays émergents mais lui donnent des interprétations différentes. Certaines sont similaires à celles qui ont été apportées précédemment dans la littérature, notamment les asymétries d'information et les aléas moraux (Ju and Wei, 2006, 2007), et les contraintes de crédit (Aoki *et al.*, 2006; Matsuyama, 2004, 2005; Caballero *et al.*, 2008). D'autres, notamment Mendoza *et al.* (2007a) et Mendoza *et al.* (2007b), en

[4] Ces rentes peuvent être dues au risque moral (Gertler and Rogoff, 1990; Schleifer and Wolfenzon, 2002), ou à l'asymétrie d'information (Gordon and Bovenberg, 1996; Boyd and Smith, 1997).

[5] Voir par exemple (Barro *et al.*, 1995; Verdier, 2008).

[6] Il ne s'agit pas de la seule explication. Chinn and Ito (2005), par exemple, soutiennent que la raison principale est interne aux Etats-Unis et se situe dans leur déficit public excessif (”déficits jumeaux”).

considérant la capacité qu'ont les marchés financiers domestiques à mutualiser le risque entre les agents, mettent l'accent sur l'épargne de précaution.

Parallèlement à ces développements, des travaux empiriques récents montrent que les flux de capitaux sont plus pervers encore que ne le suggère le paradoxe de Lucas. Prasad *et al.* (2007) montrent que, pendant les années 2000, non seulement les capitaux ont afflué des pays pauvres vers les pays riches, mais la croissance est corrélée positivement avec les flux de capitaux *sortants* dans les pays en développement, alors que la corrélation est inversée pour les pays industriels. Ainsi, "au premier abord, il y aurait une prime de croissance pour les pays [émergents] ne recourant pas au financement étranger" (Prasad *et al.* (2007), p.205). Aizenman and Pinto (2007) établissent les mêmes conclusions. Ces faits peuvent aussi être rapprochés des déséquilibres mondiaux. En effet, les pays émergents exportent leurs capitaux vers les Etats-Unis, et ceci malgré le fait qu'ils aient crû plus vite que ces derniers. Gourinchas and Jeanne (2007) confirment ces résultats. Ils montrent ainsi que le capital a afflué vers les pays où la croissance de la PGF a été relativement plus faible, ce qui est à contre-courant de la théorie néoclassique. Pour le distinguer du Paradoxe de Lucas, ils nomment ce phénomène le "paradoxe de l'allocation", car il concerne non le *niveau* des flux de capitaux Nord-Sud, mais leur *allocation* entre pays du Sud. De plus, ils montrent que, contrairement au paradoxe de Lucas, ce phénomène ne peut pas s'expliquer par des facteurs qui font baisser le rendement privé du capital. En effet, même en tenant compte de ces facteurs, les flux se comportent à l'opposé de ce qu'ont attendrait. C'est là où l'investissement est le plus faible que le capital a le plus afflué. Ainsi, si le paradoxe de Lucas, qui peut se ramener au paradoxe du faible investissement dans les pays émergents, peut s'expliquer par des facteurs qui abaissent le niveau du capital de long terme, ce n'est pas le cas du paradoxe de l'allocation, qui est un paradoxe de la déconnection de l'investissement et des flux de capitaux.

Comme le soulignent Gourinchas and Jeanne (2007), des explications possibles du paradoxe de l'allocation existent dans la littérature. Tout d'abord, la relation positive entre la croissance et le compte courant (i.e. les flux sortants) peut être reliée à la littérature sur la relation positive entre épargne et croissance. Ce lien a été établi au niveau des pays par Carroll and Weil (1994) et plus récemment par Attanasio *et al.* (2000). Deux grandes familles de modèles peuvent expliquer ce lien : les modèles à générations imbriquées et les modèles avec habitudes de consommation. Il convient d'examiner chacune d'elles afin de déterminer si elles peuvent être enrichies pour tenir compte de la relation entre croissance et compte courant, qui est égal à l'épargne moins l'investissement. Premièrement, l'hypothèse du cycle de vie de Modigliani (1986) a pour conséquence que les pays à forte croissance ont un taux d'épargne plus élevé car les ménages jeunes, qui sont dans la phase d'épargne de leur cycle de vie, sont plus riches que les ménages âgés, qui sont dans leur phase de désépargne. Cependant, dans l'approche de Modigliani, une croissance plus élevée n'implique que de plus grandes différences de revenus entre jeunes et vieux (effet de composition). Or, au niveau individuel, la croissance augmente la richesse intertemporelle des agents. Ceux-ci, afin de lisser leur consommation, doivent emprunter plus (effet richesse). Carroll and Summers (1991) montrent que l'effet richesse domine l'effet de composition. Ainsi, même dans le cadre du cycle de vie, la croissance devrait être corrélée négativement avec l'épargne, et à plus forte raison avec le compte courant. Deuxièmement, Carroll *et al.* (2000) mettent en valeur le rôle de l'habitude pour expliquer le lien positif entre croissance et épargne. Dans ce type de modèle, l'élasticité de substitution intertemporelle est plus élevée, donc l'épargne est plus sensible à un changement de taux d'intérêt. Cependant, cette propriété ne peut aboutir à une relation positive entre épargne et croissance qu'en économie fermée, où le taux d'intérêt dépend du rendement marginal du capital. Dans une économie ouverte, le canal du taux d'intérêt est supprimé, puisque ce dernier est déterminé au niveau international.

La relation positive entre sorties de capitaux et croissance peut aussi être abordée du point de vue du commerce. En effet, le compte courant est égal aux exportations moins les importations. Or, des études relient la croissance de certains pays au rôle bénéfique des exportations. Pour Dooley *et al.* (2004), Dooley *et al.* (2005a), Rodrik (2006) et Rodrik (2007), les politiques visant à promouvoir les exportations, en particulier en maintenant un taux de change sous-évalué, sont favorables au secteur manufacturier. Cependant, ces études ne disent pas comment la croissance à son tour influence la balance commerciale. Cette dernière est souvent considérée comme exogène. En effet, dans cette littérature, ce n'est pas tant son solde que sa composition en termes d'importations et d'exportations qui compte. La contribution d'Aghion *et al.* (2006b) peut être rapprochée également de cette branche de la littérature, même si, selon eux, ce sont les investissements directs et non les exportations qui bénéficient à la croissance. Ces études ne tiennent pas compte du comportement intertemporel des agents, autrement dit de la manière dont ils ajustent leur épargne en réponse à une croissance plus élevée.

Ainsi, bien que le paradoxe de Lucas ait donné lieu à une littérature abondante, les nouveaux faits stylisés sur les flux Nord-Sud, notamment le lien positif entre sorties de capitaux et croissance, ne sont pas encore très étudiés.

Après l'ouverture à l'épargne extérieure, la diversification du risque est la deuxième des voies majeures par lesquelles la libéralisation financière peut influencer le développement. Mais, dans la littérature, c'est d'abord l'un des biais par lesquels les systèmes financiers participent à la croissance en économie fermée. Elle permet de réduire deux principaux types de risque : le risque de production et le risque de liquidité. Le premier peut être défini comme le risque inhérent au processus de production ; il s'agit de l'aléa portant sur le résultat final de ce processus. Pour King and Levine (1993b), la diversification du risque de production permet aux agents de s'engager dans des activités innovatrices mais risquées, ce qui augmente le taux d'innovation de l'économie.[7] Mais la croissance de l'économie a aussi un effet sur le

[7] Levine (1991) et Atje and Jovanovic (1993) considèrent plus particulièrement le rôle des marchés d'actions dans la diversification des risques et la croissance. Lorsque la diversification affecte la nature des projets menés par les entrepreneurs, celle-ci a un effet positif sur l'économie.

développement des marchés financiers.[8] Du fait de ces mécanismes de réciprocité, des équilibres multiples peuvent surgir et l'économie peut être emprisonnée dans une trappe à pauvreté ou au contraire s'engager dans un processus vertueux de développement. Les gains potentiels au partage du risque sont d'autant plus élevés que le risque de production individuel est élevé et que la diversification de ce risque est à l'origine faible. Or, même dans les pays industriels, la diversification des risques domestiques est faible. Par exemple, le taux de survie d'une firme privée américaine après 5 ans est inférieur à 40% (Angeletos and Calvet, 2006). De même, aux États-Unis, 75% des actions sont détenues par des ménages dont elles constituent plus de la moitié de la richesse (Vissin-Jørgensen, 2002).[9]

Le risque de liquidité, quant à lui, peut être défini comme "l'incertitude associée à la conversion d'actifs en moyens d'échange" (Levine, 2005). L'illiquidité est en général due à des asymétries d'information ou à des coûts de transactions. Ainsi, des projets rentables mais requérant un engagement financier de long terme, peuvent subir des contretemps -des coûts aléatoires- au cours de leur mise en oeuvre. Ces projets peuvent être abandonnés en cours de route, même si la valeur actualisée du projet est supérieur au coût, faute des fonds disponibles. Grâce aux marchés financiers, la centralisation de nombreux actifs illiquides permet de générer des actifs liquides, en particulier les actions, qui peuvent être détenus par les entreprises pour faire face aux contretemps survenant pendant le processus de production. L'article fondateur de Diamond and Dybvig (1983) montre qu'en présence de coûts de vérification, une assurance contre le risque de liquidité ne peut pas se mettre en place. Un marché des titres peut alors remplacer le marché de l'assurance défaillant afin de permettre

[8] Dans l'article d'Acemoglu and Zilibotti (1997), plus le nombre de projets est élevé, plus les possibilité de diversification sont importantes, plus le marché financier est efficace dans sa fonction d'assurance, et plus les agents sont aptes à s'engager à leur tour dans de nouveaux projets risqués. Pour Saint-Paul (1992), la diversification du risque n'affecte pas le nombre des projets, mais les choix technologiques des agents : elle encourage la division du travail qui suppose des projets plus risqués mais plus rentables. Comme dans la contribution d'Acemoglu and Zilibotti (1997), une spécialisation plus poussée permet en elle-même des possibilités d'assurance accrues. Pour Grenwood and Jovanovic (1990), le mécanisme par lequel la croissance influence le développement financier tient dans les ressources supplémentaires qui permettent de financer un système financier coûteux.

[9] Voir aussi à ce sujet Hayashi *et al.* (1996) et Attanasio and Davis (1996).

aux entrepreneurs de diversifier leur risque de liquidité. Ces derniers peuvent alors investir dans des projets moins liquides mais plus rentables.[10] L'accès au crédit durant le processus de production est également un moyen d'améliorer la liquidité des entreprises.[11] Les contraintes de crédit, dans l'étude d'Aghion *et al.* (2005), jouent ainsi un rôle important dans l'allocation des investissements entre investissements de court terme et de long terme, en particulier la recherche et développement (R&D), au cours du cycle économique. En effet, c'est au cours des récessions que les firmes sont le plus incitées à investir dans la R&D, mais c'est aussi au cours de ces périodes qu'elles ont le moins accès au crédit, en particulier lorsque les marchés financiers sont peu développés. La volatilité économique a ainsi un impact négatif sur la croissance, et ce d'autant plus que le système financier est défaillant.

La diversification des risques permet ainsi d'améliorer sans ambiguïté la structure de l'épargne. Toutefois, lorsque qu'elle affecte le taux d'épargne lui-même, son impact est ambigu. La littérature qui traite du risque idiosyncratique dans des modèles à agents hétérogènes et à horizon infini est instructive à ce sujet. En particulier, les modèles à la Bewley (Aiyagari, 1994; Huggett, 1997; Krusell and Smith, 1998) montrent que le risque idiosyncratique a un effet positif sur le niveau de capital de long terme à travers l'épargne de précaution. Améliorer la diversification entre agents a donc un effet négatif sur le développement. Or, dans ces modèles, le risque ne porte que sur les dotations. Lorsque le risque porte aussi sur le rendement du capital, celui-ci doit satisfaire une prime de risque, ce qui a un effet négatif sur le stock de capital de long terme (Angeletos and Calvet, 2006). Ainsi, l'effet du risque sur le niveau développement est ambigu : il dépend de la résultante de l'effet de l'épargne de précaution sur le taux d'intérêt de long terme et de la prime de risque. Si l'effet sur le taux d'intérêt est inférieur à l'effet sur la prime de risque, alors le risque a un effet négatif sur le niveau de production. Cependant, dans Angeletos and Calvet (2006), mais aussi dans Angeletos (2007), le risque a un impact négatif pour

[10] C'est aussi l'argument de Bencivenga and Smith (1991) et Bencivenga *et al.* (1995), où un système financier plus efficace soutient ainsi le développement économique.

[11] Dans l'article de Holmstrom and Tirole (1998), des options permettant d'avoir accès à une ligne de crédit dans certains états de la nature réduit les problèmes de liquidité.

des valeurs de paramètres réalistes, en particulier pour une élasticité de substitution intertemporelle élevée par rapport à la part risquée de la richesse (Angeletos, 2007). En effet, dans ce cas, l'impact du risque sur le taux d'intérêt est faible puisqu'il suffit d'une faible variation pour équilibrer le marché des titres à la suite d'une augmentation de l'épargne de précaution.[12] [13]

Ainsi, en permettant aux agents de diversifier leur risque de production, la libéralisation financière devrait leur permettre de se spécialiser et par là d'être plus productifs, et ce d'autant plus qu'il existe des externalités sur l'accumulation du capital. C'est le cas dans Obstfeld (1994). Devereux and Smith (1994) montrent que l'effet de l'intégration sur l'épargne mondiale peut être négatif et donc qu'elle peut être préjudiciable pour la croissance. Cependant, l'analyse de ces derniers peut être soumise à la critique d'Angeletos (2007). Ainsi, que ce soit en améliorant la structure de l'épargne ou en agissant sur le niveau d'épargne lui-même, la diversification domestique et internationale des risques a, en théorie, un effet positif sur la croissance.

Toutefois, le partage international du risque reste en pratique limité. En effet, que ce soit du point de vue des moyens de la diversification (diversification des portefeuilles) que de ses effets (corrélation de la consommation entre pays et stabilisation de la consommation), les études empiriques montrent que l'intégration financière n'a pas permis de partager les risques de manière efficace. Le constat que la majorité des actions détenues par les pays développés sont des actions domestiques est un fait robuste (French and Poterba, 1991; Tesar and Werner, 1995), même si ce "biais domestique" a décru ces dernières années (Chan *et al.*, 2005). Cette constatation a donné naissance à de nombreuses recherches (cf. Lewis (1999) pour une revue de la littérature), qui ont permis de proposer des explications

[12] Dans l'article de Covas (2006), la réduction du risque a un impact global négatif sur l'accumulation de capital, mais Angeletos (2007) montre que cela provient d'une mauvaise spécification du modèle et donc d'une mauvaise paramétrisation.

[13] Le même raisonnement s'applique aux modèles AK (Krebs, 2003; Jones *et al.*, 2005), à la différence près que dans ce cas le risque affecte la croissance de long terme et non le niveau de production.

au biais domestique dans la détention d'actions.[14] Parallèlement, on constate que, dans les faits, la dynamique de la consommation n'est pas conforme à ce que prédirait le partage international des risques. Notamment, les taux de croissance de la consommation devraient être plus corrélés entre pays que les taux de croissance de la production, or c'est l'inverse qui est observé (Backus *et al.*, 1992; Devereux *et al.*, 1992). Dans l'absolu, les marchés financiers sont donc peu efficaces en ce qui concerne le partage des risques. Cependant, on peut encore se demander si l'ouverture financière au cours du temps ne permet pas de *relativement* mieux assurer la consommation. Les résultats des études sur la question sont mitigés. Les études montrent que la coordination des cycles nationaux a augmenté pendant la période de mondialisation (Stock and Watson, 2003; Bordo and Helbling, 2003; Imbs, 2006). Cependant, en ce qui concerne la corrélation de la consommation, les résultats sont plus contrastés. Imbs (2006) établit que l'intégration financière est associée à une plus grande synchronisation de la consommation. Cependant, Kose *et al.* (2003) montrent que, contrairement aux prédictions de la théorie, la corrélation inter-pays de la croissance de la consommation n'a pas augmenté pendant les années 1990, précisément au moment où la libéralisation financière aurait dû permettre un meilleur partage des risques. D'autres études établissent que la mondialisation n'a pas permis non plus de stabiliser la consommation, notamment celle des pays émergents (Prasad *et al.*, 2003; Bekaert *et al.*, 2006).

Jusqu'à récemment, ces deux branches de la littérature, celle qui étudie les flux Nord-Sud et celle qui étudie le partage du risque, ont évolué de manière relativement autonome, bien qu'elles aient toutes deux des implications en termes de flux de capitaux. La première met l'accent sur la dette et les flux nets, sans parvenir à reproduire les faits stylisés. La deuxième s'est penchée surtout sur le rôle de diversification du risque par les marchés domestiques et internationaux. En général,

[14] Parmi ces explications, on peut citer la présence d'un biais domestique dans la consommation (Obstfeld, 2006; Coeurdacier, 2008), le rôle d'assurance de la consommation domestique que jouent les revenus du travail (Bottazi *et al.*, 1996; Engel and Matsumoto, 2006) ou encore les titres nominaux (Coeurdacier *et al.*, 2007).

cette dernière branche implique des flux de capitaux bilatéraux, en particulier en termes d'actions, mais pas forcément de flux nets. Cependant, s'il est vrai que les marchés financiers, notamment avec leur fonction de partage des risques, jouent un rôle positif dans le niveau de vie et la croissance, ce partage reste incomplet. Comme il a été rappelé plus haut, l'intégration internationale ne permet pas de compléter significativement les lacunes des marchés domestiques en termes de partage des risques. Or, les freins à la diversification des risques individuels et internationaux ont une implication importante en termes de flux nets : comme le montrent Mendoza *et al.* (2007a) et Mendoza *et al.* (2007b), c'est par la détention de titres sans risques, par l'épargne de précaution, que les agents tentent de limiter leur risque individuel. Or, cette épargne de précaution devrait jouer un rôle tandis que les pays émergents investissent dans leur production risquée, et donc modifier la relation entre croissance et flux de capitaux. Les deux premiers chapitres de cette thèse montrent qu'en ouvrant le modèle de croissance néoclassique aux apports de la littérature sur le risque, les faits stylisés sur les liens entre croissance et flux de capitaux peuvent être mieux compris.

Les deux premiers chapitres de cette thèse traitent de cette relation entre flux de capitaux et croissance. le premier met en parallèle les déséquilibres mondiaux récents et la croissance des pays émergents, en insistant sur le rôle du risque de liquidité et des choix technologiques. Le deuxième tente d'expliquer quant à lui de la corrélation entre flux de capitaux et croissance dans les pays en développement, en introduisant un risque de production individuel dans le modèle de croissance néoclassique.

L'apport du **premier chapitre** réside dans la mise en relation deux faits généralement considérés de manière indépendante : 1) les déséquilibres du compte courant des pays industriels, en particulier des Etats-Unis, et 2) la croissance de la productivité du travail dans les pays émergents depuis les années 1990. Ces deux faits peuvent être rattachés chacun à une littérature abondante : celle, sur les déséquilibres mondiaux, déjà mentionnée plus haut, et celle sur le rattrapage des pays en développement. En particulier, dans les contributions théoriques cherchant à expliquer les déséquilibres mondiaux, la croissance est en général ignorée, parfois même elle contredit les faits. Dans le modèle de Mendoza *et al.* (2007a), par exemple, le stock de capital est fixe et donc l'ouverture financière n'a aucun impact sur la croissance. Dans les contributions de Mendoza *et al.* (2007b) et Matsuyama (2005), l'ouverture financière fait augmenter la position extérieure nette des pays en développement mais fait baisser l'investissement domestique. Or, on constate, qu'au contraire, tandis que les pays émergents investissent dans les pays développés, leur croissance est supérieure à celle de ces derniers. Caballero *et al.* (2008) sont les seuls à expliquer les déséquilibres mondiaux tout en tenant compte de la croissance dans les économies émergentes. Dans leur modèle, si les pays émergents exportent leurs capitaux malgré leur croissance soutenue, c'est parce que leurs secteurs financiers ne sont pas assez développés pour leur permettre de stocker de la valeur.

Ce chapitre tente de combler cette lacune en proposant un modèle d'équilibre général où ces deux faits résultent de l'intégration financière entre deux pays, un pays émergent et un pays industriel. Le méchanisme repose sur (i) l'existence de deux technologies, l'une plus productive mais plus fragile financièrement ; et sur (ii) l'hétérogénéité des marchés financiers domestiques dans les pays industriels et émergents. Ainsi, l'intégration financière affecte non seulement la position extérieure nette mais aussi l'allocation du capital domestique entre les deux technologies.

L'introduction de deux types d'investissements se justifie comme suit. Le compte courant est égal à l'épargne moins l'investissement. Du point de vue des pays émergents, on observe dans les données à la fois une hausse du compte courant et de la production par tête. Si l'on suppose qu'il n'existe qu'une technologie, toutes choses égales par ailleurs, une hausse de la production par tête suppose une augmentation de l'investissement. Ainsi, pour que le compte courant augmente, il faudrait que l'épargne augmente encore plus que l'investissement. Or, si, comme on l'a exposé plus haut, il existe bien des théories où l'investissement et l'épargne sont corrélés positivement, il n'est pas sûr que ces mêmes théories impliquent que l'épargne varie plus que l'investissement. C'est une autre voie qui est explorée ici : elle consiste à considérer non pas le *niveau* l'investissement, mais sa *composition*. Ainsi, ce n'est pas la corrélation entre compte courant et investissement total qui compte pour expliquer le lien entre compte courant et croissance, mais la corrélation entre le compte courant et le "bon" type d'investissement, c'est-à-dire l'investissement le plus productif. Ainsi, même à épargne constante, on pourrait avoir une augmentation du compte courant et une augmentation de la productivité grâce à une meilleure allocation du capital. Cette approche est appuyée par le fait que la croissance des pays émergents n'est pas due qu'à l'accumulation du capital mais aussi à une hausse de la PGF.

Ainsi, le modèle est d'abord développé avec une épargne constante afin de mettre l'accent sur les conséquences de l'intégration financière en termes de flux de capitaux et de réallocation du capital dans les pays émergents. L'investissement le plus productif est un investissement de long terme sujet à des chocs de liquidité et à des contraintes financières. Par contre, l'investissement le moins productif, de même que le titre liquide, est un investissement de court terme qui peut être utilisé comme collatéral. Ce modèle est proche de celui d'Aghion *et al.* (2005). Il traduit l'idée que les investissements les plus productifs, tels la R&D, nécessitent une durée plus longue que les investissements classiques avant d'être rentables et sont soumis à plus de risques durant le processus de mise en oeuvre. Le mécanisme du modèle est alors le suivant. En autarcie, le pays émergent, où le secteur financier est peu développé, sur-investit dans le capital de court terme afin d'utiliser la production obtenue à partir de ce dernier pour satisfaire un éventuel choc de liquidité. En conséquence, il sous-investit dans le capital de long terme, du fait des ressources excessives utilisée pour le capital de court terme. Lorsque les marchés financiers s'intègrent, c'est-à-dire lorsque les agents ont la possibilité d'échanger des titres de dette liquides entre pays, le pays industriel peut offrir des titres liquides mieux rémunérés au pays émergent. En effet, le pays industriel a un niveau de développement financier plus élevé. Il peut donc mieux rémunérer les titres car les ressources y sont mieux allouées. Ainsi, le pays émergent substitue du titre au capital de court terme dans le collatéral, tandis qu'il peut investir plus dans le capital de long terme grâce aux ressources dégagées par l'augmentation du rendement des actifs utilisé dans le collatéral. Le pays émergent connaît donc à la fois une augmentation du compte courant et une réallocation du capital qui se traduit par une hausse de la PGF.

Ce modèle est ensuite étendu à un cadre d'horizon infini où l'épargne s'ajuste. La convergence vers l'état stationnaire d'un pays émergent relativement peu doté en capital reproduit non seulement les flux de capitaux entre pays émergents et industriels, mais implique aussi, comme dans les données, des gains endogènes de PGF et une augmentation de l'investissement agrégé, qui se traduisent par une croissance plus forte dans les pays émergents.

Le **deuxième chapitre** aborde la question plus générale de la corrélation des flux de capitaux et de la croissance parmi les pays émergents. Il traite du paradoxe de l'allocation mis en évidence par Aizenman and Pinto (2007), Prasad *et al.* (2007) et Gourinchas and Jeanne (2007), à savoir que les capitaux affluent vers les pays où la croissance de la productivité est la plus faible, et non là où elle est la plus forte, comme le prédit la théorie néoclassique. En effet, la croissance de la productivité tire le rendement marginal du capital vers le haut et donc devrait inciter les agents domestiques à s'endetter afin d'investir dans leur production. Or, si les pays les plus productifs sont bien ceux où le taux d'investissement est le plus élevé, ceux-ci ont moins recours à l'endettement. Alors que le paradoxe de Lucas peut se réduire à un paradoxe sur l'investissement dans les pays émergents (c'est parce que la PGF est moins élevée qu'au Nord et qu'il existe des distorsions sur le rendement du capital au Sud qu'il y a moins d'incitations à investir et donc à emprunter), le paradoxe de l'allocation est un paradoxe de la déconnection, voire de la relation perverse, entre investissement et flux de capitaux. En effet, Gourinchas and Jeanne (2007), à partir du modèle de croissance néoclassique standard, calculent le niveau de flux qui serait cohérent au regard du niveau d'investissement observé. Le paradoxe de Lucas est ainsi supprimé en calibrant un niveau de distorsion (une taxe sur le rendement du capital) de sorte que, par construction, le rendement privé du capital s'égalise entre pays. Malgré cela, le niveau prédit de flux entrants est corrélé négativement avec les flux observés.

Ce chapitre tente de résoudre le paradoxe de l'allocation en introduisant du risque d'investissement dans le modèle de croissance néoclassique. En effet, dans la version standard de ce dernier, on suppose que l'investissement productif n'est pas risqué. Dans ce cas, aux yeux des investisseurs, les titres de dette et l'investissement productif sont de parfaits substituts. Lorsque le rendement de ce dernier est plus élevé que celui du premier, il est optimal de s'endetter afin d'investir dans la production. Ainsi, investissement et endettement devraient être corrélés positivement, ce qui, comme on l'a vu, est contredit par les données. Cependant, comme il a été souligné plus haut, l'hypothèse que l'investissement productif soit sans risque est contestable. Le modèle de croissance néoclassique est donc enrichi par l'introduction de risque individuel dans la production, ce qui rend le rendement de l'investissement productif risqué. On suppose aussi que ce risque, au moins en partie, n'est pas assurable. Or, l'introduction d'un risque de production non assurable, fût-il minime, change radicalement la relation entre l'investissement privé et le titre de dette dans le portefeuille des agents. Au lieu d'être des actifs identiques, ceux-ci sont des substituts imparfaits. En effet, en l'absence de possibilités d'assurance du risque individuel, c'est le titre de dette, sans risque, qui joue le rôle d'auto-assurance. Ainsi, en cas de choc négatif important, la consommation est protégée d'une chute trop substantielle par la présence d'un stock d'actifs sans risque dans lequel les agents peuvent puiser en cas de coup dur. Il s'agit d'une épargne de précaution. Par conséquent, lorsque les agents augmentent l'investissement en réponse à une hausse de la PGF, ils augmentent par la même occasion leur stock d'actifs sans risque afin de s'auto-assurer contre le risque supplémentaire qu'ils prennent.

En suivant la méthode de Gourinchas and Jeanne (2007), le modèle est calibré de sorte à rendre parfaitement compte de l'investissement observé dans un échantillon de 66 pays émergents entre 1980 et 2000. Les flux prédits par le modèle, avec ou sans risque, sont alors comparés aux flux observés entre 1980 et 2000. Les premiers sont négativement corrélés aux derniers lorsqu'on adopte l'approche sans risque, ce qui renvoie aux résultats de Gourinchas and Jeanne (2007). Par contre, ils sont corrélés positivement au sein de l'approche du portefeuille (avec risque). Ce renversement des prédictions peut être rapproché de deux phénomènes : (i) les flux sortants observés sont positivement corrélés avec la croissance de la PGF, phénomène qui est à la source du paradoxe dans l'approche sans risque, mais qui est cohérent avec l'approche du portefeuille, car la détention de titres étrangers sans risque répond à l'investissement dans le capital domestique risqué ; (ii) les pays avec une part plus élevée de capital dans leur portefeuille en début de période sont ceux qui ont connu les plus petites entrées de capitaux, conformément à ce que prédit l'approche du portefeuille. Ceci s'explique par le fait que, contrairement à l'approche sans risque, les parts de capital et d'actifs sans risque dans le portefeuille sont déterminées à long terme et sont les mêmes dans tous les pays. La convergence vers l'état stationnaire implique donc une plus petite augmentation de la part de capital dans les pays où il compose déjà une part élevée du portefeuille. Le niveau des titres sans risque devrait donc moins diminuer dans ces pays.

Les deux premiers chapitres montrent que la faible capacité des marchés financiers des pays émergents à gérer les risques de production et de liquidité des entreprises peut expliquer les faits stylisés associés aux flux de capitaux, ainsi que leur lien avec la croissance. Le développement financier peut également expliquer l'absence de relation empirique stable entre flexibilité du taux de change et croissance. Le troisième chapitre montre ainsi qu'en présence de contraintes de crédit, qui rendent les entreprises plus vulnérables à leur risque de liquidité, les pays émergents qui souffrent du "péché originel" (i.e. d'une dette dollarisée) diminuent leur potentiel de croissance s'ils ne fixent pas leur taux de change. Le manque de robustesse des analyses empirique sur les performances des régimes de change peut ainsi être relié à l'existence de non-linéarités dues à la dollarisation. Cette approche s'insère à la fois dans la littérature sur les effets de la volatilité sur la croissance et dans celle qui étudie les pays émergents et leur "peur du change flottant".

La littérature sur les performances des régimes de change n'a pas mis en évidence de relation empirique stable entre flexibilité du taux de change et croissance. Les travaux sur la question concluent en général soit à la neutralité de la politique de change, soit à l'hétérogénéité de ses effets dans les pays émergents et industriels. Baxter and Stockman (1989) sont les premiers à mettre en avant ce paradoxe de l'instabilité des effets du régime de change. Depuis, la littérature n'a pas permis d'établir de lien clair entre volatilité du taux de change et croissance : Husain *et al.* (2005) trouvent que la flexibilité du taux de change a des effets bénéfiques dans les pays industriels et neutres dans les pays en développement. En utilisant une classification différente des régimes de change, Dubas *et al.* (2005) trouvent qu'un régime fixe a de bonnes performances économiques dans ces derniers alors qu'il est neutre pour les premiers. De même, De Grauwe and Schnabl (2005) montrent que la stabilité du taux de change est associée à une croissance plus forte dans les pays d'Europe centrale et orientale. L'effet estimé de la flexibilité du taux de change est donc en général plus négatif dans les pays développement que dans les pays industriels. Cette instabilité des résultats empiriques peut être expliquée par la non-linéarité de l'effet de la flexibilité du taux de change sur la croissance.

En particulier, Aghion *et al.* (2006a) suggèrent que cette non-linéarité est due au niveau de développement financier. Ainsi, c'est dans les pays ayant un secteur financier peu développé que les effets de la flexibilité du taux de change s'avèrent néfastes. En effet, comme le défendent Aghion *et al.* (2006a), Aghion *et al.* (2007) et Aghion and Marinescu (2007), lorsque les firmes font face à des contraintes de crédit, il est important de mettre en oeuvre des politiques qui stabilisent leur revenu, y compris pour favoriser la croissance de la productivité. En effet, dans la mesure où les firmes ne bénéficient pas autant des périodes d'expansion qu'elles ne souffrent des périodes de récession, la volatilité macroéconomique a un impact négatif sur leur capacité à financer des chocs de liquidité. Comme ce sont les activités les plus innovantes qui sont le plus souvent sujettes aux chocs de liquidité, la stabilisation des cycles macroéconomiques a un impact positif sur la croissance, et à plus forte raison si les firmes ont un accès limité au crédit (Aghion *et al.*, 2007; Aghion and Marinescu, 2007). En économie ouverte, ce problème se pose d'une manière d'autant plus aiguë que les firmes sont soumises à des chocs extérieurs. Ainsi, Aghion *et al.* (2006a) montrent empiriquement que la stabilité du taux de change a un effet d'autant plus bénéfique sur la croissance que le développement financier est faible. L'argument théorique est que le change fixe permet justement de stabiliser les profits des entreprises.

Or, le développement financier n'est pas la seule source d'hétérogénéité entre pays industriels et en développement. Le "péché originel", c'est-à-dire l'incapacité des économies émergentes à emprunter dans leur propre monnaie, est aussi un élément qui peut expliquer l'impact différent de la volatilité du taux de change. La dollarisation financière est en effet fréquemment pointée du doigt comme une source de vulnérabilité dans les pays émergents (Eichengreen and Hausmann, 1999; Reinhart *et al.*, 2003; Calvo *et al.*, 2004). Elle est aussi souvent considérée comme étant à la source de la "peur du change flottant" (Calvo and Reinhart, 2002).

En particulier, nous montrons que, comme le souligne Obstfeld (2008), l'incapacité à emprunter dans leur monnaie domestique empêche les pays émergents de profiter pleinement des avantages de l'intégration financière. En effet, comme c'est le cas dans notre modèle, le régime de change fixe permet de stabiliser les revenus. Il a donc des avantages en termes de stabilisation de la consommation, notamment celle de biens non échangeables. Le change flexible donne aussi une plus grande marge de manoeuvre au sein du "trilemme" (Obstfeld, 2008; Obstfeld *et al.*, 2008). Il permet ainsi de viser des objectifs de politique intérieure, tandis que le régime de change fixe, lorsque les capitaux peuvent circuler sans entraves, suppose l'abandon de ces objectifs. Le change fixe souffre alors de crédibilité et peut traverser des crises si la politique intérieure est soumise à des tensions trop fortes. Le change flexible est donc le régime qui permet aux pays de profiter sans encombre des avantages de la libéralisation financière (circulation des capitaux), sans souffrir de ses affres (abandon des objectifs domestiques et crises). Or, à cause de la dollarisation de la dette, les pays émergents sont contraints dans leur résolution du trilemme, et sont réduits à une "peur du change flottant".

Le **troisième chapitre** tient compte du rôle de la dollarisation de la dette sur l'impact de la volatilité du taux de change sur la croissance. Un modèle est d'abord développé afin d'en déduire des hypothèses à tester sur un panel de pays indutriels et en développement. Dans le modèle, comme dans l'article d'Aghion *et al.* (2006a), les entreprises doivent financer un choc de liquidité transitoire pour pouvoir innover. D'autre part, la volatilité du taux de change affecte celle des revenus des firmes en présence de rigidités nominales sur les salaires. Elle affecte donc leur capacité moyenne à innover. Pour pouvoir tenir compte de la dollarisation financière, ce cadre est enrichi de deux hypothèses : 1) la production est partagée entre biens échangeables et non échangeables alors que le coût de liquidité est en bien échangeable ; 2) les revenus sont nets des intérêts sur la dette, alors que dans le modèle d'Aghion *et al.* (2006a), ils ne sont composés que des profits bruts. Toutes choses égales par ailleurs, une dépréciation nominale fait baisser la valeur de la production de biens non échangeables en termes d'échangeables, ce qui limite la capacité des agents à financer le coût de liquidité. Cependant, si une partie de la dette est dénommée en monnaie locale, alors une dépréciation nominale diminue les paiements d'intérêt, ce qui limite l'impact sur les revenus de la firmes et lui permet donc de faire face plus facilement au coût de liquidité. A priori, un taux de change flexible est plus mauvais pour la croissance qu'un taux de change fixe lorsque la dette est dollarisée. Lorsque le niveau de dollarisation diminue, l'avantage relatif du taux de change fixe diminue.

Cependant, il ne va pas de soi que ce résultat subsiste en équilibre général. Au contraire, selon Milton Friedman, le régime de change flexible stabilise la production en présence de rigidités nominales. Toutefois, ce qui compte ici est la production mesurée en termes de monnaie étrangère. Or, celle-ci dépend à la fois de la production en termes réels et du taux de change réel. Si le change flexible a bien un effet relativement stabilisateur sur la production par rapport au change fixe dans notre modèle, il a un effet relativement déstabilisateur sur le taux de change réel. Ainsi, si l'élasticité de substitution entre les biens échangeables et non échangeables est faible (ce qui est couramment admis dans la littérature), c'est son effet déstabilisateur sur le taux de change réel qui l'emporte. Les prédictions évoquées restent donc valables à l'équilibre général. Celles-ci sont testées et confirmées sur un échantillon de 77 pays industriels et émergents entre 1995 et 2004.

Chapitre I

Financial Integration, Technological Change in Emerging Markets and Global Imbalances

1 Introduction

This paper tries to explain four stylized facts. The first one has fueled heated debates among economists : 1) *the US have run a persistent current account deficit since the beginning of the 1990's.* Figure I.1 (a) shows that the aggregate deficit of the US, Australia and the UK (U) is no longer compensated by surpluses in Europe and Japan (J), but rather by surpluses elsewhere, notably in emerging countries (EM)[1]. I confront this fact to another one, illustrated in Figure I.1 (b) : 2) *labor productivity increased in the EM relatively to U between the early 1990's and the mid-2000's.* Namely, Figure I.1 (b) shows that the relative output per worker increased steadily during the period, and in 2003 the gains reached 25% as compared to 1990. Figure I.2 analyzes the sources of the relative growth of emerging markets by presenting the

[1] I follow Caballero *et al.* (2008) in defining the country groups.

relative evolution of their capital per worker and total factor productivity (TFP)[2]. It appears that 3) *the relative level of capital per worker increased during the period and is 21% higher in 2003 than in 1990.* In the meantime, 4) *the relative TFP surged during the period and was 12% higher in 2003 than in 1990.* Therefore, the strong growth of emerging markets is partly due to TFP growth, and not only to capital accumulation. TFP growth even explains two thirds of the relative growth of EM.[3]

On the one hand, the first fact has drawn a lot of attention in the literature, but the second one is at best ignored or taken as exogenous, at worst contradicted. On the other hand, the study of productivity catch-up has given birth to a huge strand of literature, but, except some exceptions, ignore the first fact. This chapter aims at fueling this gap by providing a general equilibrium framework to explain these two facts as the endogenous outcome of financial integration. I focus on the interaction between U and EM since, according to Figure I.1 (a), the current account surpluses in the EM constitute most of the counterpart of the U deficits. When explaining Facts 1 and 2, I will also be attentive at taking into account Facts 3 and 4, that is : relative growth in emerging countries is originated in both capital accumulation and TFP growth.

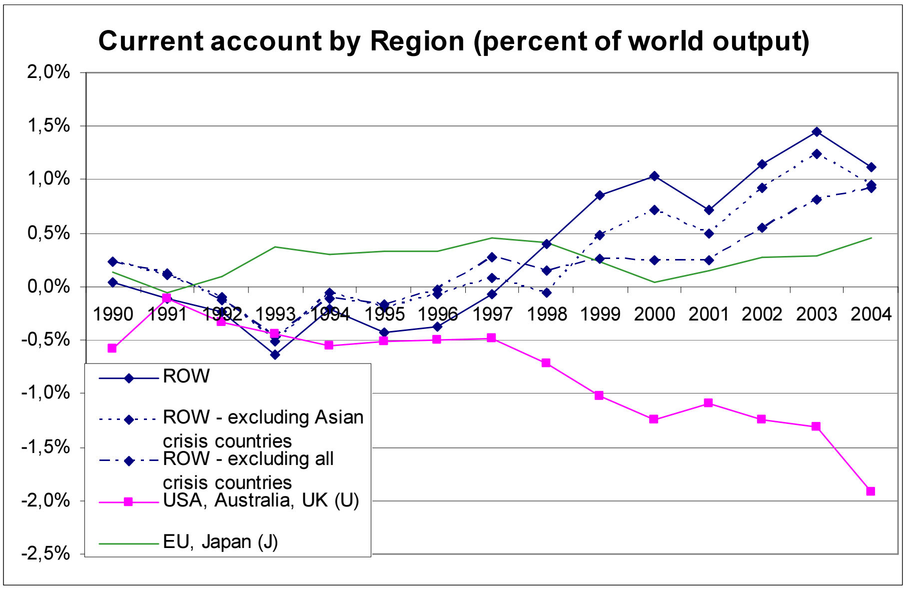
Consider the conjunction of labor productivity growth and current account surpluses in emerging markets (Facts 1 and 2). The main challenge of the study is to generate a model where financial globalization triggers both a rise in the current account and in labor productivity. The key feature of the framework is the interaction between financial development, financial globalization and technological change. The focus on technological change can be motivated as follows. Consider the definition

[2] Capital stocks in EM and U are estimated with the perpetual inventory method, using the procedure of Caselli (2004). In order to calculate TFP, I start from the following definition of production per worker : $y = Ax^{\alpha}$, where x is the level of capital per worker. TFP values in EM and U are then estimated as $y^i/(x^i)^{\alpha}$, $i \in \{EM, U\}$, where $\alpha = 0.36$.

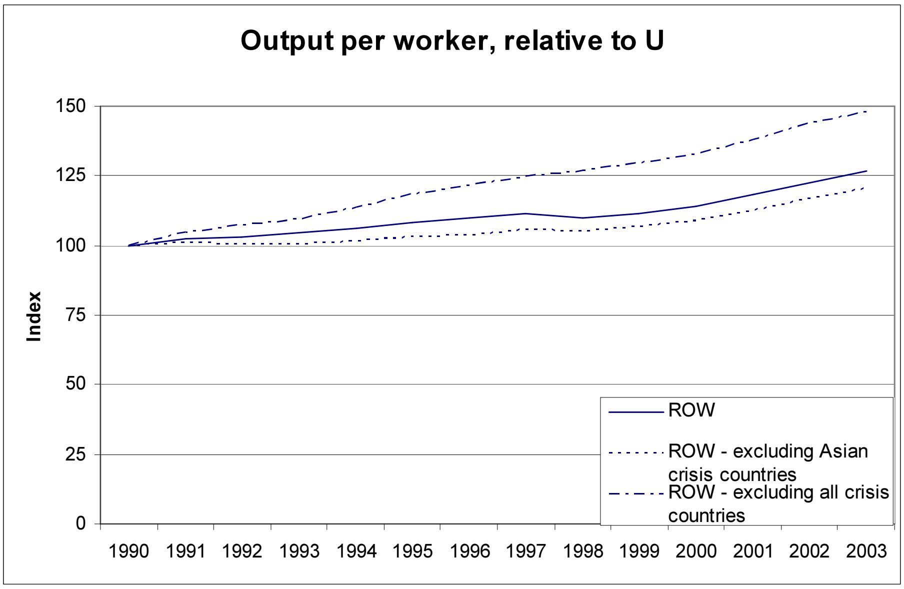
[3] The share of relative growth in EM due to TFP is calculated as $\ln\left(\frac{A^{EM}_{2003}/A^{U}_{2003}}{A^{EM}_{1990}/A^{U}_{1990}}\right) / \ln\left(\frac{y^{EM}_{2003}/y^{U}_{2003}}{y^{EM}_{1990}/y^{U}_{1990}}\right)$. Indeed, the relative growth in EM can be decomposed as follows : $\ln\left(\frac{y^{EM}_{2003}/y^{U}_{2003}}{y^{EM}_{1990}/y^{U}_{1990}}\right) = \ln\left(\frac{A^{EM}_{2003}/A^{U}_{2003}}{A^{EM}_{1990}/A^{U}_{1990}}\right) + \alpha \ln\left(\frac{x^{EM}_{2003}/x^{U}_{2003}}{x^{EM}_{1990}/x^{U}_{1990}}\right)$.

FIG. I.1 – Stylized facts - Global imbalances and relative growth in emerging countries

(a) Global imbalances



(b) Productivity growth in emerging markets



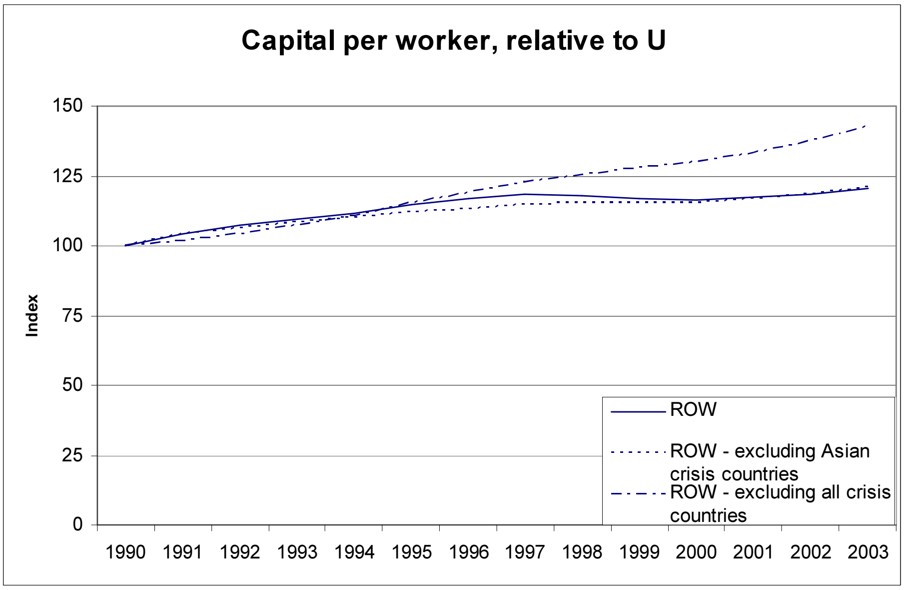
Source : World Bank (World Development Indicators) and Penn World Tables 6.2 (Heston *et al.*, 2006).
U : United States, Australia, United Kingdom.
J : Japan, Eurozone.
EM : Argentina, Brazil, Chile, China, Colombia, Costa Rica, Ecuador, Egypt, Hong Kong, India, Indonesia, Korea, Malaysia, Mexico, Nigeria, Panama, Peru, Philippines, Poland, Russia, Singapore, Thailand and Venezuela.

of the current account surplus (CA) :

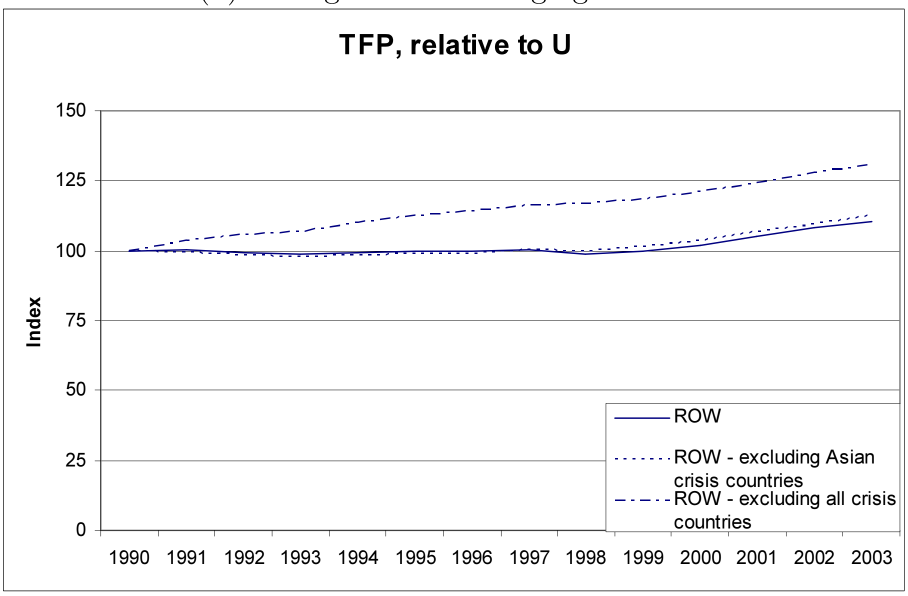
$$CA = S - I$$

FIG. I.2 – Stylized facts - Sources of growth

(a) Capital accumulation in emerging markets



(b) TFP growth in emerging markets



Source : Penn World Tables 6.2 (Heston *et al.*, 2006).
U : United States, Australia, United Kingdom.
J : Japan, Eurozone.
EM : Argentina, Brazil, Chile, China, Colombia, Costa Rica, Ecuador, Egypt, Hong Kong, India, Indonesia, Korea, Malaysia, Mexico, Nigeria, Panama, Peru, Philippines, Poland, Russia, Singapore, Thailand and Venezuela.
Capital stocks in EM and U are estimated with the perpetual inventory method, using the procedure of Caselli (2004). TFP values in EM and U are estimated as $y^i/(x^i)^\alpha$, $i \in \{EM, U\}$, where $\alpha = 0.36$, y^i and x^i are respectively output per worker and capital per worker in i.

where S denotes savings and I investment. For a given amount of savings, a higher current account surplus means less investment. Therefore, to be consistent with the facts (that is a positive current account and growth in EM), savings should increase more than investment in the emerging economies. Some theories that link savings to growth can account for the positive comovement between S and I but, as Gourinchas and Jeanne (2007) argue, it is not clear why S should move more than I. The limits of these theories have been detailed in the general introduction (namely, Modigliani's OLG model (Modigliani, 1986), the infinite horizon model with habit formation proposed by Carroll *et al.* (2000)). Trade-related growth (Dooley *et al.*, 2004, 2005a; Rodrik, 2006, 2007) is also a potential candidate to explain the correlation between CA and I, since the current account is the financial counterpart of the trade balance. However, as argued in the general introduction, these theories are in general concerned with the structure of trade, and not with trade balance.

In this chapter, the focus is not on the correlation between CA and I itself. A different route is taken : the idea is that it is not the *quantity* but the *composition* of investment that matters. When there are different technologies, a positive correlation between CA and productivity does not suppose necessarily that CA and I are positively related at the aggregate level. Rather, CA should be related to the *right* type of investments, that is the most productive. This idea is rendered by introducing two technologies, one more productive than the other but submitted to idiosyncratic liquidity risk and credit constraints, as in Aghion *et al.* (2005). In this framework, the composition of investment depends on the availability of liquid assets used for self-insurance purposes. Since international markets are more developed financially, they provide a better access to these assets. Therefore, financial globalization can trigger a better allocation of investment in the developing economy by enabling domestic agents to hold more liquid assets in the industrial economy. This translates into higher productivity and a positive current account, even with given savings S.

For pedagogical issues and in order to convey the main intuition, the model is first developed with a constant level of savings S. The mechanism can be summed up as follows. Under autarky, the liquidity risk cannot be perfectly insured in the emerging economy and the agents invest in the less productive technology for precautionary purposes. There is an overaccumulation of the less productive capital and the autarky interest rate is low relative to the industrial economy. As a result, when financial globalization occurs, the emerging economy experiences an interest rate rise. This has two effects on the emerging economy : on the one hand, it triggers a substitution between foreign assets and the less productive capital, which was in excess ; on the other hand, it lowers the cost of self-insurance and thus allows the agents to invest more in the productive technology. In the developing country, CA increases and I decreases, but the composition of I changes in favor of the more productive technology. If the productivity differential between the two technologies is high, the country is poor and financial development is low, then the economy experiences a productivity surge. Therefore, production and foreign assets can rise simultaneously in the emerging market while maintaining the level of savings constant. As a corollary, the industrial economy experiences a decline in its external position. This framework therefore can fit the two stylized facts highlighted above (Facts 1 and 2). In particular, growth in the emerging country is due to TFP (Fact 4). These results still hold when the savings rate is made endogenous in a dynamic Ramsey growth model. Besides, in the calibration analysis, the relative capital accumulation in the emerging country (Fact 3) can be replicated when it is capital-scarce before financial integration.

The remainder of the chapter is organized as follows : Section 2 reviews in more details the related literature ; Section 3 lays down a static model to convey the main intuitions while section 4 extends it to a dynamic Ramsey model ; finally, Section 5 considers the outcome of the Ramsey model in terms of medium-run dynamics and uses a calibration approach to confront the results to the four facts.

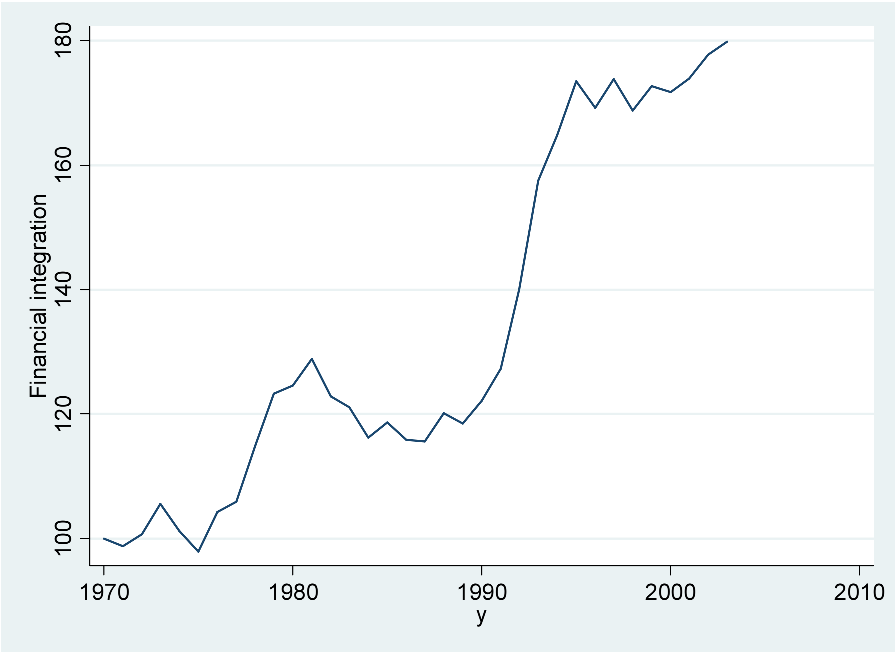
2 Related literature

This chapter is related to the literature on capital composition and capital misallocation. Economists have highlighted the importance of capital quality in explaining the differences in TFP across countries (Caselli and Wilson, 2004; Caselli, 2004). Others (Banerjee and Duflo, 2005; Hsieh and Klenow, 2007; Restuccia and Rogerson, 2007) have stressed the potential gains associated with a better allocation of capital to more productive uses. In particular, some have highlighted the role of financial development in the composition of investment and technology adoption. In Obstfeld (1994), more productive technologies are riskier. As a consequence, the economy benefits from financial globalization through a greater access to insurance. Other notable contributions in that field are Matsuyama (2007), Aghion *et al.* (2005) and Aghion *et al.* (2007). A common assumption is that more productive investments are also more financially demanding. They show that endogenous changes in investment technologies can occur along the business cycle and on the equilibrium growth path. Here, I study the implication of this approach in terms of comovement of growth and current account, using the framework of Aghion *et al.* (2005). This approach based on capital misallocation is supported by the two last facts, illustrated in Figure I.2 : 3) relative capital accumulation and 4) relative TFP growth in emerging countries. In this chapter's approach, growth in emerging markets is due to the convergence of the level of capital per head to its steady state, but also to the endogenous reallocation of capital to the more productive technology, which translates into a higher aggregate TFP. In the calibration analysis, I will keep track of these two additional facts.

This study is also related to the recent and rich debate on the ”saving glut”, concerned with the first stylized fact, that is the decline in the US current account and the matching rise in emerging countries. Some argue that the main reason is the twin deficits led by the rise in the US public deficit (Chinn and Ito, 2005) ; others that the origin lies in emerging markets excess savings. The latter point to the poor financial markets in emerging countries as the origin of global imbalances, but this explanation has been interpreted in different manners. First, for some, the main aspect is the incapacity of developing economies to protect themselves from episodic financial crises. Among them, Bernanke (2005) points to the role of the credit crunch that took place in the mid-90's in emerging markets and aroused the will to build reserve war-chests against future turmoils. This view has been also explored by Gruber and Kamin (2007), Obstfeld *et al.* (2008) and Rancière and Jeanne (2006). Others, as Caballero *et al.* (2008), view the financial crises as affecting the financial intermediation system itself, which increases the demand of emerging markets investors for foreign assets. Second, for others, it is the last wave of financial liberalization that revealed the flaws of the financial system of emerging markets. Mendoza *et al.* (2007a) and Mendoza *et al.* (2007b) focus on the financial integration of countries with a high demand for assets due to thin domestic financial markets. Matsuyama (2005) and Ju and Wei (2006, 2007) rely on a similar argument to explain the "uphill flows" phenomenon.

This last approach is the closest to mine. It presupposes that financial crises episodes are not at the core of the stylized facts. To back that view, consider again Figures I.1 and I.2. The general picture remains unaffected when excluding the countries that were primarily affected by the Asian crisis (Thailand, Korea, Indonesia and the Philippines). We also go further by excluding other countries that went through financial crises during the period (Brazil, Argentina and Russia). The main trends are unchanged. The reason is that China, which accounts for most of the stylized facts, did not suffer a crisis. In support of my approach, consider also Figure I.3. This graph is constructed using the data on current account liberalization from Chinn and Ito (2007). Their index of financial openness is averaged across the U, J and EM countries (the average is weighted by GDP) and rescaled in order to be equal to 100 in 1970. Compared to the 1970's, the 1980's are more integrated financially, but the 1990's globalization surge is way more marked. The previous stylized facts could therefore be related to financial globalization. My approach is also backed by the empirical results of Forbes (2008) : she finds that financial development and capital controls are the main determinants of investment in US assets.

Fig. I.3 – Financial integration



Source : Chinn and Ito (2007) and Lane and Milesi-Ferretti (2006).
Figures are the GDP-weighted average across a sample including the countries in U, J and EM whose data are available for the whole period.

Some of the papers I review could be confronted to the above stylized facts. The common idea is that the low degree of financial development in emerging markets introduces a wedge between the social and private return to capital. This wedge induces domestic investors to turn to foreign financial markets. In Mendoza *et al.* (2007a) and Mendoza *et al.* (2007b), this wedge is due to the risk premium created by precautionary savings. In Matsuyama (2005), it comes from the presence of credit constraints among entrepreneurs. In Ju and Wei (2006, 2007), it comes from informational rents. These approaches are successful in explaining the first fact. However, they miss the second one, that is the relative TFP growth in developing countries. Others are more successful. In Caballero *et al.* (2008), high growth economies can still export capital if their level of development is sufficiently low. In Aghion *et al.* (2006b), foreign investment has positive externalities on growth and is favored by domestic savings because it constitutes a collateral. However, both studies respectively take the growth rate and the savings rate as exogenous, whereas empirical evidence suggests that they cause one another (Attanasio *et al.*, 2000). It is also doubtful that growth is constant during long periods and that savings do not react to growth perspectives. The strength of my approach is that growth, savings and investment behaviors are determined endogenously.

3 Static model

This section focuses on the impact of financial globalization on portfolio choices for one period, taking the whole amount invested as given. This helps grasping the main intuition before switching to the dynamic environment with endogenous savings. This analysis is applied to an economy with two countries in which the bond market integrates.

3.1 Economic environment

There are two countries indexed by $i \in \{I, E\}$, I denoting the industrial country and E the emerging one. For the moment, the countries' index is neglected since we are interested first in their individual behavior. Each country is populated by a continuum of identical entrepreneurs of length one who live one period. Each entrepreneur is endowed with wealth w. He makes his portfolio decisions at the beginning of the period and consumes the yield of his portfolio at the end of the period. As in Aghion *et al.* (2005), he can invest in three different types of assets : the bond b, the short-term investment k and the long-term investment z.

Timing : The detailed timing is the following :

- Morning : the entrepreneur invests his wealth w in b, k and z.
- Noon : the bond yields Rb, the short-term investment yields $f(k)$, with $f' > 0$ and $f'' < 0$.

- Evening : the production activity in which the long-term investment z is involved is compromised by a transitory liquidity cost shock. With probability $\frac{1}{2}$, the liquidity shock is equal to $\Phi > 0$ and the entrepreneur has to pay Φ (bad shock). If the cost is paid, then the long-term investment yields $g(z) + \Phi$, with $g' > 0$, $g'' < 0$ and $g > f$. If not, then the whole production is lost. With probability $\frac{1}{2}$, the entrepreneur receives Φ and the long-term investment yields $g(z) - \Phi$ (good shock).
- Night : the entrepreneur consumes the return of his portfolio : either $Rb + f(k) + g(z)$ or $Rb + f(k)$, depending on the nature of the shock that occurred in the evening and on the decision to finance it.

The distribution of the liquidity cost implies that there is no aggregate risk : $\frac{1}{2}\Phi - \frac{1}{2}\Phi = 0$. The fact that the entrepreneur recovers the liquidity cost at the end of the period ensures that the shock is transitory and that the liquidity shock is neutral regarding ex post profits. In other words, Φ affects the decision to invest only through the possibility to lose $g(z)$.

z can be viewed as a long-term investment, involving more time than the short-term investment k. It is more productive than k, but it is also more risky and submitted to possible hazards. This kind of investment can be interpreted as R&D expenses, or as the cost of adopting a new technology which has to be adapted or a technology which involves more human capital. The liquidity cost can be viewed as a shock threatening the completion of the investment process. For example, the new machines have to be adapted to a new legislation or the entrepreneur that has acquired new skills falls ill. In either case, all the investment expenditure can be lost if the liquidity shock is not overcome.

Insurance : Since there is no aggregate risk, the liquidity shock can be perfectly hedged. But, because of imperfect financial markets, only a fraction $1 - \rho \leq 1$ can be insured. The entrepreneur thus faces a liquidity shock $\phi = \rho\Phi$ with probability $\frac{1}{2}$ and receives ϕ with probability $\frac{1}{2}$. ϕ is therefore the resulting perceived liquidity shock. It summarizes the level of financial markets incompleteness.

Financing constraints : At noon, there are no credit markets, so the entrepreneurs who suffer from the liquidity cost cannot pay except if :

$$\phi \leq f(k) + Rb$$

The other entrepreneurs receive ϕ so they do not face any financing constraint.

Therefore, because it is more risky, the long-term investment is more financially-demanding and more vulnerable than the short-term one. On the contrary, $f(k)$ and the yield from b can be used to secure the long-term production. (k, b) can therefore be viewed as the "liquid portfolio", because it can be liquidated without cost in order to pay for the transitory shock.

3.2 Individual decisions

Entrepreneurs maximize their end-of-period expected consumption :

$$\max_{\{k,b,z\}} Rb + f(k) + \frac{1}{2}g(z) + \mathbf{1}_{\{f(k)+Rb \geq \phi\}}\frac{1}{2}g(z) \quad \text{(I.1)}$$

$$\text{s.t } b + k + z \leq w$$

With probability $\frac{1}{2}$, entrepreneurs face the good shock and consume $Rb + f(k) + g(z)$. With probability $\frac{1}{2}$, they face the bad shock and consume $Rb + f(k) + g(z)$ if they can pay ϕ $(f(k) + Rb \geq \phi)$. If they cannot $(f(k) + Rb < \phi)$, then they consume $Rb + f(k)$. If ϕ is small, then the entrepreneur would choose the first best portfolio maximizing $Rb + f(k) + g(z)$. But if ϕ is high, then the first best portfolio would violate the financing constraint. The entrepreneur would have to choose whether to satisfy the constraint and get $g(z)$ or to violate the constraint and get $g(z)$ only with probability $\frac{1}{2}$. Indeed, if z is sufficiently productive with regards to the liquid portfolio, it can be profitable to choose not to satisfy the constraint, even at the expense of the risk of losing $g(z)$. This program is therefore not standard. To understand individual decisions, I consider first the case in which the entrepreneurs want to overcome the bad shock. In that case, they have to satisfy the financing constraint. The corresponding program can be written as :

$$max_{\{k,b,z\}} Rb + f(k) + g(z) \tag{I.2}$$

$$\text{s.t.} \begin{cases} b + k + z \leq w & (\lambda \geq 0) \quad \text{(BC)} \\ \phi \leq f(k) + Rb & (\gamma \geq 0) \quad \text{(FC)} \end{cases}$$

(BC) and (FC) are respectively the budget and financing constraints and λ and γ are the corresponding Lagrange multipliers. The first-order conditions associated with this program yield the following results :

$$f'(k) = R$$

$$g'(z) = R(1 + \gamma)$$

The marginal productivity of the short-term investment must be equal to the return of the bond, which determines k, whether (FC) is binding or not. This comes from the fact that (FC) does not interfere with the arbitrage between k and b. In other words, the return of the liquid portfolio (k, b) must be maximized, either to optimize the entrepreneur's consumption or to satisfy the financing constraint (FC).

Either (FC) is not binding ($\gamma = 0$) and $g'(z) = R$, or (FC) is binding ($\gamma > 0$) and $\phi = f(k) + Rb$. In that case, $g'(z) > R$: the entrepreneur cannot invest as much as he would like in the long-term investment z.

There are two possible solutions :

- If $f(k^*) + Rb^* \geq \phi$, (FC) is not binding and the solution is the first best one, labeled (k^*, z^*, b^*) :

$$k^* = f'^{-1}(R), \qquad z^* = g'^{-1}(R), \qquad b^* = w - k^* - z^*$$

– If $f(k^*) + Rb^* < \phi$, the first best allocation is not implementable so (FC) is binding. The solution is the constrained one, labeled $(\bar{k}, \bar{z}, \bar{b})$:

$$\bar{k} = k^*, \qquad \bar{b} = \tfrac{\phi - f(k^*)}{R}, \qquad \bar{z} = w - k^* - \bar{b}$$

For a given R, if the entrepreneur is constrained, we have $\bar{b} > b^*$ and $\bar{z} < z^*$. The entrepreneur under-invests in the more productive technology as compared to the first-best solution because he has to hold an additional amount of bonds in order to satisfy the financing constraint.

Consider next the case where entrepreneurs anticipate that they will not be able to overcome the bad shock, which means that $\phi > f(k) + Rb$. Therefore, they anticipate that they will get $Rb + f(k) + g(z)$ with probability $\frac{1}{2}$ (good shock) and $Rb + f(k)$ with probability $\frac{1}{2}$ (bad shock). They solve the following programme :

$$max_{\{k,b,z\}} Rb + f(k) + \frac{1}{2} g(z) \tag{I.3}$$

$$\text{s.t. } w \geq b + k + z$$

The first order conditions lead to the following results :

$$f'(k) = R$$

$$g'(z) = 2R$$

which yields the following solution :

$$k^{**}(R) = k^*(R), \qquad z^{**}(R) = g'^{-1}(2R), \qquad b^{**}(R) = w - k^* - z^{**}$$

(k^{**}, z^{**}, b^{**}) is labeled the "risky" allocation. The production of the long term investment is less efficient so the entrepreneur invests less in z than in the first best case : $z^{**}(R) < z^*(R)$.

The following lemma shows when this risky allocation can be ruled out :

Lemma 3.1 *(General case) :*

For a given R, if $g'\left(w - f'^{-1}(R) - \frac{\phi - f'^{-1}(R)}{R}\right) \leq 2R$*, then the solution to Problem (I.1) is the solution to Problem (I.2) :*

$$k(R) = k^*(R), \qquad z(R) = \min(z^*(R), \bar{z}(R)), \qquad b(R) = \max(b^*(R), \bar{b}(R))$$

Proof : If $z^*(R) \leq \bar{z}(R)$, then the first best is implementable and the solution is $z^*(R)$. If $z^*(R) > \bar{z}(R)$, then the solution is either $\bar{z}(R)$ (the entrepreneur chooses to satisfy the financial constraint) or $z^{**}(R)$ (the financial constraint is violated and the entrepreneur takes into account the fact that the long-term production is less efficient).

If $\bar{z}(R) \geq z^{**}(R)$, then, since $k^*(R) = \bar{k}(R) = k^{**}(R)$, $\bar{b}(R) \leq b^{**}(R)$. As a consequence, $\phi = R\bar{b}(R) + f(k^*(R)) \leq Rb^{**}(R) + f(k^*(R))$: the financing constraint is satisfied for $z^{**}(R)$. Besides, $g'(z^{**}(R)) > R$. If $z = z^{**}(R)$, the entrepreneur could be better-off by increasing z without violating the financing constraint. Therefore, the entrepreneur would prefer $z = \bar{z}(R)$ over $z = z^{**}(R)$. Finally, according to the definitions of $z^{**}(R)$ and $\bar{z}(R)$, $\bar{z}(R) \geq z^{**}(R)$ is equivalent to $g'\left(w - f'^{-1}(R) - \frac{\phi - f'^{-1}(R)}{R}\right) \leq 2R$.[4] ■

Provided that $\bar{z}(R) \geq z^{**}(R)$, the risky allocation can be ruled out and the entrepreneurs' program can be reduced to a standard constrained maximization problem, which corresponds to Problem (I.2). If, besides, $z^*(R) > \bar{z}(R)$, which means that $g'(\bar{z}(R)) > R$, then the constrained allocation is chosen. Therefore, the range of w and ϕ over which the entrepreneurs choose the constrained allocation is defined by

$$R < g'\left(w - f'^{-1}(R) - \frac{\phi - f'^{-1}(R)}{R}\right) \leq 2R$$

On the one hand, if the entrepreneur is poor (w low) and faces large liquidity shocks (ϕ high), he might not be able to choose the first best allocation because he

[4] Note that if $\bar{z}(R) < z^{**}(R)$, the financing constraint is binding for $z^{**}(R)$. The entrepreneur has the choice between investing $\bar{z}(R)$ with a higher productivity ($g(z)$) or investing a higher amount $z^{**}(R)$ with a poorer average technology ($\frac{1}{2}g(z)$). This case is inconclusive : depending on the parameters and on R, $\bar{z}(R)$ or $z^{**}(R)$ could be chosen.

would not be able to overcome the bad shock. On the other hand, if the entrepreneur is too poor and faces too large liquidity shocks, then it could be too costly to satisfy the financing constraint and the entrepreneur might choose the risky allocation. For intermediary levels of w and ϕ, he chooses the constrained allocation.

3.3 Comparative statics

The approach here is to compare the investment decisions under autarky and financial globalization, defined by cross-border trade in bonds. As in Mendoza *et al.* (2007a), the two countries are supposed to be identical, except for the level of market incompleteness ϕ. The industrial country I is financially developed while the emerging one E is not. In order to be more specific, I define the two following cases :

– Perfect financial markets (PFM) : $\phi = 0$. The entrepreneurs are perfectly insured against liquidity shocks so the first-best decisions apply.

– Imperfect financial markets (IFM) : the parameters of the model are such that the PFM allocation is not implementable under autarky : $f(k^*(R^{a*})) < \phi$, where R^{a*} is the autarky interest rate that would prevail under PFM.

We assume then that the industrial country I has PFM, while the emerging country E has IFM.

Two types of equilibria are compared :

– The autarky equilibrium, defined by the zero-net demand for bonds in each country : $b^I = b^E = 0$.

$\bar{R}^a$ denotes the autarky interest rate under IFM (that is in E) and R^{a*} the autarky interest rate under PFM (that is in I).

– The financial globalization equilibrium, defined by the ability to trade bonds between countries. It implies a world zero-net demand for bonds : $b^I + b^E = 0$.

We are interested in the way financial globalization affects the net external position b, investment in both kinds of capital k and z, and production in both countries.

3.3.1 Autarky

Consider the investment decisions under perfect and imperfect financial markets when the economy is under autarky. For any variable X, X^{a*} denotes its autarky value under PFM and $\bar{X}^a$ its autarky value under IFM. We solve first for the portfolio choices and then derive a proposition for I and E.

Under PFM :

Under autarky, $b^{a*} = 0$ so $z^{a*} = w - k^{a*}$, according to the resource constraint. The optimal allocation satisfies $g'(w - k^{a*}) = f'(k^{a*})$, which defines the level of short term investment k^{a*}. Then we can infer the level of long-term investment $z^{a*} = w - k^{a*}$ and the autarky interest rate $R^{a*} = f'(k^{a*})$.

Under IFM :

By definition of IFM, $f(k^*(R^{a*})) < \phi$. This means that the first-best portfolio cannot be implemented under autarky, so the solution is either the constrained or the risky one. Let's consider the constrained solution : under autarky, $\bar{b}^a = 0$ so, since the credit constraint is binding, $f(\bar{k}^a) = \phi$, which defines $\bar{k}^a$ as $\bar{k}^a = f^{-1}(\phi)$. Then we can infer $\bar{R}^a = f'(f^{-1}(\phi))$ and $\bar{z}^a = w - f^{-1}(\phi)$.

In order to rule out the risky allocation under autarky in E, we make the following assumption :

Assumption 3.1 *(Ruling out the risky allocation under autarky in E) :* $g'(w - f^{-1}(\phi^E)) < 2f'(f^{-1}(\phi^E))$.

Assumption 3.1 insures that $\bar{z}(\bar{R}^a) \geq z^{**}(\bar{R}^a)$ in E, which is sufficient to rule out the risky allocation (Lemma 3.1) for $R = \bar{R}^a$. It requires that wealth w is not too low and that the degree of market incompleteness ϕ is not too high. Otherwise, the financing constraint could be so stringent that the entrepreneur would rather violate it, even if the long-term production is at risk. Under Assumption 3.1 and IFM, the constrained solution exists in autarky.

Proposition 3.1 *(General case) : Autarky*

Under Assumption 3.1, the constrained allocation is a solution in E under autarky while the first-best allocation is chosen in I. If the constrained allocation is indeed chosen in E, the autarky stock of k is higher, the stock of z is lower and the interest rate is lower in E than in I.

Proof :

By definition of IFM, $f(k^*(R^{a*})) < \phi^E$, which implies that $f(k^*(R^{a*})) < f(\bar{k}(\bar{R}^a))$. This yields $k^*(R^{a*}) < \bar{k}(\bar{R}^a)$ (or, alternatively, $k^{a*} < \bar{k}^a$).

As a corollary, since $z = w - k$, $z^*(R^{a*}) > \bar{z}(\bar{R}^a)$ (or, alternatively, $z^{a*} > \bar{z}^a$). Similarly, $R = f'(k)$, so $\bar{R}^a < R^{a*}$.

Finally, I has PFM, so the first best allocation is chosen. E has IFM, and Assumption 3.1 rules out the risky allocation in E for $R = \bar{R}^a$, according to Lemma 3.1. Therefore, the constrained allocation is compatible with autarky. ■

Figure I.4 illustrates the mechanism. It represents the demands for bonds and for short-term and long-term capital in a country with perfect financial markets (the industrial country) and a country with binding financing constraints (the emerging country). These countries differ only with regards to the level of financial development. The short-term investment k is decreasing in R and it is identical in both countries since it follows the same optimality rule. The bond b is increasing with R in both countries, but, for a given interest rate, the demand for bonds is higher in the constrained economy because of the precautionary hoarding motive. As a corollary, the demand for long-term investment is lower, because less resources are available. In order to equilibrate the domestic bond market, the autarky interest rate has to be lower in the constrained country than under PFM so that bond holdings are discouraged. The corresponding level of short-term capital is higher in the constrained country than in the IFM one since b and k are substitutes, while the level of long-term capital is lower.

The consequence of the binding financing constraint in the emerging country is that there is an over-accumulation of the short-term investment k. Because of financial markets imperfections, it has to be used as a store for liquidity to avoid compromising the production involving the long-term investment. As a consequence, because of the resource constraint, there is an under-accumulation of the long-term investment z.

3.3.2 Financial globalization

What is the effect of the possibility to trade bonds between countries on foreign assets, investment and production, from a comparative statics point of view ? In order to answer this question, remember that Proposition 3.1 showed that $\bar{R}^a < R^{a*}$. For the world bond market to clear, the world interest rate R^o will lay between the two autarky interest rates. We will thus have : $\bar{R}^a < R^o < R^{a*}$. When capital markets integrate, the industrial country experiences a drop in its interest rate while the emerging one experiences a rise in its own rate.

Investment

Proposition 3.2 *(General case) : Effect of financial integration on investment*

Under Assumption 3.1, a solution where the constrained allocation is chosen under general equilibrium in E exists and exhibits the following features :

- *When financial markets integrate, I experiences a drop in the interest rate. Besides, k and z rise and b becomes negative.*
- *When financial markets integrate, E experiences a rise in the interest rate. Besides, k falls, z rises and b becomes positive.*

The formal proof is provided in the appendix.

As for the effect of financial markets integration in the industrial country, the intuition is as follows : when financial markets integrate, the industrial economy experiences a drop in the interest rate, so the entrepreneurs take advantage of the new financing opportunities by increasing their debt and reallocating their resources in favor of the productive investments.

For the effect of financial globalization in the emerging country, the mechanisms are different. Differentiating the financing constraint (FC) with respect to R yields :

$$\frac{\partial \bar{b}}{\partial R} = \underbrace{-\frac{\partial \bar{k}}{\partial R}}_{\text{Substitution effect}>0} \underbrace{-\frac{\bar{b}}{R}}_{\text{Wealth effect }<0\text{ or }>0}$$

The first term of the derivative represents the substitution effect and it is positive. When the bond return R rises, there is a substitution between the bond and the short-term investment in favor of the former. The second term represents the wealth effect and depends on the sign of the amount invested in the bond. If the entrepreneur is indebted, then a rise in R increases debt repayments. In order to satisfy the financing constraint, a further decrease in the debt level is therefore required (i.e. a further increase in b). The wealth effect is then positive. If, on the opposite, the entrepreneur holds positive claims, then an increase in R would stimulate his revenues. Therefore, he does not need to raise b a lot to satisfy the financing constraint. The wealth effect is then is negative. Notice that in this particular case where $\bar{b}$ starts from zero, $\bar{b}$ becomes positive after an increase in the interest rate, since there is no wealth effect around $\bar{b} = 0$.

Similarly, differentiating the budget constraint (BC) with respect to R and replacing the derivative of b yields :

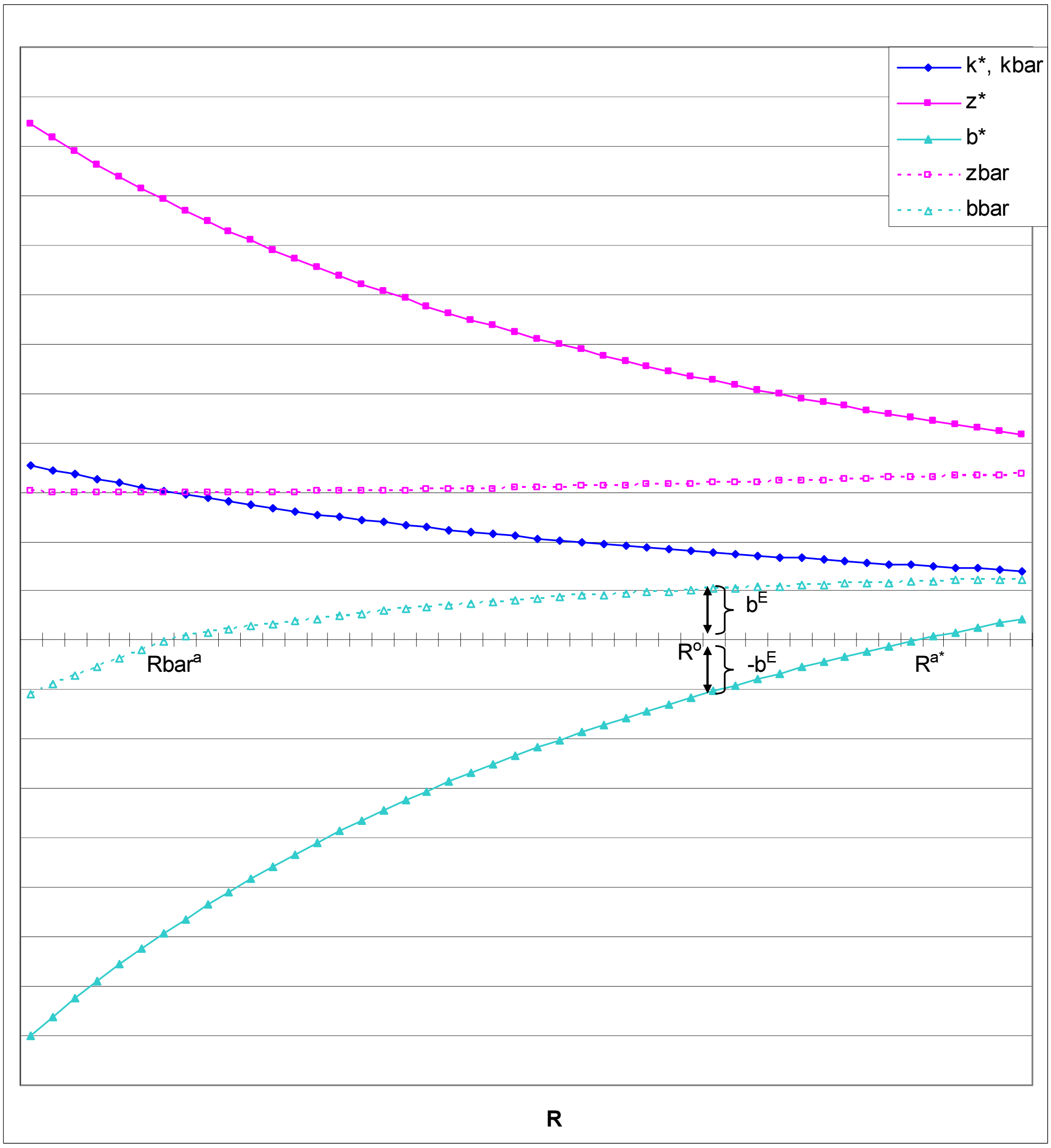
$$\frac{\partial \bar{z}}{\partial R} = -\frac{\partial \bar{k}}{\partial R} - \frac{\partial \bar{b}}{\partial R} = \frac{\bar{b}}{R}$$

The interest rate has an impact on $\bar{z}$ through a wealth effect opposite to that of $\bar{b}$. To understand, consider again the effect of a rise in R. According to what have been said above, if the entrepreneur is indebted ($\bar{b} < 0$), then he must increase $\bar{b}$ more than he must decrease $\bar{k}$ ($\partial\bar{b} + \partial\bar{k} > 0$) to keep the financing constraint satisfied, so $\bar{z}$ has to diminish ($\partial\bar{z} < 0$), according to the resource constraint. If he holds positive claims ($\bar{b} > 0$), then he can increase $\bar{b}$ less than he decreases $\bar{k}$ ($\partial\bar{b} + \partial\bar{k} < 0$), so $\bar{z}$ has room to increase ($\partial\bar{z} > 0$). In this particular experiment where the economy starts from autarky and experiences a rise in the interest rate when financial markets integrate, the bond level $\bar{b}$ increases and becomes positive so the wealth effect on $\bar{z}$ is positive.

To sum up, in the emerging economy, R rises after financial globalization, because its demand for bonds is higher than in the industrial country. Since R rises, k diminishes and b rises, but not as much as k falls, so z can increase without violating the resource constraint. This comes from the fact that b is substituted to the previously excessive k inside the liquid portfolio and becomes positive. Thus, thanks to the now positive external assets, the rise in R generates a positive wealth effect that enables the entrepreneur to increase z while still satisfying the financing constraint. The overall effect of a rise is then to lower the cost of hoarding, so there is room for an increase in z. Therefore, because of the financing constraint, the external wealth b and the long-term investment are complements in the emerging economy, whereas they are substitutes in the industrial one, which has PFM.

In the appendix, it is also shown that Assumption 3.1, which rules out the risky allocation for $R = \bar{R}^a$ in the developing country, is also sufficient to rule out the risky allocation for $\bar{R}^a < R < R^{a*}$. Indeed, R rises in the emerging economy as compared to autarky, so $z^{**}(R)$ decreases. Therefore, since $\bar{z}(R)$ increases, $z^{**}(R) \leq \bar{z}(R)$ is still verified. Notice also that the definition of IFM, which rules out the first best allocation under autarky, is also sufficient to rule out the first best solution under general equilibrium, because the first-best autarky interest rate is the same as under the first-best general equilibrium. This implies that, when the bond markets integrate, the equilibrium with a constrained allocation in E, though not necessarily unique (in some cases, E could switch to the risky allocation), is a valid one.

Fig. I.4 – Investment under PFM and IFM



Nota : This example is obtained with the following calibration : $w = 0.6$, $\alpha = 0.36$, $\phi = 0.65$ and $A = 2$.

The analysis of Figure I.4 can now be complemented. Finally, while in the industrial country the long-term investment z is decreasing in R (as k), in the emerging one, it is decreasing when b is negative, but increasing when b is positive. This reflects the wealth effect described earlier. Any world interest rate between the two autarky rates would then imply a rise in debt and in both investments in I because their marginal return are higher than the world interest rate. In E, investment in k decreases and b increases because the marginal return of the short term investment is lower than the world interest rate. In the meantime, z increases because of the positive wealth effect. Finally, the general equilibrium is fixed between the two autarky interest rates in order to satisfy $b^I = -b^E$, leading to the result described in Proposition 3.2.

As a preliminary conclusion, Facts 1 and 4 are satisfied. On the one hand, the industrial country experiences a deterioration of its external position which results in a current account account deficit. On the other, the aggregate TFP increases in the emerging country, since the less productive investment diminishes while the more productive one increases. Fact 3 is not satisfied in the static framework since the aggregate level of investment diminishes. This is a consequence of the assumption that savings w are fixed : if the external position in E becomes positive after financial integration, the resource constraint implies that the aggregate level of investment $k + z$ diminishes. Fact 2 remains to be examined.

Production In the industrial country, both investments increase thanks to the decrease in the interest rate ($\partial R < 0$). As a consequence, the production increases after financial markets integration :

$$\partial y^* = f'(k^*) \underbrace{\frac{\partial k^*}{\partial R}}_{<0} \underbrace{\partial R}_{<0} + g'(z^*) \underbrace{\frac{\partial z^*}{\partial R}}_{<0} \underbrace{\partial R}_{<0} > 0$$

In the emerging country, the impact of financial markets integration on production is ambiguous, because of the rise in the interest rate ($\partial R > 0$) implies a diminution in the short-term investment and a rise in the long-term investment :

$$\partial \bar{y} = g'(\bar{z}) \underbrace{\frac{\partial \bar{z}}{\partial R}}_{>0} \underbrace{\partial R}_{>0} + f'(\bar{k}) \underbrace{\frac{\partial \bar{k}}{\partial R}}_{<0} \underbrace{\partial R}_{>0}$$

The overall effect on production depends on whether the gains from increasing z compensate for the losses from decreasing k. Notice that the evolution of production can be decomposed as follows :

$$\partial \bar{y} = \underbrace{f'(\bar{k})\left[\frac{\partial \bar{z}}{\partial R} + \frac{\partial \bar{k}}{\partial R}\right]\partial R}_{\text{Aggregate investment effect (<0)}} + \underbrace{[g'(\bar{z}) - f'(\bar{k})]\frac{\partial \bar{z}}{\partial R}\partial R}_{\text{Investment composition effect (>0)}}$$

The impact on production of a rise in R depends both on the aggregate quantity of investment $\bar{z} + \bar{k}$, but also on the quality of investment, represented by the amount of long-term investment $\bar{z}$. The impact of the latter depends on the productivity differential between both technologies $g'(\bar{z}) - f'(\bar{k})$, which is positive since the financing constraint is binding. As for the impact on aggregate investment, it is negative according to Proposition 3.2.

Interestingly, a certain amount of disconnection between aggregate investment and production appears. Even though the aggregate level of investment is negatively related to the external position in E, production does not necessarily respond negatively to the increase in bond holdings. It can even be positively related to the external position as long as the investment composition effect is strong enough. Indeed, this effect is proportional to the productivity differential $g'(\bar{z}) - f'(\bar{k})$, which measures the amount of investment misallocation. Fact 2 can therefore be accounted for if the parameters are such that the investment composition effect compensates for the aggregate investment effect.

To understand what happens to production under IFM, I use a Cobb-Douglas specification : $f(k) = k^{\alpha}$, $g(z) = Az^{\alpha}$, with $0 < \alpha < 1$ and $A > 1$. In order to simplify the analysis, I abstract from general equilibrium effects on the interest rate, which I consider as second-order phenomena. I focus on the impact of a given rise in the interest rate.

Proposition 3.3 : *Effect of an interest rate rise on production (Cobb-Douglas case)*

If the constrained allocation holds in E, if A and ϕ^E are high, if w is small, then a rise in the interest rate has a positive effect on production in E.

Proposition 3.3 comes from the fact that A, ϕ^E and w have an impact on the amount of capital misallocation $g'(\bar{z}) - f'(\bar{k})$. When the relative productivity of the long-term investment A is high, the long-term investment is much more productive than the short-term one, so the overall impact is positive, even if the short-term investment diminishes. If the liquidity requirement ϕ^E is high, the entrepreneur accumulates more short-term capital k under autarky because he needs a higher amount of hoarding. As a consequence, the level of the long-term investment is small and its marginal productivity is high relative to the short-term one. This is also the case when the entrepreneur's wealth w is low. Consequently, the gains in terms of output from increasing the long-term investment are high and are more likely to overcome the losses from decreasing the short-term one. In other words, the higher the extent of the capital misallocation, the higher the potential gains from globalization.

Propositions 3.2 and 3.3 show that a global economy where the emerging markets are less developed financially can reproduce the stylized facts highlighted in the introduction, except Fact 3. After financial markets integrate, the industrial economy hosts capital inflows as a response to the increase in the foreign demand for bonds. This is Fact 1. On the opposite, in the emerging economy, financial globalization implies capital outflows. This increase in the external position enables the developing country to produce more by reallocating investment to the more productive technology, despite the fall in aggregate investment. In other words, the increase in production takes place through an investment composition effect, which results in an improvement in aggregate TFP and compensates for the deterioration in the total investment level. Since the composition of investment in the industrial country remains identical, there are relative TFP gains in the emerging country. This is Fact 4. However, it is unclear whether the production gains are higher in the developed or in the developing country. The quantitative section will enable us to establish Fact 2 more precisely. As for Fact 3, it is not verified since aggregate investment diminishes in the emerging country while it increases in the industrial country. However, this is because we assumed constant savings for pedagogical purposes and in order to yield the main intuitions. This is an unrealistic hypothesis that we will relax in the remainder of the chapter. The next section thus extends this static model to an intertemporal Ramsey framework to take into account endogenous saving behavior and to analyze the long-term effects of financial integration. The dynamic version will also enable us to run a quantitative analysis.

4 The Ramsey framework

4.1 Economic environment

It is assumed that an entrepreneur lives infinitely and maximizes his intertemporal utility : $\sum_{s=0}^{\infty} \beta^s \log(c_{t+s})$ with c_t his consumption in period t. Each period t, he chooses how much to consume out of his wealth and how much to invest in each of the three assets described earlier : k_{t+1}, z_{t+1} and b_{t+1}. The production processes are the same as in the one period model. The continuum of entrepreneurs is of length one. We rely on the Cobb-Douglas example with partial depreciation δ : $f(k) = k^\alpha + (1-\delta)k$ and $g(z) = Az^\alpha + (1-\delta)z$, $A > 1$, $0 < \delta < 1$.

4.2 Individual decisions

4.2.1 Individual program

Let w_t denote wealth in period t. The entrepreneur solves the following program :

$$V(w_t) = \max_{\{k_{t+1}, z_{t+1}, b_{t+1}\}} \log(w_t - b_{t+1} - k_{t+1} - z_{t+1}) \tag{I.4}$$

$$+\beta[(\tfrac{1}{2} + \tfrac{1}{2}\mathbf{1}_{\{f(k_{t+1})+R_{t+1}b_{t+1}\geq\phi\}})V(R_{t+1}b_{t+1} + f(k_{t+1}) + g(z_{t+1})) +$$
$$\tfrac{1}{2}\mathbf{1}_{\{f(k_{t+1})+R_{t+1}b_{t+1}<\phi\}}V(R_{t+1}b_{t+1} + f(k_{t+1})]$$

In period t, w_t is given and the entrepreneur chooses how much to invest in $(k_{t+1}, z_{t+1}, b_{t+1})$. He consumes $w_t - b_{t+1} - k_{t+1} - z_{t+1}$ in period t. In period $t+1$, his wealth w_{t+1} is equal to $R_{t+1}b_{t+1} + f(k_{t+1}) + g(z_{t+1})$ if the good shock occurs (with probability $\frac{1}{2}$) or if the bad shock occurs and is overcome (with probability $\frac{1}{2}$ if $f(k_{t+1}) + R_{t+1}b_{t+1} \geq \phi$, 0 otherwise). It is equal to $R_{t+1}b_{t+1} + f(k_{t+1})$ if the bad shock occurs and is not overcome (with probability $\frac{1}{2}$ if $f(k_{t+1}) + R_{t+1}b_{t+1} < \phi$, 0 otherwise).

As in the previous section, the entrepreneur's program is not standard. Consider first the simpler program where the entrepreneur chooses to satisfy the financing constraint $f(k_{t+1}) + R_{t+1}b_{t+1} \geq \phi$. We will show afterwards the conditions under which this actually happens. In that case, the entrepreneur solves a standard constrained maximization problem :

$$V(w_t) = \max_{\{k_{t+1}, z_{t+1}, b_{t+1}\}} \log(w_t - b_{t+1} - k_{t+1} - z_{t+1}) + \beta V(R_{t+1}b_{t+1} + f(k_{t+1}) + g(z_{t+1})) \tag{I.5}$$

$$\text{s.t. } f(k_{t+1}) + R_{t+1}b_{t+1} \geq \phi \ (\gamma_{t+1} \geq 0)$$

where γ_{t+1} is the Lagrangian multiplier associated with the financing constraint in $t+1$.

The first-order conditions associated with this program are the following :

$$\begin{cases} /k & \frac{1}{C_t} = \frac{\beta f'(k_{t+1})}{C_{t+1}} + \gamma_{t+1} f'(k_{t+1}) \\ /z & \frac{1}{C_t} = \frac{\beta g'(z_{t+1})}{C_{t+1}} \\ /b & \frac{1}{C_t} = \frac{\beta R_{t+1}}{C_{t+1}} + \gamma_{t+1} R_{t+1} \end{cases}$$

which yields the following results :

$$f'(k_{t+1}) = R_{t+1}$$

$$g'(z_{t+1}) = R_{t+1} + \gamma_{t+1} \frac{C_{t+1} R_{t+1}}{\beta}$$

$$\frac{C_{t+1}}{C_t} = \beta g'(z_{t+1})$$

If the entrepreneur is not constrained ($\gamma_{t+1} = 0$), then $g'(z_{t+1}) = R_{t+1}$. If on the opposite he is constrained ($\gamma_{t+1} > 0$), then $f(k_{t+1}) + R_{t+1} b_{t+1} = \phi$. Besides, $g'(z_{t+1}) > R_{t+1}$ and $\frac{C_{t+1}}{C_t} > \beta R_{t+1}$, which means that, on the one hand, there is an under-accumulation of the long-term asset, and, on the other hand, the bond and the short-term asset are in excessive demand, because of their hoarding function, as in the static model.

In the remainder of the analysis, only two cases will be considered : the case where the entrepreneur is always constrained ($f(k_{t+1}) + R_{t+1} b_{t+1} = \phi$) and the case where the level of long-term investment is always optimal ($g'(z_{t+1}) = R_{t+1}$). Appropriate conditions such that these solutions exist for the particular experiment that I will conduct will be explicited later.

4.2.2 Individual dynamic system

For a given sequence of interest rates R_t, the entrepreneur faces the following dynamic system :

$$\frac{C_{t+1}}{C_t} = \beta g'(z_{t+1}) \tag{I.6}$$

$$C_t = g(z_t) - z_{t+1} + f(k_t) - k_{t+1} + R_t b_t - b_{t+1} \tag{I.7}$$

(I.6) is the Euler equation. Equation (I.7) is derived from the budget constraint.

When the entrepreneur is unconstrained, there are four variables, C_t, b_t, k_t and z_t. However, k_t and z_t can be pinned down to R_t using $f'(k_t) = g'(z_t) = R_t$, so the number of variables is reduced to two.

When the entrepreneur is constrained, there are four variables, C_t, b_t, k_t and z_t. Here, only k_t can be pinned down to R_t using the fact that $f'(k_t) = R_t$. However, we can use the fact that $b_t = [\phi - f(k_t)]/R_t$ when the financing constraint is binding, so the number of unknown variables is reduced to two.

4.3 The experiment

We focus on the impact of financial integration on the long-term external position, the interest rate, capital accumulation and growth. There are still two countries, I, with perfect financial markets, and E, with imperfect financial markets. Now, for calibration purposes, I and E not only differ with respect to their level of financial incompleteness ϕ^i, but also with regard to their initial endowment in capital per head $x_0^i = k_0^i + z_0^i$, and to their size, that is the length n^i of their continuum of entrepreneurs. It is assumed that financial globalization (i.e. trade in bonds) occurs at $t = 0$. When financial globalizzation occurs, that is when cross-border trade in bonds is allowed, the world aggregate demand for bonds must be equal to zero at each date $t > 0 : n^I b_t^I + n^E b_t^E = 0$. We assume that I and E are in autarky before $t = 0$, which implies that $b_0^I = b_0^E = 0$.

We denote respectively z_∞ and k_∞ the values of long-term and short-term capital such that $g'(z_\infty) = f'(k_\infty) = \frac{1}{\beta}$. They correspond to the first-best steady-state levels of long-term and short-term capital. The two kinds of financial institutional environment are defined as follows :

– PFM, for which $\phi = 0$ so the first-best decisions apply.

– IFM, for which ϕ satisfies $f(k_\infty) < \phi$.[5] This condition means that the constraint is necessarily binding at steady state. We will show later that it is also a sufficient condition for the first best allocation to be ruled out for the particular experiment conducted here.

Additionally, in order to rule out the risky allocation in the emerging economy, the following assumption is made :

Assumption 4.1 *(Ruling out the risky allocation) :* $x_0^E > \bar{k}_0^E + g'^{-1}(f'(\bar{k}_0^E))$ *where* $\bar{k}_0^E$ *satisfies :* $f(\bar{k}_0^E) = \phi^E$

Assumption 4.1 states that, for the given amount of capital x_0^E in E, and for the autarky interest rate that would prevail under the constrained allocation, the constrained solution for z_0^E, which is $x_0^E - \bar{k}_0^E$, is larger than the risky one, which is $g'^{-1}(f'(\bar{k}_0^E))$. This insures, for arguments similar to Lemma 3.1, that the constrained solution is a valid one at $t = 0$. As we will show, Assumption 4.1 is also a sufficient condition for the validity of binding financing constraints all along the transition path, at least for the experiment conducted here. It requires that x_0^E is not too small and that ϕ^E is not too high.

It is assumed first in what follows that the financing constraint is binding in the emerging economy, which has IFM. It will be shown later that this assumption defines a valid equilibrium under Assumption 4.1.

The industrial economy is in steady state at $t = 0$: $z_0^I = z_\infty$ and $k_0^I = k_\infty$. The emerging economy is assumed to be capital-scarce as compared to the industrial one at the date of financial integration. To represent this fact, I impose $x_0^E < x_\infty = k_\infty + z_\infty$. As we have additionally that $\phi^E > f(k_\infty)$, the first-best allocation is not implementable at $t = 0$. According to Assumption 4.1, the risky allocation is also ruled out in E at $t = 0$. As a consequence, the financing constraint is binding in

[5] That is, as a function of the parameters : $\phi > (\alpha/[1/\beta-(1-\delta)])^{\frac{\alpha}{1-\alpha}} + (1-\delta)(\alpha/[1/\beta-(1-\delta)])^{\frac{1}{1-\alpha}}$

E at $t = 0$. Therefore, the amount of short-term capital k_0^E in E is equal to $\bar{k}_0^E$ (so $f(k_0^E) = \phi^E$). We have then $k_0^E > k_\infty$, since $\phi^E > f(k_\infty)$. As a corollary, we have $z_0^E < z_\infty$, since $x_0^E < x_\infty$. Thus, E is scarce in z, but not in k : at the date of financial integration, the emerging market is over-endowed with short-term capital, because of its liquidity needs. As in the static model, the demand for liquid assets is greater in E than in I. This translates into a lower autarky interest rate in E : $f'(k_0^E) < f'(k_\infty)$.

4.4 General equilibrium dynamic system

Assume first that the financing constraints are binding in E (we will show later that this is indeed the case). Applying Equations (I.6) and (I.7) in I and E, where the entrepreneurs are not constrained, and in E, where they are, and using the fact that $R_t = g'(z_t^I)$, $f'(k_t^I) = R_t$ and $n^I b_t^I = -n^E b_t^E = -n^E \frac{1}{R_t}[\phi - f(k_t^I)]$, we find :

$$\frac{C_{t+1}^I}{C_t^I} = \beta g'(z_{t+1}^I) \text{ for } t \geq 0 \tag{I.8}$$

$$C_t^I = g(z_t^I) - z_{t+1}^I + f(f'^{-1}(g'(z_t^I))) - f'^{-1}(g'(z_{t+1}^I))$$
$$-\frac{n^E}{n^I}[\phi - f(f'^{-1}(g'(z_t^I)))] + \frac{n^E}{n^I g'(z_{t+1}^I)}[\phi - f(f'^{-1}(g'(z_{t+1}^I)))] \text{ for } t > 0 \tag{I.9}$$

and on the date of financial integration, since $b_0^I = 0$:

$$C_0^I = g(z_0^I) - z_1^I + f(f'^{-1}(g'(z_0^I))) - f'^{-1}(g'(z_1^I)) + \frac{n^E}{n^I g'(z_1^I)}[\phi - f(f'^{-1}(g'(z_1^I)))]$$

$$\frac{C_{t+1}^E}{C_t^E} = \beta g'(z_{t+1}^E) \text{ for } t \geq 0 \tag{I.10}$$

$$C_t^E = g(z_t^E) - z_{t+1}^E + f(f'^{-1}(g'(z_{t+1}^I))) - f'^{-1}(g'(z_t^I))$$
$$+[\phi - f(f'^{-1}(g'(z_t^I)))] - \frac{1}{g'(z_{t+1}^I)}[\phi - f(f'^{-1}(g'(z_{t+1}^I)))] \text{ for } t > 0 \tag{I.11}$$

and on the date of financial integration, since $b_0^E = 0$:

$$C_0^E = g(z_0^E) - z_1^E + \phi - f'^{-1}(g'(z_1^I)) - \frac{1}{g'(z_1^I)}[\phi - f(f'^{-1}(g'(z_1^I)))]$$

Equations (I.8) and (I.9), which govern the dynamics of the developed economy, are independent from the rest of the system, since they only involve z^I and c^I. Once the dynamics of z^I and c^I is solved using this independent dynamic sub-system with 2 variables and 2 equations, the dynamics of z^E and c^E can be inferred using Equations (I.10) and (I.11).

4.5 Effect of financial globalization in the long run

Here, I examine the long-run impact of financial integration at $t = 0$.

Proposition 4.1 : *Effect of financial markets globalization in the long run*

Under Assumption 4.1, the solution where the emerging economy satisfies the financing constraint at $t = 0$ and at steady state exists and exhibits the following features :

(i) *The emerging economy experiences in the long run an increase in the more productive investment, a decrease in the less productive investment and a positive external position. On the whole the investment level increases.*

(ii) *The industrial economy experiences no change in its investment levels in the long run, but exhibits a negative external position.*

Assume first that the financing constraint is satisfied in the emerging economy at steady state. The dynamics is characterized by Equations (I.8)-(I.11). According to Equation (I.8), the steady state in I is characterized by constant consumption and by a constant marginal return to z equal to $1/\beta$. Therefore, the marginal return to k converges also to $1/\beta$, and so does the interest rate. With trade in bonds, from the point of view of the emerging economy, the world interest rate converges to $\frac{1}{\beta}$. As a consequence, the emerging economy's short-term capital adjusts to $1/\beta$ in the long run. As for its long-term capital, the constancy of consumption implies that it adjusts to the inverse of the time discount factor $1/\beta$. Therefore, with trade in bonds, the steady state in both I and E is characterized by a constant interest rate equal to $1/\beta$ and by identical investment levels : $z^I_\infty = z^E_\infty = z_\infty$ and $k^I_\infty = k^E_\infty = k_\infty$. How do these steady-state outcomes compare to the initial conditions ?

Consider first (i). The intuition for the emerging economy is as follows. Before financial markets integrate, the demand for liquid assets is higher in E than in I. Under autarky, the only available liquid asset is k. As a consequence, E holds excessive short-term capital ($k^E_0 > k_\infty$). However, when financial markets integrate, the financing constraint can be satisfied by holding external bonds, while k can adjust to the world interest rate. In the long run, k is equal to k_∞, since the steady-state interest rate is defined by I's discount factor, which is identical to E's. Put differently, thanks to financial integration, the steady-state level of short-term capital is equal to the first-best one, since the world interest rate is pinned down to the industrial country's, which does not suffer from any financing constraint. E then experiences a decline in the less productive investment. As for the external position of E, it is necessarily positive to satisfy the financing constraint, since the steady-state level of short-term investment is not sufficient to satisfy the liquidity requirements ($f(k_\infty) < \phi$). Besides, at $t = 0$, the country is scarce in long-term investment z, which means that $z^E_0 < z_\infty$ by assumption. Therefore, the emerging market experiences a rise in the more productive investment. The rise in the investment level comes from the assumption that E is capital-scarce in $t = 0$: $x^E_0 = x_\infty$.

(ii) is straightforward : the industrial country experiences no changes in its capital stocks in the long run compared to their initial levels, since they start at steady state. However, in general equilibrium, its external position should be the counterpart of the emerging country's. Since the emerging country runs a positive external position, the industrial economy is necessarily indebted in the long run.

Finally, we have to show that this solution is possible. We have shown earlier that under Assumption 4.1, the case where E satisfies the financing constraint at $t = 0$ exists. In this case, $k^E_0 > k_\infty$, which implies that the steady-state interest rate is higher than the autarky interest rate in E at $t = 0$. Therefore, the risky allocation is lower at steady state than at $t = 0$. Since z_0^E is lower than z_∞, which is the value of the long-term investment in the long run when the financing constraint is satisfied, then the risky allocation is lower than the constrained one, and it is not optimal for the entrepreneurs to switch to the risky level. Thus, the steady state solution where E satisfies the financing constraint does exist.

Now these results can be confronted to the stylized facts. Fact 1 to 4 are satisfied, as long as we compare the starting point to the ending one. We note : 1) a deterioration of the external position in I, 2) an increase in individual productivity in E relative to I due to : 3) a relative increase in the aggregate level of capital per head and 4) a relative increase in TFP. This last outcome is due to the switch from the less productive technology to the more productive one in E, while the technological structure is unchanged in I. What is left is to determine whether the medium-term patterns are respected qualitatively and whether the model is able to reproduce the facts in terms of the order of magnitude. This is the object of the next section.

5 Effect of financial globalization in the medium run

In this section, I study the qualitative and quantitative implications of the model in the medium run. The goal is to apply the experiment detailed in the preceding section. In other words, I evaluate the impact of financial globalization in a world composed of two countries, one, I, which is at its stationary equilibrium on the date of financial integration and which benefits from perfect financial markets, and the other, E, which is capital-scarce and suffers from poor domestic financial markets. We should be particularly attentive to the impact of financial globalization on the external asset position, the current account, growth and its different sources : capital accumulation or TFP growth driven by capital reallocation. The purpose here is not to match the data exactly, but rather to reproduce the right patterns (qualitative fit) and check whether the magnitude of the trends are reasonable (quantitative fit).

The first country (I) is representative of the U group, mainly composed of the United States, but which includes also Australia and the United Kingdom. The second one (E) aggregates countries in the EM group, which is composed of a significant number of emerging economies : Argentina, Brazil, Chile, China, Colombia, Costa Rica, Ecuador, Egypt, Hong Kong, India, Indonesia, Korea, Malaysia, Mexico, Nigeria, Panama, Peru, Philippines, Poland, Russia, Singapore, Thailand and Venezuela. I assume that financial markets integrate in 1990 and observe the economic behavior in I and E in order to confront them to the data for the period 1990-2003.

5.1 Calibration

α is set to 0.36, β to 0.96, δ to 10%, as is common in the literature. The ratio of workers n^E/n^I is set so that the steady state share of U's GDP ($n^I y^I$) in the world GDP (defined as $n^I y^I + n^E y^E$), which is also the share of U's workers in the world population when convergence is achieved, is equal to 60%, its value in the last observed period (2003). This gives a ratio of 1.5.

The baseline value for A is set to 2. This value is in the range of firms productivities estimated by Banerjee and Duflo (2005) and Restuccia and Rogerson (2007). Besides, it yields a standard error for the logarithm of TFP equal to 0.3 at steady state, which is close to the one measured by Bartelsman *et al.* (2006) for the US.

The initial level of capital per head in EM in the beginning of period x_0^E is set such that the share of EM capital in the world stock ($n^E x_0^E/[n^E x_0^E + n^I x_\infty]$ according to the model) is equal to 47%, its observed value in the beginning-of-period (1990). This gives a level of capital per head in EM x_0^E equal to 60% of the level of capital per head in U x_∞. Capital stocks in EM and U are estimated with the perpetual inventory method, using the procedure of Caselli (2004).

One important parameter, EM's initial share of long-term capital in total capital z_0^E/x_0^E, remains to be defined. Two methods are used to set this value. The first method, which is the baseline one, consists in fixing this value in order to match the observed relative change in EM's TFP between 1990 and 2003 (+12%). TFP is not measured as the productivity average across technologies weighted by the investment or production shares of these technologies, but as y/x^α, which corresponds to the stylized facts of Figure I.2. As we do not have real estimates for z and k, we must use a measure based on aggregate investment, and not on its components in order to compare the outcome of the model to the data. The resulting initial share of long-term capital in EM z_0^E/x_0^E varies with A. When $A = 2$, it represents 38% of the corresponding variable in U. For the sensitivity analysis, we also use another benchmark to set z_0^E/x_0^E : the observed end-of-period external position in U as a share of GDP (-22%). The external position in U as a share of GDP is simply given by b^I/y^I after 13 periods.

The baseline parameter set as well as the variables that were used to define them is summed up in Table I.1.

TAB. I.1 – Baseline parameter set

Parameter	Value	Target	Source
α	0.36		
β	0.96		
δ	0.10		
A	2	$\sigma(\ln(TFP)) = 0.3$	Bartelsman et al. (2006)
n^E/n^I	1.5	$n^I/(n^I + n^E) = 60\%$	Penn World Tables 6.2
x_0^E/x_∞	60%	$\frac{n^E(k_0^E+z_0^E)}{n^E(k_0^E+z_0^E)+n^I(k_\infty+z_\infty)} = 90\%$	Penn World Tables 6.2
$\frac{z_0^E/x_0^E}{x_\infty/x_\infty}$	38%	$(A_T^E/A_0^E)/(A_T^I/A_0^I) = 12\%$	Penn World Tables 6.2

5.2 Qualitative fit

Here, I determine whether the medium-term patterns of Figures I.1 and I.2 are recovered. The results are showed analytically for the linear approximation of the dynamic system (I.8)-(I.11) and illustrated using the baseline calibration.[6]

The dynamic system (I.8)-(I.11) is linearized around the steady state. The evolution of the industrial economy boils down to a linear dynamic system of two equations and two unknown, C_t^I and z_t^I. Once the dynamics of z^I is solved using this independent dynamic sub-system with 2 variables and 2 equations, the dynamics of z^E can be inferred using the log-linearized version of Equations (I.10) and (I.11). The appendix provides the results of the log-linearization in more detail.

Proposition 5.1

If the emerging country is constrained and if $|\phi^E - f(k_\infty)|$ is sufficiently close to zero, then, after financial integration, the industrial country experiences first a drop and then progressive increase in the interest rate. It experiences a sharp increase and then a declining path for z and k. The same pattern holds for y.

The formal proof is available in the appendix.

The intuition of the dynamics is as follows. Before financial globalization, because of financial frictions and its need for liquidity, the emerging country holds excessive amounts of short-term capital. This is apparent in Figure I.5, which represents the behavior of some key variables. In particular, graphs (a) and (b) show that the level of short-term capital is higher in E than in I. As a consequence, the autarky interest rate is lower, as graph (c) illustrates it. Therefore, when financial markets integrate, the world interest rate adjusts in between. From the industrial country's point of view, the interest rate falls, which stimulates investment and production. This is apparent in graphs (a) and (e). After this initial shock, the interest rate begins

[6] Even if the model is solved analytically in the appendix in order to establish Propositions 5.1 and 5.2, the simulations are obtained using DYNARE (Juillard, 1996) in order to be consistent with the extension with capital installation costs.

to rise progressively towards its long-run value. As a corollary, the investment and production levels decrease towards their steady-state after the initial rise.

Note that the hypothesis that $|\phi^E - f(k_\infty)|$ is small is made to insure that the trajectory of z^I is unique.[7]

What does this imply for capital accumulation in the developing country ?

Proposition 5.2

Under Assumption 4.1, if $\Delta z_0^E < 0$, if $|\phi^E - f(k_\infty)|$ and $|\phi^E - f(k_\infty)|/|\Delta z_0^E|$ are sufficiently close to zero, then, after financial integration :

(i) *The solution with permanently binding financing constraints in the emerging economy exists and is unique.*

(ii) *The emerging country experiences a sharp, then progressive increase in the interest rate. It experiences a growing path for b and z and a decreasing path for k. The path for y, after an initial adjustment, is increasing in the early stages of transition.*

(iii) *The production in the emerging country is increasing relative to the industrial one along the transition path, after an initial adjustment.*

The formal proof is available in the appendix.

(i) derives from the fact that if the entrepreneurs anticipate the interest rate path consistent with binding financing constraints, then the constraints are actually binding, since this path is unconsistent with both the first-best and risky solutions for z^E. The argument is similar to the one for Proposition 4.1 and relies on the fact that the interest rate and the constrained z^E are increasing on the constrained path for the corresponding set of assumptions.

Consider (ii). Assume that the financing constraint is binding all along the transition path in the emerging economy : $b_t^E = [\phi^E - f(f'^{-1}(R_t))]/R_t$, where R_t is

[7] As in Woodford (1986), the cohabitation of two kinds of agents, one constrained and the other unconstrained, can generate instability.

the world intrest rate. The external position in E is therefore determined exactly as in the static model, and its derivative with respect to R is the same :

$$\frac{\partial b^E}{\partial R} = \underbrace{-\frac{\partial k}{\partial R}}_{\text{Substitution effect}>0} \underbrace{-\frac{b^E}{R}}_{\text{Wealth effect }<0 \text{ or } >0}$$

The sign of the effect of the interest rate on b^E depends on the relative magnitude of the wealth and substitution effects. Wealth and substitution effects determine the impact of the variation in interest rate in exactly the same fashion as in the static model : on the one hand, if the interest rate rises, then the external bond is substituted to the short-term capital, which makes the level of bonds increase ; on the other hand, if the level of bonds is positive, then the increase in the interest rate eases the liquidity requirements, so the level of bonds does not need to rise a lot. If this wealth effect is high, the level of bonds might even decrease. Therefore, since the external position is small (ϕ^E close to $f(k_\infty)$), the substitution effect dominates and the level of bonds increases with the interest rate ($\partial b^E/\partial R$). Consider now the path of the interest rate R_t from the point of view of the emerging country : as illustrated by graph (c) of Figure I.5, it is set above the initial autarky interest rate after financial integration because the demand for bonds is lower in I, and then continues to increase as it converges to its steady state level. As a result, the bond level is increasing in E, as graph (b) shows. As a counterpart, the external position of the industrial country b_t^I is declining, as illustrated in graph (a). Therefore, E will exhibit current account surpluses on the transition path while I will exhibit deficits, as graph (d) indicates.

z^E follows an increasing path for two reasons : initial scarcity and wealth effects similar to the ones discussed in the static case. First, since the level of bond holdings is constrained, z^E does not adjust immediately to the world interest rate and behaves rather as under autarky. Namely, because it is in a scarce supply, it follows an increasing path towards its steady state. Second, the world interest rate is increasing steadily from the point of view of E, which eases the credit constraint more and more at each period, enabling entrepreneurs in E to invest more in the long-term capital z^E. Indeed, since the bond level is positive, an increase in the interest rate stimulates the yield of the liquid portfolio "mechanically", and the amount of resources necessary to satisfy the financing constraint diminishes. This wealth effect provides therefore additional resources which are then dedicated to the long-term investment. This last effect contributes up to 5% of the growth in he long-term investment in E. The resulting increasing path for z^E is provided in graph (b).

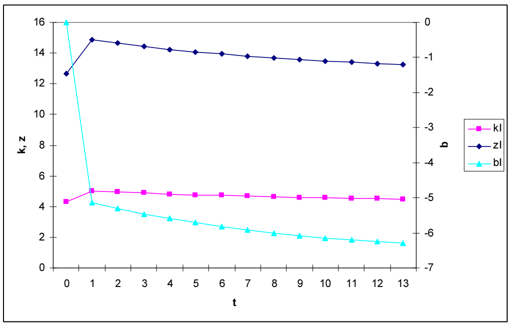
On the opposite, k^E, which adjusts to the world interest rate, follows a decreasing path, as illustrated in graph (b). The result is therefore ambiguous for y^E. However, it can be shown that when $|\phi^E - f(k_\infty)|$ is small relative to $|\Delta z_0^E|$, y^E is increasing in the early stages of transition, as illustrated in grph (e). Indeed, $|\phi^E - f(k_\infty)|$ gives the extent of the interest rate adjustment at the date of financial integration and the distance to steady state of the new world interest rate. By extension, it also gives the distance of k^E to its steady state. Therefore, the hypothesis that $|\phi^E - f(k_\infty)|$ is small relative to $|\Delta z_0^E|$ implies that z^E is further from its steady state than k^E. It thus converges more rapidly and production benefits more from the increase of the long-term capital than it suffers from the fall in short-term investment.

(iii) states that, despite the fact that y^E is not always growing, it is increasing as compared to y^I. Indeed, the growth of y^E is reversed for high ts only because of the decline in short-term investment, which affects y^I in the same way. As a consequence, E and I differ only with regards to the long-term investment, which is increasing in E and decreasing in I. Therefore, in relative terms, y^E is growing as compared to y^I, as illustrated in graph (f). However, the graph shows that this is true only at the date of financial integration, where the production in E falls relatively to I. This comes from the sharp initial adjustment in short-term capital, also visible in graph (f).

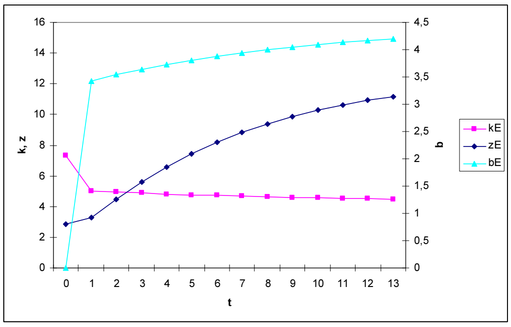
Proposition 5.2 implies that, under the specified conditions, the equilibrium with permanently binding financing constraints in the emerging market exists and

FIG. I.5 – Effect of financial integration at $t = 0$

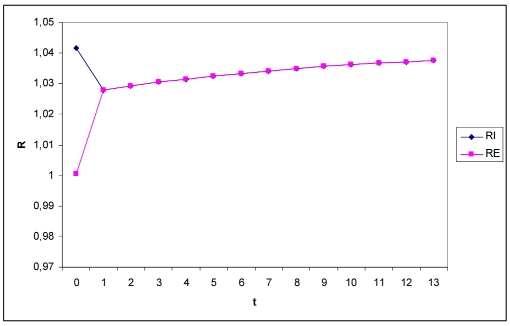
(a) On I's portfolio



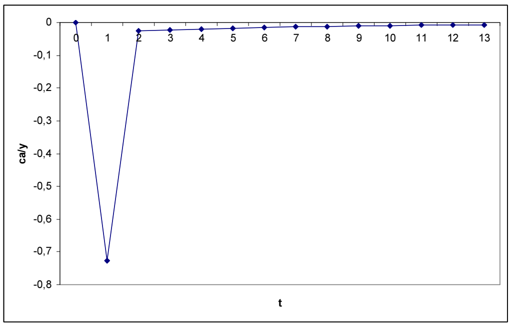
(b) On E's portfolio



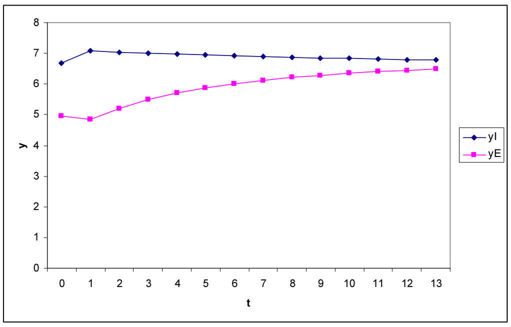
(c) On the interest rate in I and E



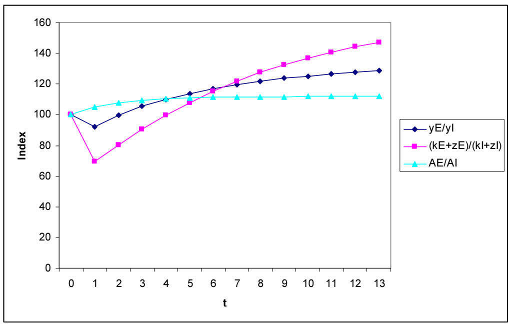
(d) On I's CA balances-GDP ratio



(e) On production per worker



(f) On relative growth



Nota : This simulation is obtained with the baseline parametrization summed up in Table I.1.

that in this equilibrium, the developing country exhibits current account surpluses, which are the counterpart of deficits in the industrial one (Fact 1). Besides, the production per head (entrepreneur) is increasing in the emerging country relative to the industrial one (Fact 2). This relative increase takes place thanks to capital accumulation (Fact 3), but also through aggregate TFP gains due to capital reallocation (Fact 4). Relative TFP increases smoothly in the calibration (graph (f) of Figure I.5), as in the data (Figure I.2), but relative aggregate capital and relative production per capita exhibit an initial fall in the simulation, while it increases steadily in the data (Figures I.1 and I.2). This can be explained by the fact that, in the emerging country, the adjustment in short-term capital is sharp, while the adjustment in long-term capital is smooth, as graph (b) shows. This shortcoming can be limited by adding capital installation costs.

Overall, the qualitative implications of the model in terms of qualitative adjustment of the variables of interest are globally satisfying, except for the initial adjustment. This issue will be tackled later by adding capital installation costs. Another question is whether the calibration of the model yields the adequate orders of magnitude for the stylized facts.

5.3 Quantitative fit

The results of the baseline method are reported in columns (a)-(c) of Table I.2 for $A = 2$, the baseline value for A, but also for $A = 1.7$ and $A = 3$, for robustness analysis. In column (d), z_0^E/x_0^E is set such that the external debt is equal to 22% of GDP on average between 1990 and 2003, with $A = 2$. The inferred share of initial long-term capital in total capital is not shown directly, but as a ratio of U's : $\frac{z_0^E/x_0^E}{z_\infty/x_\infty}$. The following values are also reported for each calibration : TFP growth, the growth of capital per worker, the growth of production per worker in E, all relative to I ; the share of growth in E attributable to growth in relative TFP ; the end-of-period external position as a share of GDP and average current account as a share of GDP in I. Because of the lack of data on k and z, each calibration method uses a key stylized fact to determine z_0^E. However, it is still possible to confront the model to the other facts. For example, when z_0^E is set to match the observed TFP growth, I examine b^I/y^I and the share of growth that is due to TFP (columns (a)-(c)) ; when it is set to match the US's external position, I examine TFP growth and the share of growth that is due to TFP (column (d)). Last, column (e) gives the observed values of the corresponding variables. The variables that were set to their observed values in the calibration columns are presented in bold characters.

TAB. I.2 – Calibration results

	Baseline	Sensitivity			Data
	(a)	(b)	(c)	(d)	(e)
A	2	1,7	3	2	Unobservable
$\frac{z_0^E/x_0^E}{z_\infty/x_\infty}$	38%	34%	46%	64%	Unobservable
TFP growth of E relative to I	**12%**	**12%**	**12%**	4%	**12%**
Growth of capital per worker in E relative to I	44%	47%	38%	52%	**21%**
Growth of production per worker in E relative to I	28%	29%	26%	21%	**18%**
% of relative growth due to TFP	46%	44%	49%	19%	**68%**
End-of-period b^I/y^I	-61%	-53%	-73%	**-22%**	**-22%**
Average $\Delta b^I/y^I$	4,8%	-4,1%	-5,7%	-1.7%	**-2,6%**

Source : World Bank (World Development Indicators), Lane and Milesi-Ferretti (2006) and Penn World Tables 6.2 (Heston *et al.*, 2006).
I corresponds to U : United States, Australia, United Kingdom.
E corresponds to EM : Argentina, Brazil, Chile, China, Colombia, Costa Rica, Ecuador, Egypt, Hong Kong, India, Indonesia, Korea, Malaysia, Mexico, Nigeria, Panama, Peru, Philippines, Poland, Russia, Singapore, Thailand and Venezuela.
Period : 1990-2003.
Capital stocks in EM and U are estimated with the perpetual inventory method, using the procedure of Caselli (2004). TFP values in EM and U are estimated as $y^i/(x^i)^\alpha$, $i \in \{EM, U\}$, where $\alpha = 0.36$, y^i and x^i are respectively output per worker and capital per worker in i.

In the baseline calibration with fixed growth in relative TFP (column (a) of Table I.2), the growth in relative output per worker is 1.5 times higher than in the data. This is a consequence of the fact that the model over-estimates the amount of growth in relative capital per worker by more than twice. As a result, the share of growth attributable to TFP is not as high as in the data : it is one third smaller. The amounts of end-of-period external debt and average current account deficit in I are over-estimated respectively by a factor of three and two. However, given the parsimony of the model, these are not bad results : the estimates are in the right order of magnitude. In the model, the external position and capital adjust too quickly. With appropriate installation costs on investment, the model could fit the data better. In other words, the bias of the model goes in the right direction : making it more realistic by adding adjustment costs could make it closer to the data. We check this in the extension with capital installation costs.

Consider now the additional columns (b) and (c) of Table I.2, which give the calibration results for different values of A. Notice that, in columns (a)-(c), the estimated share of long-term capital in total capital is increasing in A relatively to the steady state : the higher the productivity of the long-term investment compared to the short-term one, the lower the amount of misallocation needed to generate a given growth in aggregate TFP. Notice also that the higher A, the higher the growth in relative capital per worker. This is a composition effect : when A is large, the share of z in aggregate capital is higher at steady state. Since, in E, z grows while k decreases, it implies that the share of growing investment is high, which results in a higher growth in aggregate investment. I's indebtment level is increasing in A. This is because, when A is high, the steady-state level of capital is high, which implies that, to be consistent with the observed initial share of E in world's capital, the inferred initial level of aggregate capital in E is large, including k. Therefore, when financial markets integrate, the adjustment in E's external position is large. The same holds for average current account deficits. As a consequence, the results which are closer to the data, as far as the external position is concerned, are obtained with $A = 1.7$.

In the calibration with fixed external position in I, summed up in column (d) of Table I.2, the better fit in terms of capital flows is compensated by a worse fit in terms of growth as compared to column (a). The average current account deficit in I corresponds quite well to the data, but growth in relative TFP is underestimated. This is intuitive : the external debt of I is an indirect measure of the initial misallocation in E, because it gives the amount of the adjutment in short-term capital in E after financial integration. In column (d), the external debt of I is smaller than in (a), which implies that the initial misallocation in E is not as strong, so the aggregate gains in TFP due to a better allocation of capital are smaller. A corollary of this limited misallocation is that the fall in short-term capital is mitigated, which leads to a higher aggregate growth in investment. As a result, the share of growth due to TFP is even lower. Still, as before, the introduction of capital installation costs could make these results closer to the data. Besides, our interpretation of the origins of TFP growth is not exclusive of others, for example knowledge transfers from North to South. Put differently, calibrating the model in order to match the external position of U gives an amount of TFP growth due to capital reallocation smaller than in the data, which is compatible with other sources of TFP growth.

5.4 Adding capital installation costs

In this section, the model is enriched with capital installation costs in order to make the model fit better the data. In particular, I check whether : (i) the initial fall in investment in E is limited, making the dynamics of relative aggregate capital stocks and productions look more like in the data ; (ii) the external position and current account adjustments in I are quantitatively closer to the data when matching the parameters to account for the observed TFP growth.

Define i^k as the investment in short-term capital and i^z as the investment in long-term capital. The entrepreneur's program is modified by the introduction of capital installation costs. It can be written as follows :

$$V(k_t, z_t, b_t) =$$

$$\max_{\left\{k_{t+1}, z_{t+1}, b_{t+1}, i_t^k, i_t^z\right\}} \log \left(f(k_t) + g(z_t) + R_t b_t - b_{t+1} - k_{t+1} - z_{t+1} - k_t \Psi \left(\frac{i_t^k}{k_t} \right) - z_t \Psi \left(\frac{i_t^z}{z_t} \right) \right)$$

$$+\beta V(k_{t+1}, z_{t+1}, b_{t+1}) \qquad \text{(I.12)}$$

$$\text{s.t.} \begin{cases} f(k_{t+1}) + R_{t+1} b_{t+1} \geq \phi \\ i_t^k = k_{t+1} - (1-\delta) k_t \\ i_t^z = z_{t+1} - (1-\delta) z_t \end{cases}$$

The installation costs per unit of capital are defined in the standard following way :

$$\Psi(x) = \frac{\psi}{2} (x - \delta)^2 \tag{I.13}$$

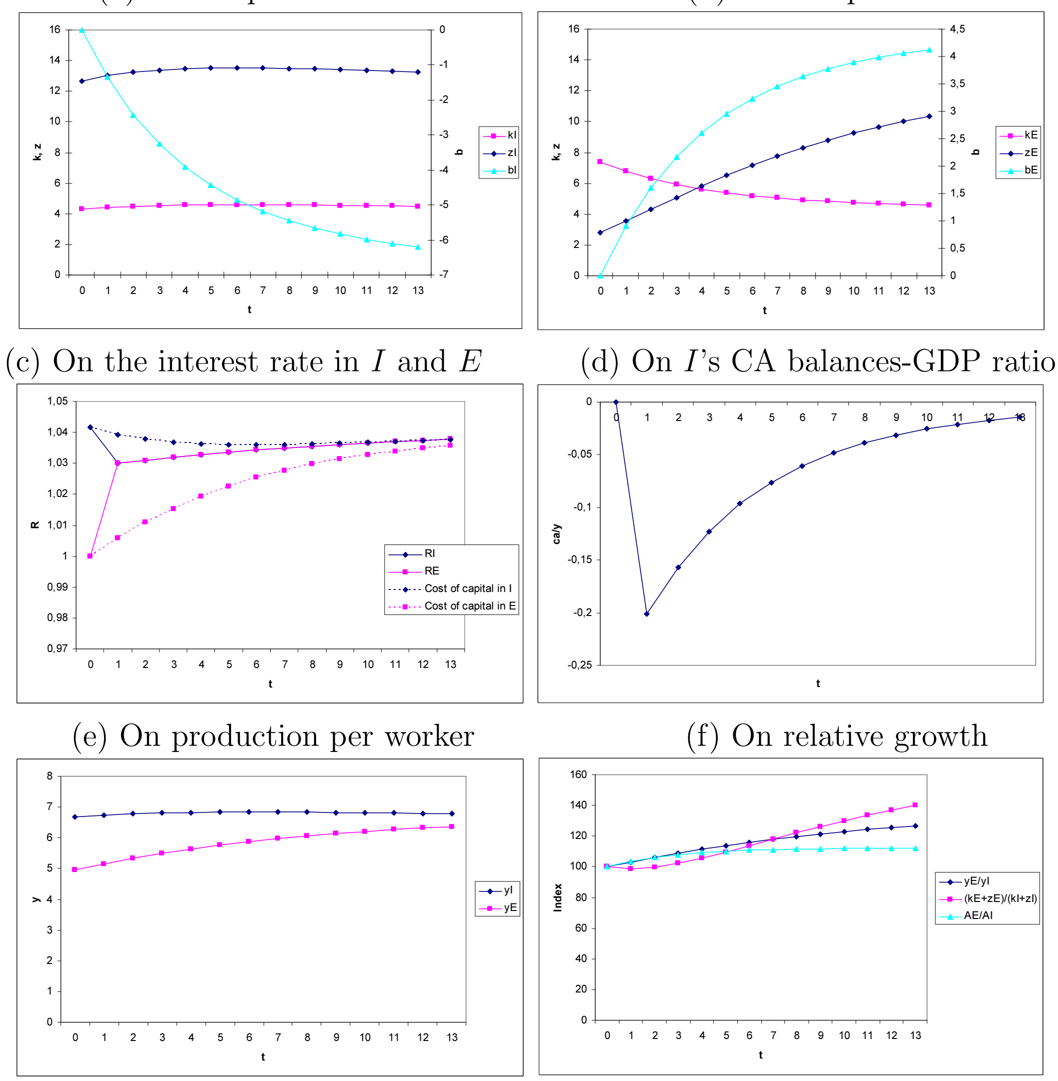
Equation (I.13) implies that any change in the stock of capital is costly, whether it has to be increased or decreased. It also implies that installation costs are zero when the firm's investment is at its steady state level δ. Besides, this specification entails that it is not only costly to change the stock of aggregate capital, but also to transfer capital from one technology to the other. ψ is the key parameter of the installation costs. It represents their size.

This program is solved using DYNARE (Juillard, 1996), with the baseline calibration of Table I.1. Only $\frac{z_0^E / x_0^E}{z_\infty / x_\infty}$ changes slightly in order to fit the observed increase in TFP in E. For this purpose, it is set to 37%. The baseline calibration for ψ, the installation cost parameter, is set to 1. This specification is chosen to match the estimates of Gilchrist and Sim (2007) and Eberly *et al.* (2008) on firm-level data[8]. Gilchrist and Sim (2007) find estimates of ψ which are robustly close to 1. The estimates of Eberly *et al.* (2008) range between 0.8 and 1.8. For the sensitivity analysis, I also set ψ to 0.5, 2 and 5. The results are reported in Figure I.6 and Table I.3.

Graph (c) in Figure I.6 presents both the interest rate and the cost of capital. The initial fall in the interest rate in I increases the incentives to invest for domestic agents. However, the fall in the cost of capital is limited by the increase in the installation cost. The cost of capital therefore stays temporarily above the interest

[8] Gilchrist and Sim (2007) used Korean data and Eberly *et al.* (2008) relied on US data.

FIG. I.6 – Effect of financial integration at $t = 0$ - Capital installation costs



(a) On I's portfolio (b) On E's portfolio

(c) On the interest rate in I and E (d) On I's CA balances-GDP ratio

(e) On production per worker (f) On relative growth

Nota : This simulation is obtained with the baseline parametrization summed up in Table I.1, except for $\frac{z_0^E/x_0^E}{z_\infty/x_\infty}$, which is set to 37%.

rate. In E, because of the initial increase in the interest rate, the agents want to hold more short-term capital. However, the installation costs incurred by the diminution in the stock of short-term capital decrease the incentives to diminish the stock of capital. The cost of short-term capital therefore stays temporarily below the interest rate. Consequently, as graphs (a) and (b) show, the introduction of installation costs makes the adjustment in the capital stocks smoother. In particular, the stock of short-term capital does not fall sharply in E when financial markets integrate. Similarly, the initial adjustment in the capital stocks in I is delayed. As a consequence, the relative stock of aggregate capital is almost flat at the date of financial integration and the relative production per capita increases from the beginning to the end of the period (graph (f)).

Noticeably, graph (b) of Figure I.6 shows that, as bonds are substituted to short-term capital in E's liquid portfolio, E's external position increases progressively. The progressive increase in E's assets is matched by the progressive increase in I's debt. The adjustment in the current account of I is therefore smoother than in the baseline case.

TAB. I.3 – Calibration results - Capital installation costs

	Baseline	Sensitivity			Data
	(a)	(b)	(c)	(d)	(e)
A	2	2	2	2	Unobservable
$\frac{z_0^E/(k_0^E+z_0^E)}{z_\infty/(k_\infty+z_\infty)}$	37%	37%	36%	35%	Unobservable
ψ	1	0.5	2	5	Unobservable
TFP growth of E relative to I	**12%**	**12%**	**12%**	**12%**	**12%**
Growth of capital per worker in E relative to I	37%	40%	33%	26%	**21%**
Growth of production per worker in E relative to I	25%	26%	24%	21%	**18%**
% of relative growth due to TFP	50%	49%	53%	57%	**68%**
End-of-period b^I/y^I	-60%	-61%	-57%	-49%	**-22%**
Average $\Delta b^I/y^I$	-4,7%	-4,8%	-4,5%	-3.9%	**-2,6%**

Source : World Bank (World Development Indicators), Lane and Milesi-Ferretti (2006) and Penn World Tables 6.2 (Heston *et al.*, 2006).
I corresponds to U : United States, Australia, United Kingdom.
E corresponds to EM : Argentina, Brazil, Chile, China, Colombia, Costa Rica, Ecuador, Egypt, Hong Kong, India, Indonesia, Korea, Malaysia, Mexico, Nigeria, Panama, Peru, Philippines, Poland, Russia, Singapore, Thailand and Venezuela.
Period : 1990-2003.
Capital stocks in EM and U are estimated with the perpetual inventory method, using the procedure of Caselli (2004). TFP values in EM and U are estimated as $y^i/(x^i)^\alpha$, $i \in \{EM, U\}$, where $\alpha = 0.36$, y^i and x^i are respectively output per worker and capital per worker in i.

As for the quantitative results shown in Table I.3, the end-of-period indebtment of I is only slightly decreased. Only for very high, unrealistic adjustment costs is the external position significantly affected. The results of column (d), drawn with the extreme hypothesis that $\psi = 5$, give a level of debt which is still twice as high as in the data. These disappointing results are due to the fact that the installation costs are effective only during the transition. As the level of capital converges to its steady state, the installation costs disappear. This is illustrated by the fact that the cost of capital in graph (c) of Figure I.6 converges towards the interest rate. At the end of the period, given our time span, this convergence is close to be achieved. Consistently, the other quantities are also unaffected for realistic levels of installation costs.

6 Conclusion

This chapter has shown that the presence of financing constraints on the more productive technology in emerging markets can account, at least qualitatively, both for their capital outflows (Fact 1) and for their relative growth since 1990 as compared to the industrial countries, in particular the US (Fact 2). This growth is due both to the convergence of the level of capital to its steady state (Fact 3), but also to TFP growth (Fact 4). The latter is due to a better allocation of capital enabled by the replacement of the less productive, short-term capital with external bonds in the portfolio of the emerging countries. Indeed, since the developed world has better financial markets, its demand for liquid assets for hoarding purposes is lower than that of the developing countries ; as a result, when financial globalization occurs, the emerging economies hold US bonds in order to use it as a hoard.

Qualitatively, in particular when accounting for capital installation costs, the model fits rather well the observed trends in the US current account, relative TFP growth and capital accumulation in emerging countries (hence their relative labor productivity growth). Quantitatively, when the model is fitted on the observed relative TFP growth, the level of debt and current account deficits in the US is over-estimated as well as the share of growth due to capital accumulation. However, the order of magnitude is partly captured. Besides, when the model is fitted on the US external position, the implied TFP growth due to capital reallocation is smaller than in the data, which is compatible with other sources of TFP growth.

7 Appendix

Proof of Proposition 3.2

First, I examine how k, z and b vary with R under PFM and IFM. Then I show how the interest rate adjusts after the financial integration of I and E. Finally, depending on how the interest rate varies from the point of view of E and I, I determine how the portfolio adjusts in both countries.

Under PFM :

$\partial k^*/\partial R = \frac{1}{f''(f'^{-1}(R))} < 0$ and $\partial z^*/\partial R = \frac{1}{g''(g'^{-1}(R))} < 0$: k^* and z^* are decreasing in R because of decreasing marginal returns. As a consequence, since $b^*(R) = w - k^*(R) - z^*(R)$, b^* is increasing in R.

Under IFM :

First, assume that the constrained allocation is chosen.

Because even for the constrained allocation the entrepreneur chooses $\bar{k}$ optimally, $\bar{k}$ is decreasing in R because it becomes relatively less efficient than $\bar{b}$: $\partial \bar{k}/\partial R = \frac{1}{f''(f'^{-1}(R))} < 0$.

Differentiating (FC) with respect to R, and using the optimality condition $f'(\bar{k}) = R$, we obtain $\partial \bar{b}/\partial R = -\partial \bar{k}/\partial R - \frac{\bar{b}}{R}$, which is positive when b small, since $\partial \bar{k}/\partial R < 0$.

Differentiating (BC) with respect to R, we find $\partial \bar{z}/\partial R = -\partial \bar{k}/\partial R - \partial \bar{b}/\partial R$. Replacing $\partial \bar{b}/\partial R$, this yields : $\partial \bar{z}/\partial R = \frac{\bar{b}}{R}$.

We have $\bar{b}(\bar{R}^a) = 0$, so when $R = \bar{R}^a$, we have $\partial\bar{b}/\partial R = -\partial\bar{k}/\partial R > 0$. Therefore, in the neighborhood of $\bar{R}^a$, if $R < \bar{R}^a$, then $\bar{b} < 0$, so $\partial\bar{b}/\partial R > 0$. $\bar{b}$ is therefore always negative when $R < \bar{R}^a$, and we have $\partial\bar{b}/\partial R > 0$ and $\partial\bar{z}/\partial R > 0$. However, when $R > \bar{R}^a$, $\partial\bar{b}/\partial R$ has an ambiguous sign. Still, for $R > \bar{R}^a$, it can be shown that $\bar{b} > 0$ and as a consequence $\partial\bar{z}/\partial R > 0$. Indeed, it can be seen that, when b is high, b can decrease with R but it never becomes negative : if b falls a lot, then $\partial\bar{k}/\partial R$ will eventually become predominant, and b would start to rise again.

Adjustment of R after financial integration :

For $R < \bar{R}^a$, both b^* and $\bar{b}$ are negative. For $R > R^{a*}$, both b^* and $\bar{b}$ are positive. For $\bar{R}^a \leq R \leq R^{a*}$, $b^* \leq 0$ and $\bar{b} \geq 0$, so, if there exists a solution R^o such that $b^*(R^o) = -\bar{b}(R^o)$, it is necessary in the $[\bar{R}^a, R^{a*}]$ interval. Such a solution exists by continuity of b^* and $\bar{b}$ since $\bar{b}(\bar{R}^a) = 0$, $\bar{b}(R^{a*}) \geq 0$, $b^*(\bar{R}^a) < 0$ and $b^*(R^{a*}) = 0$.

Now, we can show that for $R = R^o$, the credit constraint is still binding in the emerging economy by ruling out the first-best allocation and the risky one. First, a sufficient condition for ruling out the first-best allocation is $z^*(R^o) \geq \bar{z}(R^o)$. This condition is equivalent to $w - f(k * (R^o)) - b^*(R^o) \geq w - f(\bar{k}(R^o)) - \bar{b}(R^o)$, which corresponds to $b^*(R^o) \leq \bar{b}(R^o)$. We have shown that $b^*(R) \leq 0$ and $\bar{b}(R) \geq 0$ for all $R \in [\bar{R}^a, R^{a*}]$, and since $R^o \in [\bar{R}^a, R^{a*}]$, we have necessarily $b^*(R^o) \leq \bar{b}(R^o)$. Therefore, the first-best allocation is not implementable for $R = R^o$. Similarly, Assumption 3.1 implies that $\bar{z}(\bar{R}^a) > z^{**}(\bar{R}^a)$. Besides, we have shown that for $R > \bar{R}^a$, $\partial\bar{z}/\partial R > 0$. On the other hand, $\partial z^{**}/\partial R < 0$. Therefore, $\bar{z}(R^o) > z^{**}(R^o)$, which implies that the allocation for $R = R^o$ is the constrained one.

As a conclusion, a solution with a binding financing constraint in the emerging markets exists and is characterized by an interest rate R^o in the $[\bar{R}^a, R^{a*}]$ interval.

Adjustment of the portfolio after financial integration :

Consider the general equilibrium solution characterized by $R = R^o$.

Since the industrial economy experiences a drop in the interest rate when financial markets integrate, k^* and z^* rise and b^* decreases.

Since the emerging economy experiences a drop in the interest rate when financial markets integrate, $\bar{k}$ falls while $\bar{z}$ and $\bar{b}$ rise. ■

Proof of Proposition 3.3

We consider the solution satisfying Assumption 3.1 highlighted in Proposition 3.2, with a binding financing constraint in E. In the Cobb-Douglas case :

$$\bar{k} = \left(\frac{\alpha}{R}\right)^{\frac{1}{1-\alpha}}, \qquad \bar{b} = \frac{\Phi}{R} - \frac{1}{\alpha}\left(\frac{\alpha}{R}\right)^{\frac{1}{1-\alpha}}, \qquad \bar{z} = w - \frac{\Phi}{R} + \frac{1-\alpha}{\alpha}\left(\frac{\alpha}{R}\right)^{\frac{1}{1-\alpha}}$$

Then the derivatives can be inferred :

$$\partial\bar{k}/\partial R = -\frac{1}{1-\alpha}\frac{\alpha^{\frac{1}{1-\alpha}}}{R^{\frac{2-\alpha}{1-\alpha}}}, \qquad \partial\bar{b}/\partial R = -\frac{\Phi}{R^2} + \frac{1}{1-\alpha}\frac{\alpha^{\frac{\alpha}{1-\alpha}}}{R^{\frac{2-\alpha}{1-\alpha}}}, \qquad \partial\bar{z}/\partial R = \frac{\Phi}{R^2} - \frac{\alpha^{\frac{\alpha}{1-\alpha}}}{R^{\frac{2-\alpha}{1-\alpha}}}$$

Which implies :

$\partial\bar{y}/\partial R > 0$

$$\Leftrightarrow \underbrace{A\alpha\left(w - \frac{\Phi}{R} + \frac{1-\alpha}{\alpha}\left(\frac{\alpha}{R}\right)^{\frac{1}{1-\alpha}}\right)^{-(1-\alpha)}}_{g'(\bar{z})}\underbrace{\left(\frac{\Phi}{R^2} - \frac{\alpha^{\frac{\alpha}{1-\alpha}}}{R^{\frac{2-\alpha}{1-\alpha}}}\right)}_{\partial\bar{z}/\partial R} + \underbrace{R}_{f'(\bar{k})}\underbrace{\left(\frac{-1}{1-\alpha}\frac{\alpha^{\frac{1}{1-\alpha}}}{R^{\frac{2-\alpha}{1-\alpha}}}\right)}_{\partial\bar{k}/\partial R} > 0$$

$$\Leftrightarrow A\alpha\left(\underbrace{\frac{\Phi}{R^2} - \frac{\alpha^{\frac{\alpha}{1-\alpha}}}{R^{\frac{2-\alpha}{1-\alpha}}}}_{b/R(>0)}\right) > \frac{1}{1-\alpha}\left(\frac{\alpha}{R}\right)^{\frac{1}{1-\alpha}}\left(\underbrace{w - \frac{\Phi}{R} + \frac{1-\alpha}{\alpha}\left(\frac{\alpha}{R}\right)^{\frac{1}{1-\alpha}}}_{z(>0)}\right)^{(1-\alpha)}$$

Which is true if A or Φ high, or if w small.

If the above condition is satisfied, that is if A and ϕ^E high, if w small, then $\partial\bar{y}/\partial R > 0$. ■

Proof of Proposition 5.1

The (I.8) and (I.9) system that characterizes the dynamics of the industrial country is linearized around the financial globalization steady state (z_∞, C^I_∞) :

$$\Delta C^I_{t+1} = \Delta C^I_t - \beta\left[\kappa + (1-\beta)\frac{n^E}{n^I}[\phi - f(k_\infty)]g''(z_\infty)\right]\Delta z^I_{t+1} \text{ for } t \geq 0 \qquad \text{(I.14)}$$

$$\Delta C_t^I = \frac{\chi}{\beta}\Delta z_t^I - (\chi + \beta^2 g''(z_\infty)\frac{n^E}{n^I}[\phi - f(k_\infty)])\Delta z_{t+1}^I \text{ for } t > 0 \tag{I.15}$$

and at $t = 0$:

$$\Delta C_0^I = -\left(\chi + \beta^2 g''(z_\infty)\frac{n^E}{n^I}[\phi - f(k_\infty)]\right)\Delta z_1^I + \frac{n^E}{n^I}[\phi - f(k_\infty)] \tag{I.16}$$

where $\kappa = (1 + A^{\frac{-1}{1-\alpha}})\left(\frac{1}{\beta} - [1 - \delta(1-\alpha)]\right)\left(\frac{1}{\beta} - [1-\delta]\right)$ and $\chi = 1 + 2A^{\frac{-1}{1-\alpha}} > 1$.

Equations (I.14), (I.15) and (I.16), which govern the dynamics of the industrial economy, are independent from the rest of the system, since they only involve z^I and C^I. Once the dynamics of z^I is solved using this independent dynamic sub-system with 2 variables and 2 equations, the dynamics of z^E can be inferred using Equations (I.10) and (I.11).

We replace ΔC_{t+1}^I and ΔC_t^I in (I.14) using (I.15). We obtain the following second-order difference equation for Δz^I :

$$\Delta z_{t+2}^I - \left(1 + \frac{\chi}{\beta(\chi + \beta^2 g''(z_\infty)\frac{n^E}{n^I}[\phi - f(k_\infty)])} + \frac{\beta\left(\kappa + (1-\beta)\frac{n^E}{n^I}[\phi - f(k_\infty)]g''(z_\infty)\right)}{\chi + \beta^2 g''(z_\infty)\frac{n^E}{n^I}[\phi - f(k_\infty)]}\right)\Delta z_{t+1}^I + \frac{\chi}{\beta(\chi + \beta^2 g''(z_\infty)\frac{n^E}{n^I}[\phi - f(k_\infty)])}\Delta z_t^I = 0$$

The characteristic polynomial of this difference equation is :

$$P_I(x) = x^2 - \left(1 + \frac{\chi}{\beta(\chi + \beta^2 g''(z_\infty)\frac{n^E}{n^I}[\phi - f(k_\infty)])} + \frac{\beta\left(\kappa + (1-\beta)\frac{n^E}{n^I}[\phi - f(k_\infty)]g''(z_\infty)\right)}{\chi + \beta^2 g''(z_\infty)\frac{n^E}{n^I}[\phi - f(k_\infty)]}\right)x + \frac{\chi}{\beta(\chi + \beta^2 g''(z_\infty)\frac{n^E}{n^I}[\phi - f(k_\infty)])} = 0$$

Under the condition $\chi > -\beta^2 g''(z_\infty)\frac{n^E}{n^I}[\phi - f(k_\infty)]$, the above second-order polynomial has two positive roots, one above one and denoted λ_I', and the other below one and denoted λ_I. The former is irrelevant because it leads to a path for Δz_t^I that is explosive. Then we know that, for all $t > 0$:

$$\Delta z_{t+1}^I = \lambda_I \Delta z_t^I$$

with $\Delta z_1^I = \frac{n^E}{n^I} \frac{\phi - f(k_\infty)}{\lambda_I'}$ as an initial condition, derived from Equation (I.16). At impact, z^I thus increases in the industrial country and then slowly decreases towards its steady state.

If the emerging country is credit constrained all along the transition path, then the industrial country's dynamics is well described by the previous equations. If $\phi - f(k_\infty)$ is small, then $\chi > -\beta^2 g''(z_\infty) \frac{n^E}{n^I} [\phi - f(k_\infty)]$. Therefore, as said before, Δz^I admits a unique trajectory towards the steady state.

Since $\phi > f(k_\infty)$ and $\lambda_I' > 1$, $\Delta z_1^I = \frac{n^E}{n^I} \frac{\phi - f(k_\infty)}{\lambda_I'} > 0$. This yields the dynamics for z^I when the emerging country is constrained, but also for k^I, y^I and the world interest rate R_t, since $\Delta k_t^I = A^{\frac{-1}{1-\alpha}} \Delta z_t^I$, $\Delta y_t^I = 1/\beta(1 + A^{\frac{-1}{1-\alpha}}) \Delta z_t^I$ and $\Delta R_t = g''(z_\infty) \Delta z_t^I$. ■

Proof of Proposition 5.2

Equations (I.10) and (I.11) are log-linearized around the steady state (z_∞, C_∞^I) :

$$\Delta C_{t+1}^E = \Delta C_t^E - \beta \left(\kappa - \frac{1-\beta}{\beta} g''(z_\infty) [\phi - f(k_\infty)] \right) \Delta z_{t+1}^E \text{ for } t \geq 0 \tag{I.17}$$

$$\Delta C_t^E = \frac{1}{\beta} \Delta z_t^E - \Delta z_{t+1}^E + \beta^2 g''(z_\infty) [\phi - f(k_\infty)] \Delta z_{t+1}^I \text{ for } t \geq 0 \tag{I.18}$$

Evolution of z_t^E :

Replacing ΔC_{t+1}^E and ΔC_t^E in Equation (I.17) using (I.18), we find that Δz_t^E is defined implicitly by the following second-order difference equation :

$$\Delta z^E_{t+2} - \left(\frac{1}{\beta} + \beta\left(\kappa - \frac{1-\beta}{\beta}g''(z_\infty)[\phi - f(k_\infty)]\right) + 1\right)\Delta z^E_{t+1} + \frac{1}{\beta}\Delta z^E_t$$

$$= -\beta^2 g''(z_\infty)[\phi - f(k_\infty)](1-\lambda_I)\Delta z^I_{t+1} \quad \text{(I.19)}$$

The characteristic polynomial of the homogeneous equation is

$$P_E(x) = x^2 - \left(\frac{1}{\beta} + \beta\left(\kappa - \frac{1-\beta}{\beta}g''(z_\infty)[\phi - f(k_\infty)]\right) + 1\right)x + \frac{1}{\beta} = 0$$

This polynomial has two positive roots, $\lambda'_E > 1$, and λ_E, which is positive and lower than one. The only relevant root is therefore λ_E. A particular solution to the general equation is of the form : $\Delta z^E_t = v\Delta z^I_{t+1}$. v must satisfy :

$$v\left[\lambda_I^2 - \left(\frac{1}{\beta} + \beta\left(\kappa - \frac{1-\beta}{\beta}g''(z_\infty)[\phi - f(k_\infty)]\right) + 1\right)\lambda_I + \frac{1}{\beta}\right]$$

$$= -\beta^2(1-\lambda_I)g''(z_\infty)[\phi - f(k_\infty)]$$

As a result : $v = \frac{-\beta^2(1-\lambda_I)g''(z_\infty)[\phi - f(k_\infty)]}{(\lambda_E-\lambda_I)(\lambda'_E-\lambda_I)}$.

The general, converging solution for Δz^E_t is then of the following form $\Delta z^E_t = \lambda^t_E\Delta z'_0 + v\Delta z^I_{t+1}$. Here, Δz_0 is given so $\Delta z'_0$ must satisfy $\Delta z^E_0 = \Delta z'_0 + v\Delta z^I_1$, so we have :

$$\Delta z^E_t = \lambda^t_E(\Delta z^E_0 - v\Delta z^I_1) + \lambda^t_I v\Delta z^I_1 \quad \text{(I.20)}$$

To study the evolution of z^E, we have to determine the sign of v, which is the same as $\lambda_E - \lambda_I$. Consider the case where $\phi^E = f(k_\infty)$: $P_I(\lambda) - P_E(\lambda) = \beta\kappa(1-1/\chi)\lambda$. We have $\chi > 1$, so, for $\lambda > 0$, $P_I(\lambda) > P_E(\lambda)$. As a result, $P_I(\lambda_E) > P_E(\lambda_E) = 0$. Since P_I is decreasing on the $[0,1]$ interval, and $P_I(\lambda_I) = 0$, then $\lambda_I > \lambda_E$. This is still the case by continuity when ϕ^E close to $f(k_\infty)$. Therefore, $v < 0$.

As a consequence, since Δz^I_1 is of the same sign as $\phi^E - f(k_\infty)$, which is positive, the second term of the RHS is negative. Since, additionally, $\Delta z^E_0 < 0$ and Δz^I_1 and v are proportional to $|\phi^E - f(k_\infty)|$, which is small compared to $|\Delta z^E_0|$, the second term is also negative. Therefore, Δz_t^E is always negative and z^E is increasing in t.

Existence of the constrained solution : We now show that the solution defined by Equation (I.20) under the hypothesis of forever binding financing constraints does exist. We have to prove first that if z_t^E follows (I.20), then the entrepreneurs are indeed constrained. It is the case as long as $\Delta z_t^I > \Delta z_t^E$. $\phi^E > f(k_\infty)$ implies that $\Delta z_t^I > 0$. It has been shown also that $\Delta z_t^E < 0$. As a consequence, $\Delta z_t^I > \Delta z_t^E$ for all $t > 0$.

Second, we have to prove that under Assumption 4.1, the risky allocation is not a better choice along the transition path with binding financing constraint. First, recall that Assumption 4.1, the risky z is below the constrained one for the interest rate corresponding to the constrained allocation. When the constraint is binding on the convergence path, z^E increases. Besides, the interest rate increases, so the corresponding risky allocation decreases. The constrained allocation is still above the risky one, so the latter is ruled out along the constrained transition path.

Evolution of b_t^E : When the economy is constrained, Δb_t^E evolves according to :

$$\Delta b_t^E = \left(-\beta^2 g''(z_\infty)[\phi - f(k_\infty)] - A^{\frac{-1}{1-\alpha}}\right) \Delta z_t^I$$

When $\phi^E - f(k_\infty)$ is small, the substitution effect dominates so Δb_t^E is of the opposite sign of Δz_t^I, which is positive : b_t^E is below its steady state and is increasing in t.

Evolution of k_t^E : After the integration of financial markets, k_t^E follows the same path as k_t^I, since $f'(k_t^E)$ is equal to the world interest rate.

Evolution of y_t^E : According to Equation (I.20) and since $\Delta k_t^E = A^{\frac{-1}{1-\alpha}} \Delta z_t^I = A^{\frac{-1}{1-\alpha}} \lambda_I^t \Delta z_1^I / \lambda_I$, the evolution of y^E is given by the following equation :

$$\Delta y_t^E = \frac{1}{\beta}\left[\lambda_E^t(\Delta z_0^E - v\Delta z_1^I) + \lambda_I^t\left(v + \frac{A^{\frac{-1}{1-\alpha}}}{\lambda_I}\right)\Delta z_1^I\right]$$

v is proportional to $\phi^E - f(k_\infty)$. Therefore, if ϕ^E is close to $f(k_\infty)$, then the second term is positive. On the opposite, as we have already shown, the first term is negative. However, Δz_1^I is proportional to $\phi^E - f(k_\infty)$, so when $\phi^E - f(k_\infty)$ is small as compared to $|\Delta z_0^E|$, the RHS is negative and increasing in t for small values of t. However, since $\lambda_I > \lambda_E$, as we have shown, the first term becomes negligible for large values of t, and the RHS becomes positive and decreasing in t.

Evolution of y_t^E/y_t^I : Up to a linear approximation, y_t^E/y_t^I evolves in the same direction as $\Delta y_t^E - \Delta y_t^I$. Besides, we have :

$$\Delta y_t^E - \Delta y_t^I = \frac{1}{\beta}\left[\lambda_E^t(\Delta z_0^E - v\Delta z_1^I) + \lambda_I^t\left(v - \frac{1}{\lambda_I}\right)\Delta z_1^I\right]$$

All the terms of the RHS are negative and increasing in t, so $\Delta y_t^E - \Delta y_t^I$ is increasing in t. ■

Chapitre II

A Reappraisal of the Allocation Puzzle through the Portfolio Approach

1 Introduction

The neoclassical growth model (Ramsey-Cass-Koopmans) predicts that a country whose marginal return on capital is above the world's interest rate and that opens to international bond markets increases its investment level through international borrowing. More precisely, when the return on domestic capital is higher than the cost of borrowing, it is optimal to borrow from the rest of the world to finance domestic investment. Under decreasing marginal returns, this takes place until the marginal return on capital equals the world's interest rate. The higher the initial discrepancy between both returns, the more the country invests and the more it has to borrow. This should generate a positive cross-country correlation between investment and capital inflows.

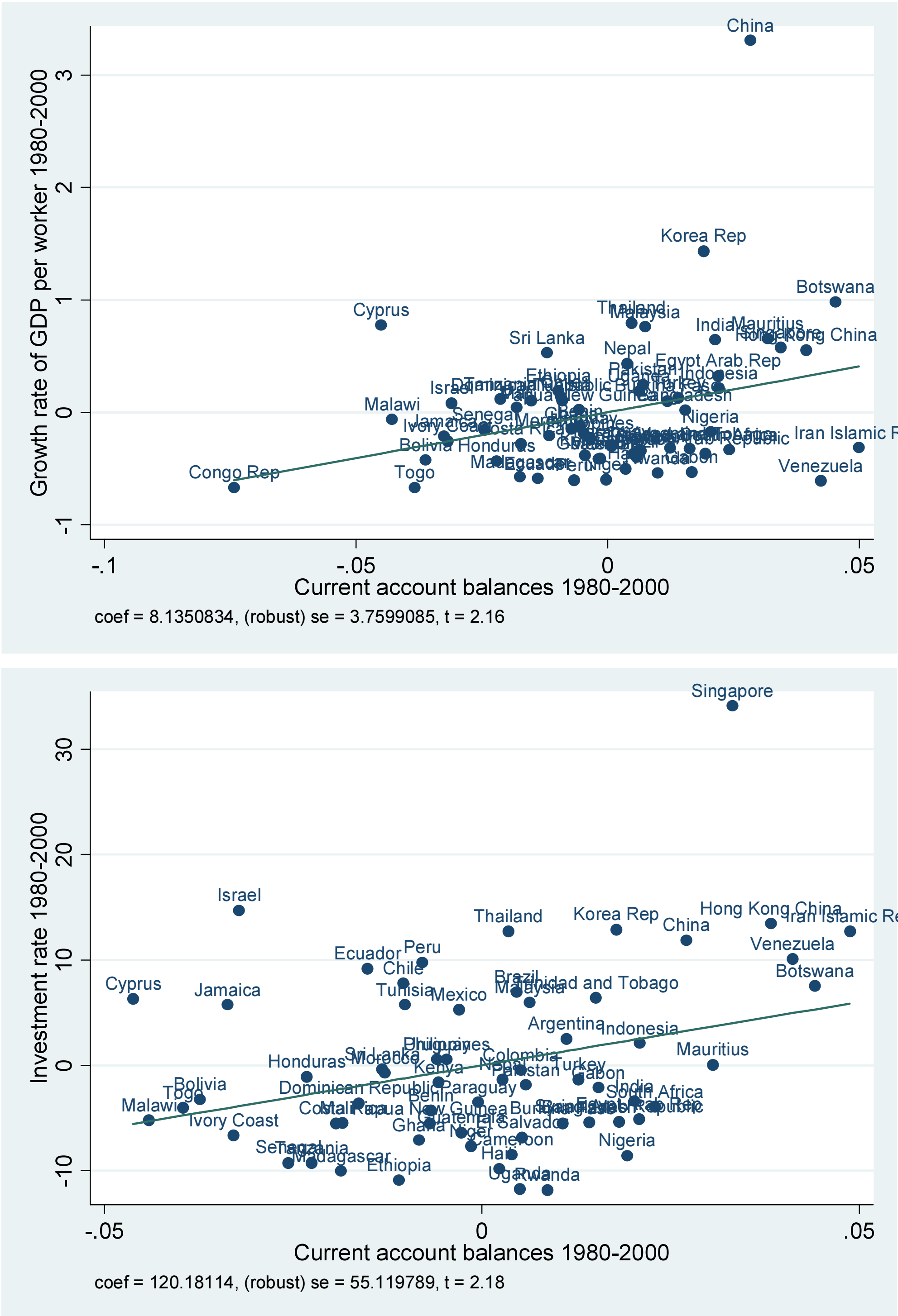
Two main elements can account for the difference between a country's marginal return on capital and the international interest rate : capital-scarcity and total factor productivity (TFP) gains. If the level of capital is low when financial markets open, then its marginal return is high relatively to the world's interest rate. Similarly, starting from equal domestic and foreign returns, an increase in TFP pushes the former above the latter. In both cases, both investment and foreign borrowing increase. Hall and Jones (1999) and Caselli (2004) show that TFP remains the main source of cross-country differences in income. Therefore, according to the textbook growth model, countries with higher productivity growth should attract more capital.

This prediction has recently been challenged by Gourinchas and Jeanne (2007). Using a calibrated neoclassical growth model in the spirit of the development accounting literature on a sample of 69 non-OECD economies between 1980 and 2000, they show that not only the model fails to predict the correct amount of capital inflows, but the predicted flows are negatively correlated with the actual ones. They call this paradox the "allocation puzzle". This puzzle comes from the fact that productivity growth is negatively correlated to capital inflows. Put differently, the more productive countries receive less capital from abroad. According to the model, countries with higher productivity growth should (i) invest more in their technology in order to keep up with productivity growth, and (ii) borrow from the rest of the world to finance their investment. Gourinchas and Jeanne (2007) show that these countries do invest more, but instead of borrowing more, they lend more. This puzzle is summarized by Figure II.1, which presents the cross-country correlation between the growth rate of GDP per worker and the average current account balances during 1980-2000 on the one hand (upper graph), and between the average investment rate and the average current account balances during the same period on the other hand (lower graph). The figure shows that capital outflows are positively related to both growth and investment[1]. Explaining the puzzle thus necessitates to account for this positive correlation between investment and capital outflows.

In this paper, I introduce investment risk in the neoclassical model used by

[1] The significant positive correlations are robust to the exclusion of China in the upper panel and Singapore in the lower panel. The resulting t-statistics are respectively 1.98 and 1.83.

FIG. II.1 – Growth of GDP per worker and investment rate against current account balances, 1980-2000



Source : Penn World Tables 6.2 (Heston *et al.*, 2006), CHELEM database.

Gourinchas and Jeanne (2007) to explain the positive correlation between investment and capital outflows. Two cases are then considered : the particular case where the level of risk is zero and the case where it is strictly greater than zero. The first case corresponds to the "riskless" approach and is similar to Gourinchas and Jeanne (2007), while the second case corresponds to a portfolio choice approach. In the riskless approach, private capital and bonds are perfect substitutes : if the marginal productivity of private capital is higher than the world interest rate on bonds, then it is optimal to borrow from the rest of the world in order to invest in private capital. In the portfolio approach, the composition of the portfolio matters. In particular, in the constant relative risk aversion (CRRA) case, bonds and private capital are constant shares of the portfolio. Intuitively, one part of the portfolio (riskless bonds) are used to self-insure against the riskiness of the other part (risky capital). In this case, a more productive domestic capital makes a country more willing to invest in private capital, but in order to invest more it has to hold a higher amount of bonds. In the long term, this is possible because a higher productivity makes the country richer. It is therefore possible to exhibit a negative correlation between productivity growth and capital inflows (i.e. a positive correlation between productivity growth and capital outflows).

The two approaches are developed and calibrated on the same sample as Gourinchas and Jeanne (2007). When using the riskless approach, the same negative correlation between predicted and observed flows as in Gourinchas and Jeanne (2007) is found. As expected, the allocation puzzle is recovered. When relying on the portfolio approach, a positive correlation between predicted and observed flows is found. Therefore, the portfolio approach outperforms the riskless one in terms of capital flows allocation. Two main facts contribute to this result : (i) countries with higher TFP growth tend to experience smaller capital inflows ; (ii) countries with larger capital shares in their portfolio at the beginning of period also experience smaller capital inflows. Fact (i) is at the core of the puzzle when using the riskless approach while it is consistent with the portfolio approach, according to the intuition developed above. Fact (ii) makes sense only within the portfolio approach and also contributes to solve the puzzle. This is because, contrasting with the riskless approach, the share of capital and safe assets in the portfolio at steady state is determined and unique across countries. Convergence towards the steady state then implies a smaller rise in the capital share in countries where capital is already a large part of the portfolio. Therefore, the level of bonds should decrease less in those countries. These two facts contribute strongly to the success of the portfolio approach in reproducing the right direction of flows. However, in assessing the magnitude of flows, the portfolio approach fares worse than the riskless one. Capital inflows to developing countries are over-estimated by several order of magnitude. Some extensions are developed in order to diminish this discrepancy.

As for the first chapter, some theories can be related to the puzzle : on the one hand, Modigliani's life-cycle hypothesis (Modigliani, 1986) and the habit-formation model (Carroll *et al.*, 2000), which account for the positive correlation between growth and savings ; on the other hand, the export-led growth theories (Dooley *et al.*, 2004, 2005a; Rodrik, 2006, 2007). The general introduction has already exposed the limits of these approaches in accounting for the positive correlation between current account balances and growth.

However, it is worth reminding how the contributions on global imbalances can be related to the allocation puzzle. The explanations that highlight the role of financial development are potential candidates to account for the allocation puzzle. Dooley *et al.* (2005b), Mendoza *et al.* (2007a), Matsuyama (2007) and Ju and Wei (2006, 2007) explain how low financial development in the South, through production risk, credit constraints or a poor financial intermediation system can lead to "uphill flows", that is, positive lending to the North. As stressed in the general introduction, these approaches can be related to the Lucas puzzle. However, as highlighted in the general introduction, the allocation puzzle cannot be reduced to the Lucas paradox, since the latter is about the magnitude and not the direction of flows. The Lucas puzzle points to the fact that the capital flows that would enable the marginal productivity of capital to equalize across countries do not take place. It can be explained by the presence of an unobserved capital wedge which depends on the country's institutions. This wedge can explain why the observed marginal productivity, measured by the capital to labor ratio, does not adjust. In fact, the ex-post, unobserved private returns, impaired by the capital wedge, do adjust. Even if this wedge is taken into account, as in Gourinchas and Jeanne (2007), capital should still flow where the level of investment is higher, that is in countries where the wedge-adjusted productivity is higher. The contributions on global imbalances, which explain uphill flows by the presence of a wedge between the marginal return to capital and the rate of return, fail to explain the allocation puzzle.

Some other studies on global imbalances show a concern for growth. Caballero *et al.* (2008) build an intergenerational model where low financial development, that is the inability of the economy to store value, increases the demand for foreign assets. As a consequence, high growth economies can still export capital if they cannot generate enough assets. This model provides a convincing explanation for the joint phenomenon of the US deficit and Asian savings glut. But growth still has a negative impact on the long-term current account and external position because it increases the domestic supply of assets. In Aghion *et al.* (2006b), domestic savings constitute a collateral and thus favors foreign investment, which has positive externalities on growth. But the consequences in terms of correlation between growth and the current account, that is savings minus investment, are unclear. Besides, they take the savings rate as exogenous, whereas empirical evidence suggests that they cause one another (Carroll and Weil, 1994; Attanasio *et al.*, 2000).

The rest of the chapter is structured as follows : Section 2 presents the model with the two approaches and their properties ; Section 3 calibrates the model and confronts the predicted capital flows according to both approaches to the data ; Section 4 provides some extensions.

2 Amending the neoclassical growth model

In this section, I build on the neoclassical growth model developed by Gourinchas and Jeanne (2007), in which capital flows are determined by their productivity path relative to the world technology frontier. The model features a small open economy and the rest of the world. The latter is unaffected by the small country's dynamics. What is examined specifically here is how investment risk modifies portfolio decisions and in particular capital flows.

Time is continuous, indexed by $t \in [0, \infty)$. There is a continuum of length 1 of infinitely-lived households, or families, indexed by i. Each household is composed of N_t members, and each member is endowed with 1 unit of labor. Labor is supplied inelastically in a competitive labor market. Each household owns a firm which employs labor in the competitive labor market. Households can invest only in the -risky- capital of their own firm or in a riskless bond. All uncertainty is idiosyncratic, and hence all aggregates are deterministic.

2.1 Firms and technology

Denote household i's net capital income by dQ_t^i. It evolves according to :

$$dQ_t^i = (1-\tau)[F(K_t^i, A_t N_t^i) - w_t N_t^i]dt - \delta K_t^i dt + \sigma K_t^i dv_t^i \qquad \text{(II.1)}$$

where K_t^i is the household's holdings in private capital, A_t the exogenous and deterministic level of productivity, N_t^i the amount of labor the firm hires in the labor market, w_t the wage rate, which is not firm-specific since the labor market is competitive. The parameter τ is a wedge on the gross capital return, that is, before subtracting capital depreciation. This is a deviation from Gourinchas and Jeanne (2007), where the wedge is on capital returns net of depreciation. This specification is chosen only for practical reasons[2] and does not change the results dramatically. As in Gourinchas and Jeanne (2007), this wedge can be interpreted as a tax on

[2] The resulting amount can be expressed as a fraction of production.

capital income, or as the result of other distorsions that would introduce a difference between social and private returns. We assume that this tax on capital return is distributed equally among households. The parameter δ is the depreciation rate. The production function F is assumed to follow a Cobb-Douglas specification : $F(K, AN) = K^{\alpha}(AN)^{1-\alpha}$, $\alpha \in (0,1)$. The technology is exactly identical to Gourinchas and Jeanne (2007), except that time is continuous and that investment risk is introduced through a standard Wiener process dv_t^i. This process is assumed to be iid across agents and time. It satisfies $E[dv_t^i = 0]$ and $E[(dv_t^i)^2] = 1$ for all i and $E[dv_t^i dv_t^j] = 0$ for all i, j, $i \neq j$. This risk can be interpreted as a production or a depreciation shock that affects the return on capital. It is assumed that this shock is averaged out across households, that is : $\int_0^1 dv_t^i = 0$. The parameter σ measures the amount of individual risk. Gourinchas and Jeanne (2007)'s specification is nested when $\sigma = 0$.

We show now that the capital income is linear in K_t^i. Denote $\tilde{k}_t^i = K_t^i/(A_t N_t^i)$ the capital per efficient unit of labor and $\tilde{y}_t^i = F(K_t^i, A_t N_t^i)/(A_t N_t^i) = f(\tilde{k}_t^i) = \tilde{k}_t^{i\alpha}$ the production per efficient unit of labor. Employment is chosen after the capital stock has been installed and the shock has been observed. Therefore, at each period t, the firm chooses employment in order to maximize $F(K_t^i, A_t N_t^i) - w_t N_t^i$, where w_t is the competitive wage per unit of labor. This yields $w_t = (1-\alpha)A_t(\tilde{k}_t^i)^{\alpha}$. Because the competitive wage is constant across firms $\tilde{k}_t^i$, the ratio of capital to efficient labor, is also constant across firms. Denote $\tilde{k}_t = \tilde{k}(\tilde{w}_t) = \tilde{w}_t^{1/\alpha}/(1-\alpha)$, where $\tilde{w} = w/A$ is the wage per efficient unit of labor. Using this result, we can write the capital income as follows :

$$dQ_t^i = r_t K_t^i dt + \sigma K_t^i dv_t^i$$

where $r_t = r(\tilde{w}_t, \tau) = (1-\tau)\alpha\tilde{k}(\tilde{w}_t)^{\alpha-1} - \delta$ is the private net return on capital. The net capital income is therefore linear in K_t^i, which makes the analysis tractable when $\sigma > 0$.

The country has an exogenous, deterministic productivity path $\{A_t\}_{t=0,\ldots,\infty}$, which is bounded by the world productivity frontier :

$$A_t \leq A_t^* = A_0^* e^{g^* t}$$

The world productivity frontier is assumed to grow at rate g^*. Following Gourinchas and Jeanne (2007), we define the difference between domestic productivity and the productivity conditional on no technological catch-up as follows :

$$e^{\pi_t} = \frac{A_t}{A_0 e^{g^* t}} \tag{II.2}$$

We assume that $\pi = lim_{t\to\infty}\pi_t$ is well defined. Therefore, the growth rate of domestic productivity converges to g^*.

2.2 The household's program

The household's preferences follow expected utility. Instantaneous utility is logarithmic. We assume, as Barro and Sala-i Martin (1995), that the representative member of the household is altruistic and maximizes the welfare of his descendants along with his own. He therefore maximizes the following family's welfare function :

$$U_t^i = E_t \int_t^{\infty} N_s \ln c_s^i e^{-\rho(s-t)} ds \tag{II.3}$$

where $\rho > 0$ is the discount rate and c_t^i is the individual consumption of the members of household i in period t. The growth rate of population is supposed to be exogenous and equal to n :

$$N_t = N_0 e^{nt}$$

For the utility function to be well defined, we must have $n < \rho$.

We now turn to the household's budget constraint.

Let B_t denote the household's holdings in riskless bond and H_t his human wealth defined as the present discounted value of future labor income and tax product :

$H_t = \int_t^{\infty} e^{-(s-t)R^*}(N_s w_s + Z_s)ds$ where R^* is the international interest rate and $Z_t = \int_0^1 \tau[F(K_t^i, A_t N_t^i) - w_t N_t^i]di = \tau\alpha\tilde{k}(\tilde{w}_t)^{\alpha-1}K_t$ is the tax product, with $K_t = \int_0^1 K_t^i di$. We thus have :

$$dH_t = (R^* H_t - N_t w_t - Z_t)dt \tag{II.4}$$

Define effective wealth as the sum of financial wealth $B_t^i + K_t^i$, and human wealth :

$$\Omega_t^i = B_t^i + K_t^i + H_t$$

The evolution of the household's financial wealth obeys to :

$$d(B_t^i + K_t^i) = dQ_t^i + [R^* B_t^i + N_t w_t + Z_t - C_t^i]dt \tag{II.5}$$

It follows from (II.1), (II.4) and (II.5), that the evolution of effective wealth, in per capita terms, can be described by :

$$d\omega_t^i = [r_t k_t^i + R^*(b_t^i + h_t) - c_t^i - n\omega_t^i]dt + \sigma k_t^i dz_t^i \tag{II.6}$$

where lower case letters, except n, the population's growth rate, stand for per capita (i.e. per family member) values. For each variable X_t^i (X_t), x_t^i (x_t) stands for X_t^i/N_t (X_t/N_t).

A key element is that the return to capital is linear in K_t^i. This translates to the linearity of effective wealth. The household maximizes his utility with respect to (II.6). When we set $\sigma = 0$, the framework corresponds to that of Gourinchas and Jeanne (2007). Otherwise, the investment rules follow the classical portfolio choice rules with CRRA utility.

This framework is similar to Kraay and Ventura (2000) and Kraay *et al.* (2005), who, among others, apply the portfolio choice model to an open economy. But the portfolio approach has been applied only in AK contexts, which cannot account for such phenomena as decreasing returns and human wealth effects. Here, we use a transformation of the budget constraint introduced by Angeletos and Panousi (2007) in order to make it linear in wealth and apply the portfolio approach to the neoclassical growth model.

2.3 Household's behavior

The linearity of the evolution of the budget constraint along with the homotheticity of preferences ensures that the household's problem reduces to a homothetic problem à la Samuelson and Merton. It follows that the optimal policy rules are linear in wealth.

Lemma 1 : *Define* $\phi_t^i = k_t^i/\omega_t^i$, *the fraction of effective wealth invested in private capital. For a given interest rate* R^* *and a given sequence of wages* $\{W_t\}$, *the policy responses of the household* i *are given by :*

$$c_t^i = (\rho - n)\omega_t^i \tag{II.7}$$

$$\phi_t^i = \phi_t = \frac{r_t - R^*}{\sigma^2} \tag{II.8}$$

Equation (II.7) shows the familiar result that consumption per capita equals the annualized value of wealth, taking into account population growth. It is a direct consequence of the log utility.

Equation (II.8) is the portfolio choice rule. It says that the risky share of the portfolio is increasing in the risk premium $r_t - R^*$ and decreasing in the amount of risk σ. When σ is large, the share of risky assets is low, while the share of safe assets is high. The share of safe assets can be viewed as a way for the household to self-insure against the potential bad shocks to the risky part of the portfolio. Even if the return on the safe assets is lower than the yield of private capital on average ($R^* < r_t$), they play the role of buffer-stock savings against uncertainty. Bonds are therefore held not only for their return but also for their insurance function.

Human wealth h_t and bond holdings b_t are both safe assets and are substitutes. Notice that Equation (II.8) implies that $b_t^i = (1-\phi_t)\omega_t^i - h_t$. When the household expects large labor and tax revenues in the future (h_t is large), he can borrow more (b_t^i decreases). This is the human wealth effect.

The share of capital in the portfolio ϕ_t is all the more reactive to the risk premium that σ is small. In the extreme case, when $\sigma = 0$, ϕ_t goes to infinity as long as the return on private capital is strictly higher than the return on bonds ($r_t > R^*$).

The individual rules (II.7) and (II.8) are linear in wealth and can therefore be written in aggregate terms : $c_t = (\rho - n)\omega_t$ and $k_t = \phi_t \omega_t$, where $y_t = \int_0^1 y_t^i di$ is the aggregate value for y_t^i. By dividing each side by A_t, they can also be written in terms of efficient units of labor. The following Lemma follows :

Lemma 2 : *Let $\tilde{x}_t = \int_0^1 \tilde{x}_t^i di$ denote the aggregate value of $\tilde{x}_t^i$, where $\tilde{x}_t^i = X_t^i/(A_t N_t^i)$ is the value of X_t^i in efficient labor terms. For a given interest rate R^*, the aggregate dynamics of the economy is characterized by :*

$$\frac{\dot{\tilde{c}}_t}{\tilde{c}_t} = \bar{R}_t - \rho - (\dot{\pi}_t + g^*) \tag{II.9}$$

with $\bar{R}_t = \phi_t^i r_t + (1-\phi_t^i)R^*$, the average return on portfolio,

$$\dot{\tilde{k}}_t + \dot{\tilde{b}}_t = f(\tilde{k}_t) - \delta\tilde{k}_t + R^*\tilde{b}_t - \tilde{c}_t - (n + \dot{\pi}_t + g^*)(\tilde{k}_t + \tilde{b}_t) \tag{II.10}$$

and :

(i) *If $\sigma > 0$:*

$$\tilde{k}_t = \frac{\phi_t}{1-\phi_t}(\tilde{h}_t + \tilde{b}_t) \tag{II.11}$$

where ϕ_t satisfies (II.8) and :

$$\dot{\tilde{h}}_t = (1 - \alpha + \tau\alpha) f(\tilde{k}_t) - (n + \dot{\pi}_t + g^* - R^*)\tilde{h}_t \tag{II.12}$$

(ii) *If* $\sigma = 0$ *:*

$$\tilde{k}_t = \tilde{k}^* = \left(\frac{\alpha(1-\tau)}{R^* + \delta}\right)^{\frac{1}{1-\alpha}} \tag{II.13}$$

Equation (II.9) is obtained by differentiating Equation (II.7) with respect to time and using the portfolio rule (II.8). It corresponds to the Euler equation of the economy. Consumption growth per efficient unit of labor increases with $\bar{R}_t$, the mean return to savings and decreases with $\dot{\pi}_t + g^*$, the growth of TFP.

Equation (II.10) is obtained from the aggregation of the individual budget constraints (II.6). Equation (II.11) is a rewriting of the portfolio choice rule (II.8).

Finally, Equation (II.13) derives from the no-arbitrage condition $r_t = R^*$ between bonds and domestic capital when $\sigma = 0$. This no-arbitrage condition is an equilibrium outcome that derives from the infinite elasticity of private capital demand to the return differential between capital and bonds. The concavity of the production function insures that this no-arbitrage condition is satisfied. This fixes the level of capital so that its private return equals the world interest rate. In this case, the average return on portfolio $\bar{R}_t$ is simply equal to the world interest rate on bonds R^*.

The labor market clears so the labor force is identical in all firms : $N_t^i = N_t$ for all i. To recover aggregate values, the per worker or per efficient units of labor values must therefore be multiplied by $A_t N_t$.

When $\sigma = 0$, Equations (II.9), (II.10) and (II.13), along with k_0, b_0 and the no-Ponzi conditions, characterize entirely the dynamics of the economy. When $\sigma > 0$, Equations (II.9), (II.10), (II.11) and (II.12) along with k_0, b_0 and the no-Ponzi conditions, characterize the dynamics. In that case, we must keep track of an additional variable, $\tilde{h}_t$, because households' wealth matters for investment.

2.4 Steady state

We define the steady state by $\dot{\tilde{k}}/\tilde{k} = 0$ and $\dot{\pi}_t = 0$. This condition implies different constraints on the world interest rate depending on σ.

Proposition 1 :

(i) *If $\sigma > 0$, the open economy steady state exists if and only if $R^* - g^* < \rho$ and is defined by :*

$$(1-\tau)f'(\tilde{k}^*) - \delta - R^* = \sqrt{\sigma^2(\rho - R^* + g^*)} \tag{II.14}$$

$$\tilde{k}^* = \frac{\phi^*}{1-\phi^*}\left[\frac{(1-\alpha+\alpha\tau)f(\tilde{k}^*)}{R^* - g^* - n} + \tilde{b}^*\right] \tag{II.15}$$

with $\phi^* = \sqrt{\frac{\rho - R^* + g^*}{\sigma^2}}$.

(ii) *If $\sigma = 0$, the open economy steady state exists if and only if $R^* - g^* = \rho$ and is defined by :*

$$(1-\tau)f'(\tilde{k}^*) - \delta = R^* \tag{II.16}$$

$$\tilde{b}^* = -\tilde{k}^* - \frac{(1-\alpha+\alpha\tau)f(\tilde{k}^*) - \tilde{c}_0 e^{-\pi}}{\rho - n} \tag{II.17}$$

with $\tilde{c}_0 = (\rho - n)\left[(1-\alpha+\alpha\tau)f(\tilde{k}^*)\int_0^\infty e^{-(\rho-n)t+\pi_t}dt + \tilde{k}_0 + \tilde{b}_0\right]$.

Equation (II.14) derives from the stationarity of consumption in efficient labor terms and the Euler equation (II.9). It states that, in the steady state equilibrium, the risk premium (LHS) is constant and depends positively on the amount of risk σ and on the difference between the discount factor ρ and the world interest rate adjusted for the growth of the world productivity $\rho - (R^* - g^*)$. Equation (II.16) is another way to write the no-arbitrage condition $r_t = R^*$ when capital is not risky, but it can also be viewed as a particular case of Equation (II.14), where $\sigma = 0$.

Equation (II.15) is the steady-state version of the portfolio allocation rule (II.11), while Equation (II.17) derives from the long-term version of the budget constraint (II.10) and from the Euler equation (II.9). In the presence of risk, safe assets, including bond holdings, are a constant share of the portfolio which depends only on the parameters of the model. But in the absence of risk, the amount of bonds is determined only by initial wealth $\tilde{k}_0 + \tilde{b}_0$. Notice that in both cases, $\phi^* > 0$ since wealth and capital are necessarily positive, but we do not have necessarily $\phi^* < 1$. This is equivalent to $h^* + b^* > 0$, which is not necessarily the case in a small open economy, since b^* can be negative. When $\sigma = 0$, the steady-state share of capital in the portfolio ϕ^* depends on initial conditions and thus can take any value above zero. When $\sigma > 0$, it depends on the parameters. However, if σ is not too small (namely, if $\sigma > \rho - R^* + g^*$), then $\phi^* < 1$.

Equations (II.14) and (II.15) on the one hand, and (II.16) and (II.17) on the other, are sufficient to determine $\tilde{k}^*$ and $\tilde{b}^*$, the steady-state values for capital and bond holdings per efficient unit of labor. Equations (II.14) and (II.16) determine $\tilde{k}^*$ unambiguously and these values can be replaced respectively in Equations (II.15) and (II.17) to determine $\tilde{b}^*$.

2.5 Capital flows

Following the method of Gourinchas and Jeanne (2007), the model is confronted with the data observed over a finite period $[0, T]$. However, before deriving the level of bonds predicted by the model, some assumptions must be made. First, we abstract from unobserved future developments in productivity by assuming that all countries have the same productivity growth rate g^* after time T.

Assumption 1 : $\pi_t = \pi$ for all $t \geq T$.

When $\sigma = 0$, $\tilde{k}_t = \tilde{k}^*$ for all t. The steady state is reached immediately. However, when $\sigma > 0$, $\tilde{k}_t$ is contingent on time, which makes it impossible to abstract on T from future $\tilde{k}_t$, except if $\tilde{k}_T$ is sufficiently close to the steady state. In particular, for T sufficiently high, $\tilde{k}_T$ is close to $\tilde{k}^*$, since $\tilde{k}$ converges to its steady state[3]. In the remainder of the analysis, it is therefore assumed that T is sufficiently large to be able to make the following approximation : $\tilde{k}_t = \tilde{k}^*$ for all $t \geq T$.

[3] See Angeletos (2007) and Angeletos and Panousi (2007) for the transitional dynamics of this kind of model.

Denote by $\Delta B/Y_0 = (B_T - B_0)/Y_0$ the amount of capital flows between 0 and T. In order to distinguish the predicted capital flows according to the riskless and portfolio approaches, denote the former $\overline{\Delta B/Y_0}$ and the latter $\widehat{\Delta B/Y_0}$.

Proposition 2 : *Under Assumption 1 and for T sufficiently large, the ratio of cumulated capital inflows to initial input is given by :*

(i) *If $\sigma = 0$:*

$$\overline{\frac{\Delta B}{Y_0}} = \frac{\tilde{k}_0 - \tilde{k}^*}{\tilde{k}_0^\alpha} e^{(n+g^*)T} + \left(e^{(n+g^*)T} - 1\right) \frac{\tilde{b}_0}{\tilde{k}_0^\alpha} - (e^\pi - 1)\frac{\tilde{k}^*}{\tilde{k}_0^\alpha} e^{(n+g^*)T}$$

$$-e^{\pi+(n+g^*)T} \frac{(1-\alpha+\alpha\tau)\tilde{k}^{*\alpha}}{\tilde{k}_0^\alpha} \int_0^T e^{-(\rho-n)t}(1-e^{\pi_t - \pi})dt \qquad \text{(II.18)}$$

(ii) *If $\sigma > 0$:*

$$\widehat{\frac{\Delta B}{Y_0}} = \frac{1-\phi^*}{\phi^*} \frac{\tilde{k}^* - \tilde{k}_0}{\tilde{k}_0^\alpha} + \frac{1-\phi^*}{\phi^*} \frac{\tilde{k}^*}{\tilde{k}_0^\alpha} \left(e^{\pi+(n+g^*)T} - 1\right) + \frac{\tilde{k}_0}{\tilde{k}_0^\alpha} \left(\frac{1}{\phi^*} - \frac{1}{\phi_0}\right)$$

$$+e^\pi \frac{(1-\alpha+\alpha\tau)\tilde{k}^{*\alpha}}{\tilde{k}_0^\alpha} \int_0^T e^{-(R^*-(n+g^*))t} e^{\pi_t - \pi} \frac{\tilde{k}_t^\alpha}{\tilde{k}^{*\alpha}} dt \qquad \text{(II.19)}$$

where $\phi_0 = \tilde{k}_0/(\tilde{k}_0 + \tilde{h}_0 + \tilde{b}_0)$ is the initial share of capital in portfolio, with $\tilde{h}_0 = (1-\alpha+\tau\alpha)\left[\int_0^T e^{-[R^*-(n+g^*)]T+\pi_t} \tilde{k}_t^\alpha dt + \frac{\tilde{k}^{*\alpha}}{R^*-(n+g^*)}\right]$ the initial human wealth.

Equations (II.18) and (II.19) give the predicted capital outflows as a function of n, g^*, ρ, R^*, τ, the sequence of productivity catch-up $\{\pi_t\}_{t=1,..,T}$ and initial values $\tilde{b}_0$ and $\tilde{k}_0$. Note that $\tilde{k}^*$ is also a function of the parameters. In the risky environment, the sequence of capital per efficient unit of labor $\{\tilde{k}_t\}_{t=1,..,T}$[4] and the initial share of capital in wealth ϕ_0 depend also on these parameters.

[4] By solving the (II.9), (II.10), (II.11) and (II.12) system.

Equation (II.18) is the continuous-time version of Gourinchas and Jeanne (2007). It can be decomposed into the same components. The same vocabulary and notations are therefore used here. Consider the first term :

$$\frac{\overline{\Delta B^c}}{Y_0} = \frac{\tilde{k}_0 - \tilde{k}^*}{\tilde{k}_0^\alpha} e^{(n+g^*)T}$$

The difference $\tilde{k}_0 - \tilde{k}^*$ is the amount immediately borrowed by the country to equalize its private return to capital to the world's interest rate. Following Gourinchas and Jeanne (2007), we call it the convergence term.

The second term,

$$\frac{\overline{\Delta B^t}}{Y_0} = \left(e^{(n+g^*)T} - 1\right) \frac{\tilde{b}_0}{\tilde{k}_0^\alpha}$$

represents the impact of the initial external position in the presence of trend growth ($n + g^* > 0$). It reflects the amount of capital outflows (or inflows) required to maintain the ratio of external position to output constant.

The third term,

$$\frac{\overline{\Delta B^i}}{Y_0} = -(e^\pi - 1) \frac{\tilde{k}^*}{\tilde{k}_0^\alpha} e^{(n+g^*)T}$$

reflects the impact of productivity catch-up on investment. Positive long-term productivity catch-up ($\pi > 0$) implies further needs in investment. It contribute negatively to the external position, because the country has to borrow from abroad.

Finally, the fourth term,

$$\frac{\overline{\Delta B^s}}{Y_0} = -e^{\pi+(n+g^*)T} \frac{(1-\alpha+\alpha\tau)\tilde{k}^{*\alpha}}{\tilde{k}_0^\alpha} \int_0^T e^{-(\rho-n)t}(1-e^{\pi_t-\pi})dt$$

reflects the impact of savings on the external position. It represents the consumption smoothing behavior. Indeed, the households adjust their consumption according to their intertemporal wealth, which depends on their discounted flow of deterministic revenue $\tilde{w}_t + \tilde{z}_t$. The path of those revenues depends on $(1-\alpha+\alpha\tau)\tilde{k}^{*\alpha}$ and on the path of π_t. All these components correspond exactly to those analyzed by Gourinchas and Jeanne (2007).

Consider now Equation (II.19), which represents the predicted flows according to the portfolio approach, that is when $\sigma > 0$. The sign of $\phi^*/(1-\phi^*)$ is critical to determine the sign of the first and second terms. We have seen that the steady-state share of capital in wealth ϕ^* is strictly positive but that it is not necessarily below one in the general case. Namely, the parameter σ must be high enough, and more precisely follow the following assumption :

Assumption 2 : $\sigma > \rho - R^* + g^*$

This assumption is maintained in the remaining analysis.[5] Some of the components of $\frac{\widehat{\Delta B}}{Y_0}$ can have the same interpretation as in the riskless approach. The first component,

$$\frac{\widehat{\Delta B^c}}{Y_0} = \frac{1-\phi^*}{\phi^*}\frac{\tilde{k}^* - \tilde{k}_0}{\tilde{k}_0^\alpha}$$

represents the impact of convergence. If $\tilde{k}_0 < \tilde{k}^*$, the country increases its capital stock. But contrary to the riskless approach, this does not imply a decrease in the net external position. On the opposite, the increase in wealth following the accumulation of private capital induces a rise in foreign assets, which are a constant fraction of wealth.

[5] The constraint that $\phi^* < 1$ and equivalently that $\phi^*/(1-\phi^*) > 0$ can be rationalized by the following general equilibrium argument. Consider a world composed by a continuum of countries indexed by j, $j \in [0,1]$. Each country taken individually is small and is negligible regarding the others taken as a whole, which corresponds to our small open economy framework. Countries can differ with respect to τ and n, but have the same level of idiosyncratic risk σ (as we will assume in the calibration section). As a result, they have the same steady-state share of capital in the portfolio ϕ^*, according to Proposition 1. Summing (II.15) across countries, we obtain :

$$\int_0^1 \tilde{k}^{*j} dj = \frac{\phi^*}{1-\phi^*}\left[\int_0^1 \frac{(1-\alpha+\alpha\tau^j)f(\tilde{k}^{*j})}{R^* - g^* - n^j} dj + \int_0^1 \tilde{b}^{*j} dj\right]$$

Since the world bond market clears, we have $\int_0^1 \tilde{b}^{*j} dj = 0$. Therefore, $\phi^*/(1-\phi^*)$ is necessarily positive as long as $\sigma > 0$. This is made possible by the adjustment of the world interest rate R^* in order to clear the bond market. It is therefore consistent with the portfolio approach to assume that $\phi^*/(1-\phi^*) > 0$.

The second term,

$$\frac{\widehat{\Delta B^i}}{Y_0} = \frac{1-\phi^*}{\phi^*}\frac{\tilde{k}^*}{\tilde{k}_0^\alpha}\left(e^{\pi+(n+g^*)T}-1\right)$$

reflects long-term productivity catch-up. Again, the sign of the contribution of this term when $\pi > 0$ is opposite to the riskless approach. The intuition is the same as for the convergence term. The increase in investment induced by productivity growth increases wealth and makes the external position rise.

The third term,

$$\frac{\widehat{\Delta B^p}}{Y_0} = \frac{\tilde{k}_0}{\tilde{k}_0^\alpha}\left(\frac{1}{\phi^*}-\frac{1}{\phi_0}\right)$$

is the portfolio structure term. It reflects the impact of changes in the structure of portfolio on external bond holdings. If, for example, the share of capital increases ($\phi^* > \phi_0$), then, holding everything equal, external bond holdings should decrease.

Finally, the fourth term,

$$\frac{\widehat{\Delta B^h}}{Y_0} = e^{\pi}\frac{(1-\alpha+\alpha\tau)\tilde{k}^{*\alpha}}{\tilde{k}_0^\alpha}\int_0^T e^{-(R^*-(n+g^*))t}e^{\pi_t-\pi}\frac{\tilde{k}_t^\alpha}{\tilde{k}^{*\alpha}}dt$$

is the human wealth term. It represents the impact of changes in human wealth between the beginning and the end of period. Holding the amount of safe assets constant, a decrease in human wealth must be compensated by an increase in bonds. This term can be related to the consumption smoothing term in the riskless approach, because it features the discounted sum of safe revenues. Notice that, contrary to the riskless approach, it does not only depend on the path of π_t, put also on the path of $\tilde{k}_t$. This is because, in the portfolio approach, the level of capital does not immediately adjust to its steady state value : it depends on the current level of wealth and not only on the world's interest rate. As a consequence, the path of deterministic revenues $\tilde{w}_t + \tilde{z}_t$ and therefore the consumption smoothing term are contingent on both the path of productivity catch-up π_t and the path of efficient capital $\tilde{k}_t$.

2.6 The role of productivity

Hall and Jones (1999) and Caselli (2004) show that TFP is a major source of the cross-country differences in income. Consistently, Gourinchas and Jeanne (2007) find that productivity growth is the main source of the allocation puzzle. It is therefore instructive to compare how it affects bond holdings in both approaches. It has been already noticed that π has opposite effects on the catch-up term in the two approaches, $\overline{\frac{\Delta B^i}{Y_0}}$ and $\widehat{\frac{\Delta B^i}{Y_0}}$. However, $\overline{\frac{\Delta B^s}{Y_0}}$ and $\widehat{\frac{\Delta B^h}{Y_0}}$ depend in a more complicated way on π and the path of π_t. In order to simplify the problem, the following assumption is made :

Assumption 3 : $\pi_t = \pi - f(t)$ *where* $f(.)$ *is common across countries and satisfies* $f(t) > 0$ *and* $\lim_{t\to\infty} f(t) = 0$.

Under Assumption 3, we can rewrite $\overline{\frac{\Delta B^s}{Y_0}}$ as :

$$\overline{\frac{\Delta B^s}{Y_0}} = -e^{\pi+(n+g^*)T}\frac{(1-\alpha+\alpha\tau)\tilde{k}^{*\alpha}}{\tilde{k}_0^{\alpha}}\int_0^T e^{-(\rho-n)t}(1-e^{-f(t)})dt$$

which is negative and proportional to the long-run productivity catch-up e^{π}. Faster relative productivity growth implies higher future income, leading to an increase in consumption and a decrease in savings. As a result, the external position deteriorates, including in the long run.

Similarly, $\widehat{\frac{\Delta B^h}{Y_0}}$ can be rewritten as follows :

$$\widehat{\frac{\Delta B^h}{Y_0}} = e^{\pi}\frac{(1-\alpha+\alpha\tau)\tilde{k}^{*\alpha}}{\tilde{k}_0^{\alpha}}\int_0^T e^{-(R^*-(n+g^*))t}e^{-f(t)}\frac{\tilde{k}_t^{\alpha}}{\tilde{k}^{*\alpha}}dt$$

which is proportional to e^{π} but positive, as opposed to $\overline{\frac{\Delta B^s}{Y_0}}$. Faster relative productivity growth here increases the level of capital outflows. This is because higher expected revenues in the future encourage the households to borrow more both in $t = 0$ and in $t = T$, but the flow of revenues between 0 and T weighs only on borrowing in $t = 0$. Faster productivity growth between these dates will thus have a positive impact on borrowing at $t = 0$, thus increasing the level of capital outflows between 0 and T. A key element here is that in the portfolio approach, the beginning-of-period level of debt is wiped out at steady state by wealth effects. On the opposite, in the riskless approach, the long-run level of debt is contingent on the inherited one, so the amount of consumption-smoothing that took place in the beginning persists in the long run.

This results in the following proposition, which is an extension of the corollary of Gourinchas and Jeanne (2007) :

Proposition 3 : *Suppose that Assumptions 1 and 3 are satisfied and consider two countries A and B, identical except for their long-run productivity catch-up* π *:*

(i) *If* $\sigma = 0$ *: country A sends more capital outflows than country B if and only if country A catches up less than country B towards the world technology frontier :*

$$\Delta B^A > \Delta B^B \textit{ if and only if } \pi^A < \pi^B$$

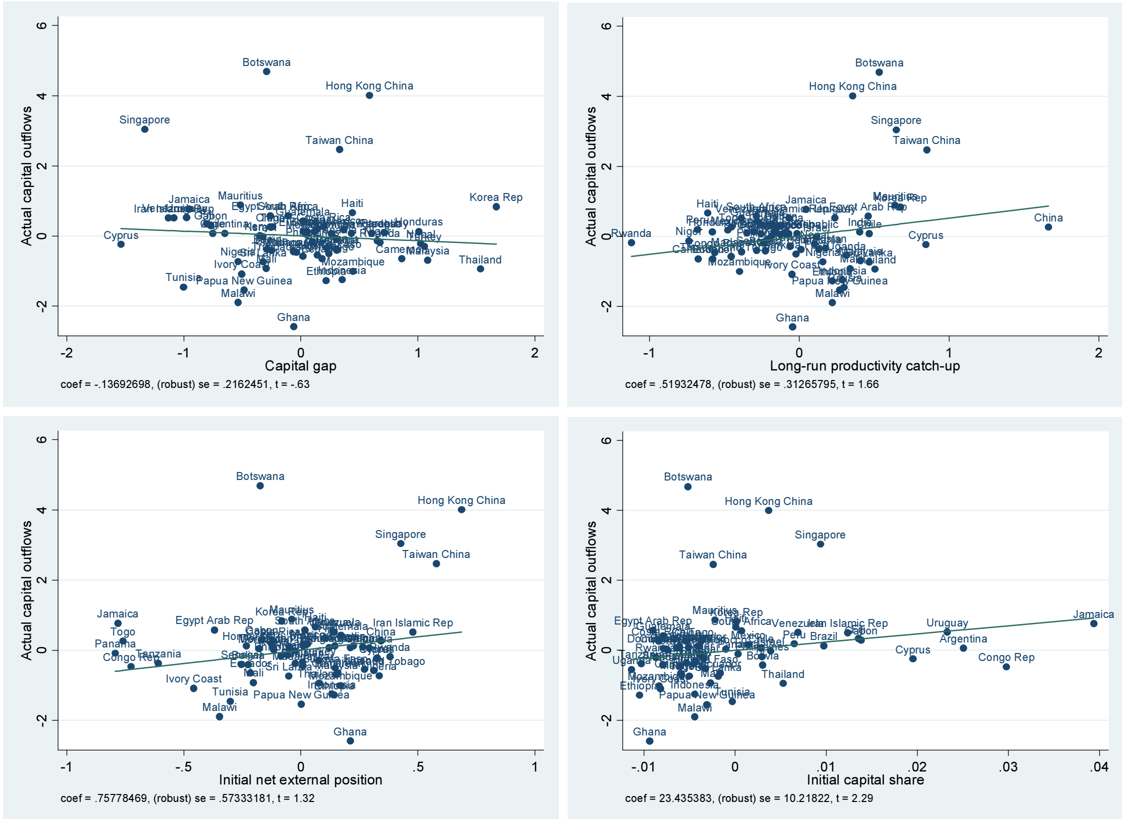
(ii) *If* $\sigma > 0$ *: under Assumption 2 and if T is sufficiently large, country A sends more capital outflows than country B if and only if country A catches up more than country B towards the world technology frontier :*

$$\Delta B^A > \Delta B^B \textit{ if and only if } \pi^A > \pi^B$$

To summarize, the presence of risk reverses completely the predictions of the neoclassical growth model in terms of capital flows. In the absence of risk, in line with Gourinchas and Jeanne (2007), countries growing faster should borrow *more*. In the presence of risk, the opposite holds : countries growing faster should borrow *less*. Both the investment and consumption channels are reversed.

In order to get an intuition of what approach is more likely to fit the reality, consider Figure II.2, which plots actual capital outflows against potential

Fig. II.2 – Actual capital outflows between 1980 and 2000 (as a share of initial GDP), against their determinants : capital gap ($(\tilde{k}^* - \tilde{k}_0)/\tilde{k}_0$), long-run productivity catch-up (π), initial external position to GDP ratio ($\tilde{b}_0)/\tilde{y}_0$) and initial share of capital in the portfolio (ϕ_0)



Source : Penn World Tables 6.2 (Heston *et al.*, 2006), Lane and Milesi-Ferretti (2006), author's calculations.

determinants. The initial net external position $\tilde{b}_0/\tilde{y}_0$ is positively correlated with actual capital outflows, which is consistent with the riskless approach, in particular with the trend component. The initial capital share ϕ_0 is also positively correlated, which is consistent with the portfolio approach, in particular with the portfolio component. However, each of these two determinants is specific to one approach, and is not exclusive of the other. The other determinants are more discriminant. The capital gap $(\tilde{k}^* - \tilde{k}_0)/\tilde{k}_0$ does not seem to be correlated in any way to actual capital flows, so it cannot be used, at least at this stage, to assess the predictive power of the model. However, the productivity catch-up π is positively correlated with capital outflows. According to Proposition 3, this is the case only in the portfolio approach

($\sigma > 0$). In the riskless approach ($\sigma = 0$), the correlation should be negative. The former approach should therefore be a better candidate to account for capital flows to developing countries. However, to confirm that, one should take into account all the determinants of capital flows together. Next section extends the calibration method used by Gourinchas and Jeanne (2007) in order to confront both approaches.

3 Capital flow accounting and calibration

In this section, we compare the two models' predictions in terms of capital flows to the data. Do developing countries with faster productivity growth and larger initial capital scarcity receive more capital flows, as the riskless approach predicts, or the opposite, as the portfolio approach suggests ? More generally, we investigate whether the portfolio approach fares better than the riskless one in explaining capital flows to developing countries. This requires, for each country, estimates for the levels of initial capital scarcity and for productivity growth.

In order to facilitate the comparison with Gourinchas and Jeanne (2007), the same time span (1980-2000) and the same sample of 69 emerging countries is used[6]. The parameters which are common across countries also follow their paper : the discount rate ρ is set to 4%, the depreciation rate δ to 6%, the capital share of output α to 0.3 and the growth rate of world productivity g^* to 1.7%. Given these parameters values, the world's interest rate R^* is equal to 5.7% when $\sigma = 0$, that is when the riskless approach is used.

In the portfolio approach, the amount of risk σ is set to 0.3, which is an amount of entrepreneurial risk commonly reported by empirical studies in the US and the

[6] This sample includes : Angola, Argentina, Bangladesh, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Cameroon, Chile, China, Colombia, the Republic of Congo, Costa Rica, Cyprus, Côte d'Ivoire, Dominican Republic, Ecuador, Egypt, Arab Republic, El Salvador, Ethiopia, Fiji, Gabon, Ghana, Guatemala, Haiti, Honduras, Hong Kong, India, Indonesia, Iran, Israel, Jamaica, Jordan, Kenya, Republic of Korea, Madagascar, Malawi, Malaysia, Mali, Mauritius, Mexico, Morocco, Mozambique, Nepal, Niger, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Rwanda, Senegal, Singapore, South Africa, Sri Lanka, Syrian Arab Republic, Taiwan,Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Uruguay and Venezuela.

Euro area (Campbell *et al.*, 2001; Kearney and Poti, 2006). The world's interest rate is then set so that the implied steady-state ratio of capital to wealth ϕ^* matches the US capital share in 2000. This gives $\phi^* = 0.08$ and $R^* = 5.64\%$.

The country-specific data are the paths for output, capital, productivity and working-age population. These data come from Version 6.2 of the Penn World Tables (Heston *et al.*, 2006). Following Gourinchas and Jeanne (2007) and Caselli (2004), the capital stock is constructed with the perpetual inventory method from time series data on real investment. The level of productivity A_t is calculated as $(y_t/k_t^{\alpha})^{1/(1-\alpha)}$ and the level of capital per efficient unit of labor $\tilde{k}_t$ as $(y_t/k_t)^{1/(1-\alpha)}$. The level of TFP A_t and the capital per efficient unit of labor $\tilde{k}_t$ are filtered using the Hodrik-Prescott method in order to suppress business cycles. The parameter n is measured as the annual growth rate of the working-age population. Under Assumption 1, the long-term catch-up π can be measured as $\ln(A_T) - \ln(A_0) - Tg^*$.

Finally, in order to determine the capital wedge τ, we proceed differently from Gourinchas and Jeanne (2007). They compute numerically a mapping from the average investment rate to the capital wedge τ, for given productivity catch-up π and population growth n. Their method cannot be extended easily to the portfolio approach, where the investment rate cannot be written explicitly as a simple function of the steady-state level of capital per efficient unit of labor $\tilde{k}^*$ but is contingent on its whole path $\{\tilde{k}_t\}_{t=1...T}$. More simply, τ is calibrated here in order to replicate the ratio of steady-state capital relative to the US, where $\tau^{US} = 0$. The capital wedge τ must therefore be interpreted in relative terms to the US. If τ is positive (negative), it means that the capital wedge is higher (lower) than in the US. Besides simplicity, this method has the advantage to yield identical capital wedges in both approaches, which facilitates the comparison. Indeed, in both cases, $\tilde{k}^*/\tilde{k}^{*US} = (1-\tau)^{1/(1-\alpha)}$. We use the fact that, assuming that $T = 20$ is a sufficiently large number, $\tilde{k}^*$ is approximately equal to $\tilde{k}_T$. We thus take $\tilde{k}^* = \tilde{k}_T$. This method assigns a high capital wedge to countries with low end-of-period capital per efficient unit of labor relative to the US. The introduction of τ shuts down the Lucas paradox since this parameter is used to adjust the private marginal return to capital to the world interest rate.

Jordan and Angola are removed from the sample because their working-age population does not satisfy $n < \rho$. The Syrian Arab Republic is also removed because it is an outlier : its predicted outflows according to the portfolio approach are well below the sample range. The sample is therefore reduced to 66 countries.

3.1 Some key parameters

Table II.1 sums up some key parameters given by the calibration method. It presents the steady-state capital stocks per efficient unit of labor $\tilde{k}^*$, measured by their end-of-period value, and the levels of capital wedge τ compatible with these steady-state values. It also provides some potential determinants : the long-term productivity catch-up π, the beginning-of-period ratio of external position to output $\tilde{b}_0/\tilde{y}_0$, the beginning-of-period capital share in the portfolio ϕ_0, the initial level of capital $\tilde{k}_0$ and the growth rate of capital $(\tilde{k}^* - \tilde{k}_0)/\tilde{k}_0$. Countries are classified by income group (World Bank classification based on 2007 GNI per capita) and by region. Finally, for robustness checks, some potential outliers (China, India, Africa) are excluded.

Consider column (2) of Table II.1. The average wedge τ on capital return is equal to 36%, which is consistent with the average wedge on capital return of 12% found in Gourinchas and Jeanne (2007). This is because the definition of capital return differs : they consider the *gross* capital return, but net of depreciation, while we consider the *net* capital return, but before depreciation.[7] Despite using a different method to compute the capital wedge, the results are comparable. The net return varies between 64% in low income countries and −9% in high income countries, which corresponds to 14% and −4% for the gross return. Notice that the capital wedge τ and the end-of-period level of capital $\tilde{k}^*$ (column (1)) are respectively decreasing and

[7] This deviation from Gourinchas and Jeanne (2007) is due to the use of a continuous-time framework.

increasing with income, except for middle-income countries : upper-middle-income countries have a lower end-of-period level of capital than lower-middle-income. This is not inconsistent with the income classification since the revenue is not defined only by capital, but also by TFP. Generally, countries that achieved a higher level of income are those who maintained a higher end-of-period capital level $\tilde{k}^*$ thanks to a lower wedge τ. Africa, which has the smallest end-of-period capital level, has therefore the highest estimated capital wedge, while Asia's estimated capital wedge is the smallest, since it benefits from a high end-of-period capital level.

TAB. II.1 – Long-term capital per efficient unit of labor, capital wedge and potential determinants of capital flows

	(1) $\tilde{k}^*$	(2) τ	(3) π	(4) $\frac{\tilde{b}_0}{\tilde{y}_0}$	(5) ϕ_0	(6) $\tilde{k}_0$	(7) $\frac{\tilde{k}^*-\tilde{k}_0}{\tilde{k}_0}$	(8) Obs.
Non-OECD†	1,88	36,37%	-6,87%	-29,91%	1,37%	2,24	-3,53%	66
Low income‡	0,80	64,44%	-15,69%	-31,72%	0,65%	0,98	1,28%	23
Lower middle income‡	2,24	26,76%	-12,75%	-35,23%	1,46%	2,56	-2,2%	22
Upper middle income‡	2,11	28,31%	-4,88%	-34,42%	1,66%	2,68	-13,61%	14
High income‡ (non-OECD†)	3,87	-9,49%	36,59%	1,82%	2,85%	4,51	-3,38%	7
Africa	1,27	52,66%	-13,04%	-39,75%	0,99%	1,77	-12,39%	27
Latin America	2,06	30,38%	-32,36%	-32,66%	1,95%	2,50	-3,9%	22
Asia	2,62	18,27%	35,92%	-10,71%	1,22%	2,65	11%	17
Excluding China and India	1,88	36,39%	-10,11%	-30,79%	1,39%	2,24	-3,16%	64
China and India	1,80	35,81%	96,6%	-1,57%	0,78%	2,20	-15,45%	2
Excluding Africa	2,31	25,1%	-2,6%	-23,09%	1,63%	2,57	2,6%	39

The figures are unweighted country averages.

† : Includes also Korea, Mexico and Turkey.

‡ : World Bank classification based on 2007 GNI per capita.

Consider now the long-run productivity catch-up π in column (3) of Table II.1. On average, non-OECD countries have fallen behind in terms of productivity. When looking into details, only high income economies have caught up with the world productivity. Consistently, countries with intensive catch-up ended up richer at the end of period. In particular, upper-middle-income countries show a less negative productivity catch-up than the lower-middle-income group, which might have compensated for their lower end-of-period capital $\tilde{k}^*$. As for the geographical pattern, it seems that only Asia's productivity has caught up with the world's level. Both Africa and Latin America fell behind.

It appears that the initial level of external position $\tilde{b}_0/\tilde{y}_0$ (column (4)) is negative on average : non-OECD countries started with an average debt of 30% of GDP. All regions started with debt, only Asia had a smaller initial level : 11% versus respectively 40% and 33% in Africa and Latin America.

The average initial share of capital in portfolio ϕ_0 (column (5)) is very low : less than 2%. This is because human wealth accounts for an extremely large part of the household's portfolio : not only is it an infinite discounted sum, but it is also inflated both by labor and productivity growth. Additionally, the net external position is small in absolute value. All this results in a small share of capital in the portfolio. It appears that this share is increasing with income (from 0.65% to 2.85%). This can be explained by the fact that initial capital $\tilde{k}_0$ is increasing with income too, as column (6) shows. Among regions, Africa has a very low share of capital : 0.99% versus respectively 1.95% and 1.22% in Latin America and Asia. The lower share of capital in Latin America than in Asia can be explained by lower productivity catch-up and therefore lower human wealth in Latin America.

Column (6) of Table II.1 presents initial capital per efficient unit of labor $\tilde{k}_0$. The main observation is that the final stock of capital is usually close to the initial one. There is no change in hierarchy due to convergence : countries with low initial capital ended up with low capital. This also appears when considering the capital global growth rates in column (7) : they are rather small in absolute value. Notice also that the capital stock *decreased* on average. This suggests that developing countries started with a stock of capital per efficient unit of labor *above* the steady-state, that is with *too much* capital. Consistently to Gourinchas and Jeanne (2006), emerging countries were not capital-scarce but capital-abundant. Among regions, only Asia increased its capital per efficient unit of labor.

3.2 Capital flows

We now turn to the confrontation of actual and predicted capital flows. In order to achieve this, actual capital flows are computed, using net foreign asset data from Lane and Milesi-Ferretti (2006). They provide estimates for the net external position in current US dollars. These estimates are calculated using the cumulated current account data and are adjusted for valuation effects. In order to be consistent with the PPP-adjusted data used here, a PPP deflator is extracted from the Penn World Table and is used to calculate a PPP-adjusted measure of net external position. Actual capital outflows during the period, as a share of initial output, are denoted $\frac{\Delta B}{Y_0}$. These estimates are confronted with the predicted values given by the riskless and portfolio approaches, respectively $\overline{\frac{\Delta B}{Y_0}}$ and $\widehat{\frac{\Delta B}{Y_0}}$, and to the components highlighted in the previous section.

3.2.1 The riskless approach

Table II.2 reproduces the outcome of the riskless approach. Column (1) reports the actual net capital outflows as a share of initial output $\Delta B/Y_0$: their size is -54% on average, which means that emerging countries have received net capital inflows during the period. Column (2) reports the predicted capital outflows based on equation (II.18). These estimates are constructed under the hypothesis that the productivity catch-up follows a linear trend : $\pi_t = \pi \min\{t/T, 1\}$, as in Gourinchas and Jeanne (2007). Our results, despite the continuous time framework and the use of a different method to calibrate the capital wedge τ, are in line with Gourinchas and Jeanne (2007). According to the model, non-OECD countries should have received capital inflows on average, which is the case. However, here, contrary to Gourinchas and Jeanne (2007), average predicted flows (column (2)) in non-OECD countries are of the same order of magnitude as the actual ones (column (1)). This comes from the fact that consumption smoothing has a lower magnitude than in their calibration. Still, when excluding African countries, capital inflows seem to be strongly overestimated. They also seem to have the right sign, but if we exclude

China and India, which account for a large part of negative outflows, the sign of predicted outflows becomes positive, while actual ones are negative on average. While unclear in terms of global trends, the model fails completely when considering the direction of flows inside the sample. According to the predictions, low-income countries should have exported capital while high-income countries should have received capital inflows. Actually, the opposite happened. Latin America and Africa should have invested abroad while Asia should have hosted capital inflows. But in fact Asia received less capital than the other regions. The origins of these discrepancies are examined by looking into the components of predicted capital flows.

TAB. II.2 – Predicted and actual capital flows between 1980 and 2000 - Riskless approach

Capital flows	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(share of initial output)	$\frac{\Delta B}{Y_0}$	$\overline{\frac{\Delta B}{Y_0}}$	$\overline{\frac{\Delta B^c}{Y_0}}$	$\overline{\frac{\Delta B^i}{Y_0}}$	$\overline{\frac{\Delta B^s}{Y_0}}$	$\overline{\frac{\Delta B^t}{Y_0}}$	Obs.
Non-OECD†	-0,54	-0,36	0,51	-0,14	-0,29	-0,43	66
Low income‡	-1,13	1,56	0,38	0,08	1,58	-0,49	23
Lower middle income‡	-0,68	-0,42	0,45	-0,10	-0,29	-0,47	22
Upper middle income‡	-0,03	0,12	0,81	0,005	-0,20	-0,50	14
High income‡ (non-OECD†)	0,82	-7,40	0,54	-1,29	-6,64	-0,02	7
Africa	-0,77	1,24	0,92	0,09	0,81	-0,58	27
Latin America	-0,46	4,81	0,55	0,41	4,31	-0,47	22
Asia	-0,29	-9,57	-0,20	-1,23	-8,00	-0,15	17
Excluding China and India	-0,55	0,70	0,51	-0,03	0,67	-0,45	64
China and India	-0,35	-34,30	0,57	-3,67	-31,19	-0,01	2
Excluding Africa	-0,38	-1,46	0,23	-0,30	-1,05	-0,33	39

$\frac{\Delta B}{Y_0}$ is the observed ratio of net capital outflows to initial output, predicted capital flows $\overline{\frac{\Delta B}{Y_0}}$ and its components $\overline{\frac{\Delta B^c}{Y_0}}$, $\overline{\frac{\Delta B^i}{Y_0}}$, $\overline{\frac{\Delta B^s}{Y_0}}$ and $\overline{\frac{\Delta B^t}{Y_0}}$ are given by (II.18).
The figures are unweighted country averages.
† : Includes also Korea, Mexico and Turkey.
‡ : World Bank classification based on 2007 GNI per capita.

After looking into components, it appears that the convergence term in column (3) of Table II.2 contributes positively to the total predicted outflows. This can be explained by the fact that, as shown above, countries have started on average above their long-term level of capital, and thus have disinvested on average. As a consequence, they should have lent to the rest of the world. This is the case in Latin America and Africa which had too much capital and should have used their extra capital stock to invest abroad, whereas Asia should have received capital from abroad to finance its growth in capital stock.

The catch-up component, in column (4), has a negative contribution. This average result is mainly driven by Asia, which had a strong positive long-term productivity catch-up : it should have borrowed from the rest of the world in order to finance the extra investment. Other non-OECD countries have fallen behind world productivity on average, namely Africa and Latin America. This relative fall in productivity should have led households to disinvest and enabled them to lend to the rest of the world.

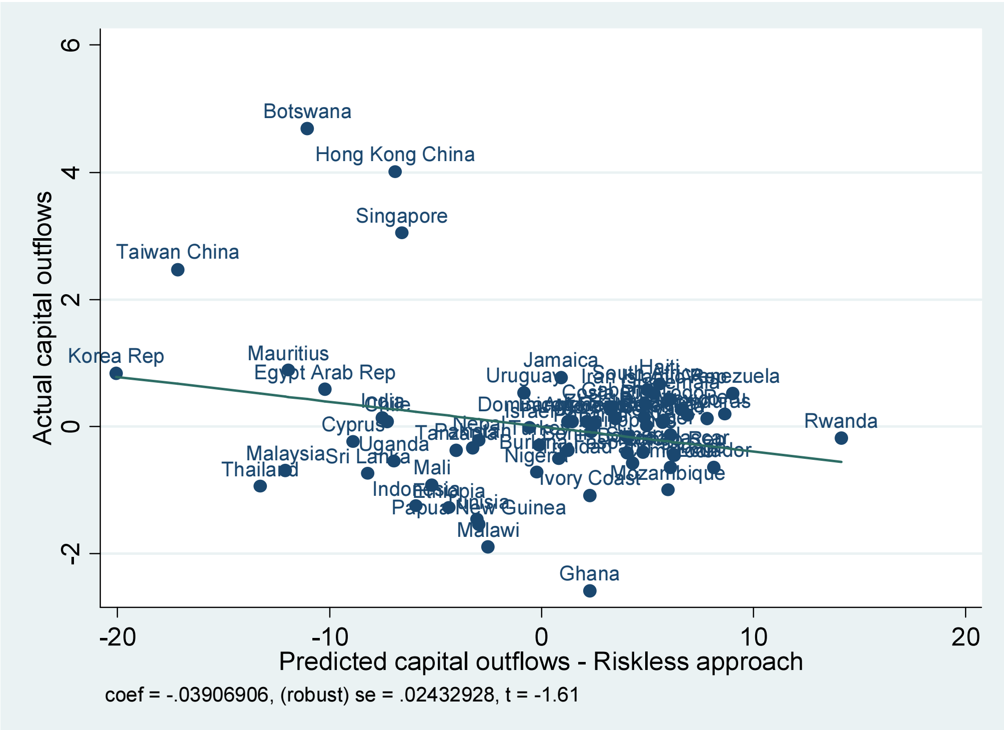
The consumption smoothing component, in column (5), is negative on average despite the negative average productivity catch-up. This is because Asian countries, which have benefited from a positive productivity catch-up, contribute highly to the sample mean. When considering regions, it still appears that Latin America and Africa, which expected a fall in their revenue because of a negative catch-up, should have saved in order to smooth consumption. The contribution of the consumption smoothing term is therefore positive for those regions. On the opposite, Asiatic countries, which expected a relative rise in their productivity and therefore a relative rise in their revenue, should have dissaved in order to smooth consumption. Their consumption smoothing term is thus negative.

These three components (convergence, catch-up and consumption smoothing) are at odds with the data. They all imply capital inflows to Asia and capital outflows from Latin America and Africa, while actually Asia received less capital than the two other regions.

Only the last one, the trend component in column (6), is consistent with the data. Indeed, as observed capital inflows, it is decreasing with income. Also, according to this component, Asia should receive less capital than Latin America and Africa. However, its quantitative importance is not sufficient to counteract the other components.

On the whole, the puzzle of Gourinchas and Jeanne (2007) seems to be robust to the continuous-time approach and to the use of an alternative method to compute the capital wedge : capital seems to flow in the wrong direction, that is less to the more productive countries than to the less productive. Figure II.3 sums up the puzzle by showing the scatter plot of actual versus predicted flows. The correlation seems, at best, non-significant and, at worst, negative.

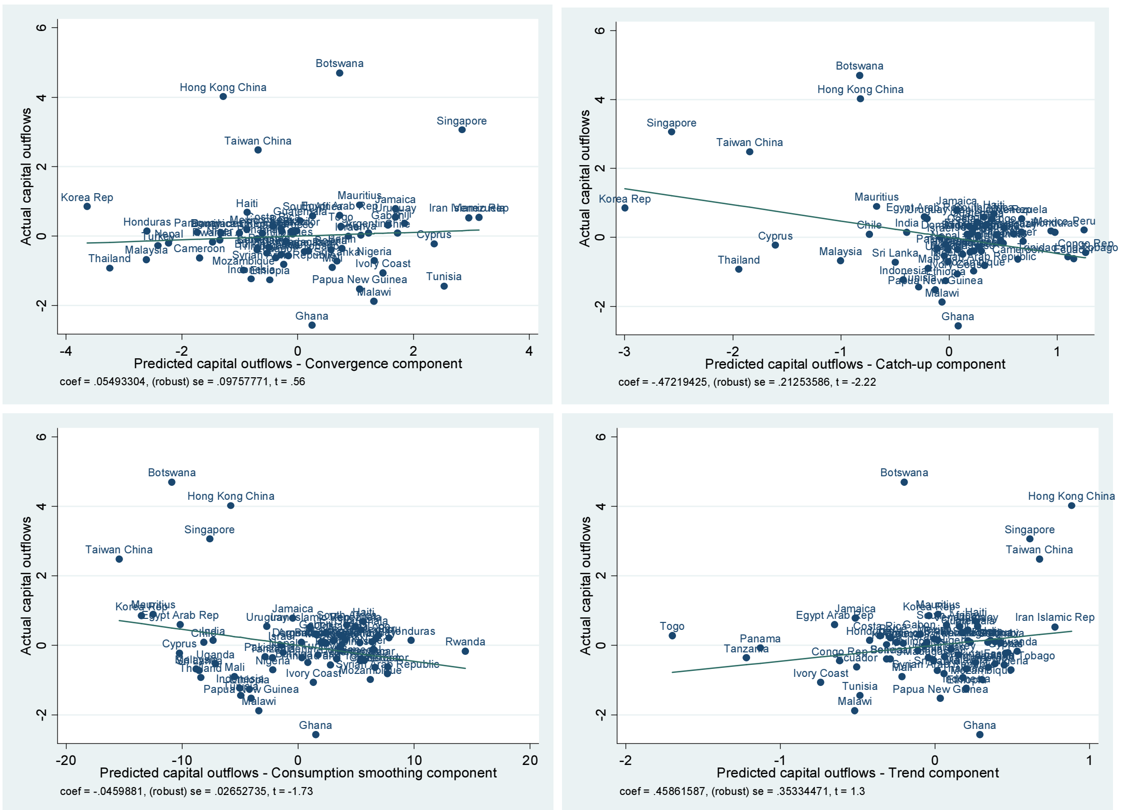
FIG. II.3 – Actual capital outflows (as a share of initial GDP) against their predicted value, according to the riskless approach, 1980-2000



Source : Penn World Tables 6.2 (Heston *et al.*, 2006), Lane and Milesi-Ferretti (2006), author's calculations.

Figure II.4 presents the scatter plots of actual capital flows against each components, stressing the contribution of each of them to the overall correlation between predicted and capital flows. The component which is the most negatively correlated with actual flows is the catch-up component. This is consistent with Gourinchas and Jeanne (2007)'s findings. After comes the consumption smoothing component, while the convergence component does not seem to be correlated anymore. Also, as expected, the trend component is the only one which is positively correlated. The puzzle is therefore mainly due to the catch-up and consumption smoothing components. Long-run productivity catch-up, which is the main determinant of these two components, is thus at the core of the puzzle. Figure II.2 showed that, indeed, long-run productivity catch-up is positively correlated with capital outflows, while the riskless approach predicted the opposite. This calibration analysis confirms that the wrong correlation with long-run productivity catch-up is responsible for the puzzle.

FIG. II.4 – Actual capital outflows (as a share of initial GDP), against the different components of predicted capital flows, 1980-2000 - Riskless approach



Source : Penn World Tables 6.2 (Heston *et al.*, 2006), Lane and Milesi-Ferretti (2006), author's calculations.

3.2.2 The portfolio approach

We have shown that the model without risk reproduces exactly the puzzle highlighted by Gourinchas and Jeanne (2007). We now turn to the extension with risk.

Table II.3 sums up the results for the portfolio approach. Column (2) reports the estimated predicted net outflows according to equation (II.19). The estimates are computed under the Assumption that the productivity catch-up follows a linear path, as in the riskless approach. The path of capital per efficient unit of labor $\tilde{k}_t$ implied by the model is approximated by the following formula : $\tilde{k}_t = \tilde{k}_0 e^{g_k \min\{t/T,1\}}$, where $g_k = \ln(\tilde{k}^*) - \ln(\tilde{k}_0)$[8].

Note first that the magnitude of predicted flows (column (2)) is well above the actual ones (column (1)), by three to four orders of magnitude. This is a shortcoming of the portfolio approach that has been already highlighted in Kraay *et al.* (2005). But this shortcoming is accentuated here by the presence of potentially huge human wealth effects, due to labor and productivity growth. This human wealth can represent more than one hundred times current income and can enable the country to borrow enormous amounts, as long as it can pledge its future labor income and transfers.

When looking into details, it appears that the main origin of the discrepancy is the portfolio term, in column (5). The magnitude of this term can be explained by the fact that the initial share of capital in the portfolio is low as compared to the steady-state one, as pointed to when analyzing Table II.1. This initial share is small because the beginning-of-period human wealth is large and the external debt is small. This results in a predicted reallocation of the portfolio in favor of capital in the long term. Provided some adjustments in human wealth, this implies that bond holdings should diminish in the long term, which is equivalent to capital inflows.

[8] The sequence of of $\{\tilde{k}_t\}_{t=1,..,T}$ could be inferred from the parameters, the initial values and the exogenous trend of productivity by solving the (II.9), (II.10), (II.11) and (II.12) system. However, the assumed trend is a good proxy for the capital dynamics since the theory predicts that it moves smoothly from $\tilde{k}_0$ to $\tilde{k}^*$.

The human wealth adjustment term, in column (6) of Table II.3, is positive in all country groups. This can be explained by the fact that human wealth falls on average between the beginning and the end of period. This fall in human capital contributes positively to capital outflows, since, holding portfolio shares constant, bond holdings are substituted to human wealth inside the safe portfolio. But this adjustment is not sufficient to compensate for the portfolio term. The magnitude of the other terms is not as striking, so the discrepancy between the data and the model comes mainly from the discrepancy between the beginning-of-period observed external position and human wealth, which results in a very negative portfolio term.

TAB. II.3 – Predicted and actual capital flows between 1980 and 2000 - Portfolio approach

Capital flows (share of initial output)	(1) $\frac{\Delta B}{Y_0}$	(2) $\widehat{\frac{\Delta B}{Y_0}}$	(3) $\widehat{\frac{\Delta B^c}{Y_0}}$	(4) $\widehat{\frac{\Delta B^i}{Y_0}}$	(5) $\widehat{\frac{\Delta B^p}{Y_0}}$	(6) $\widehat{\frac{\Delta B^h}{Y_0}}$	(7) Obs.
Non-OECD†	-0,54	-101,54	-2,55	23,56	-138,42	15,80	66
Low income‡	-1,13	-130,56	-1,54	9,82	-152,33	13,37	23
Lower middle income‡	-0,68	-101,59	-2,17	26,28	-142,35	16,59	22
Upper middle income‡	-0,03	-89,53	-4,31	23,69	-125,79	16,85	14
High income‡ (non-OECD†)	0,82	-30,04	-3,51	59,85	-105,65	19,23	7
Africa	-0,77	-131,92	-4,17	13,65	-155,55	14,03	27
Latin America	-0,46	-90,32	-3,02	12,53	-114,53	14,65	22
Asia	-0,29	-67,80	0,63	53,55	-142,13	20,11	17
Excluding China and India	-0,55	-101,99	-2,52	21,32	-136,32	15,46	64
China and India	-0,35	-87,09	-3,38	94,95	-205,59	26,96	2
Excluding Africa	-0,38	-80,50	-1,43	30,41	-126,56	17,03	39

$\frac{\Delta B}{Y_0}$ is the observed ratio of net capital outflows to initial output, predicted capital flows $\widehat{\frac{\Delta B}{Y_0}}$ and its components $\widehat{\frac{\Delta B^c}{Y_0}}$, $\widehat{\frac{\Delta B^i}{Y_0}}$, $\widehat{\frac{\Delta B^p}{Y_0}}$ and $\widehat{\frac{\Delta B^h}{Y_0}}$ are given by (II.19).
The figures are unweighted country averages.
† : Includes also Korea, Mexico and Turkey.
‡ : World Bank classification based on 2007 GNI per capita.

When abstracting from the magnitude issue, it appears that the predicted outflows in column (2) of Table II.3 exhibit the right sign, which is negative, and, contrary to the riskless approach, the right ranking between country groups. Predicted capital inflows are now decreasing with income, as the actual ones. Also, Africa is the region that receives the highest amount of capital inflows while Asia is the one that receives the smallest amount, as in the data.

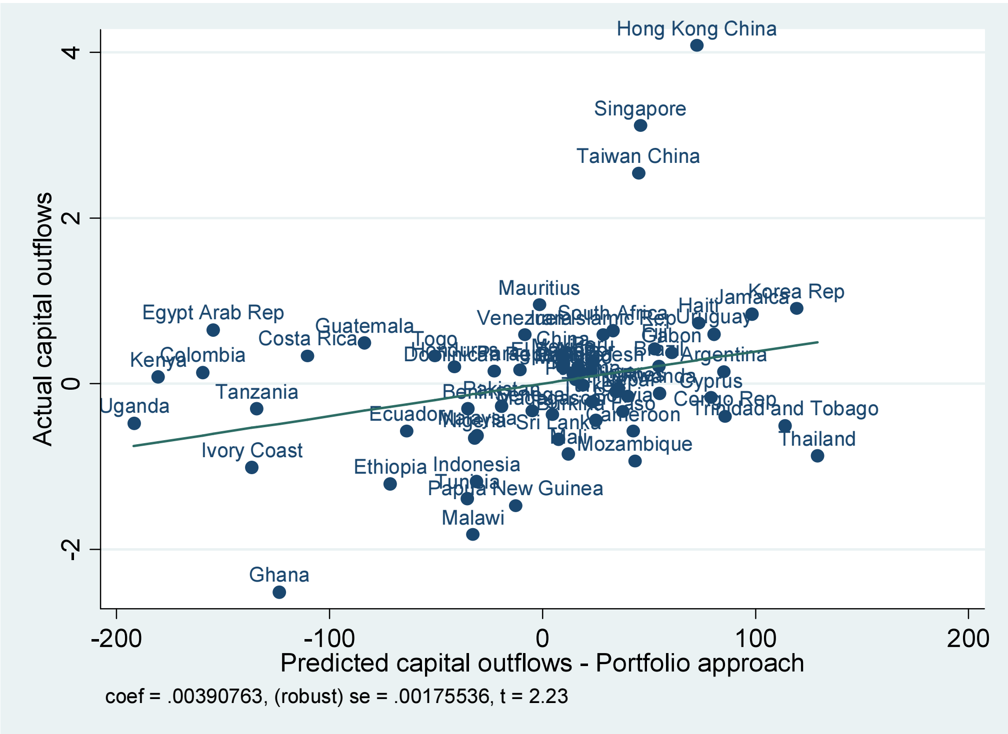
Since, on average, developing countries started from a high level of capital relative to the long-term one, the average contribution of the convergence term in column (3) of Table II.3 to capital outflows is negative. This is because, holding the portfolio structure unchanged, a less capitalized country can hold less safe assets since it has to self-insure against less risk. The sign of the contribution of the convergence term in this specification is opposite to its sign in the riskless one. Asia is supposed to export and not import capital, while Latin America and Africa are supposed to import and not export capital. Regions are now correctly ranked in terms of capital outflows when considering the convergence component. Regions are also correctly ranked when considering the catch-up term in column (4). While, in the riskless approach, Asia was supposed to receive more inflows than the other non-OECD countries, the estimates here suggest that it should export more capital, which matches the data better, not in terms of the direction of flows but in terms of hierarchy between regions. To understand this predictions' reversal for the convergence and catch-up terms, note that both high productivity catch-up and positive convergence imply investment in domestic technology. In the riskless approach, more investment is financed through more borrowing from abroad while in the portfolio approach, more investment implies more safe assets to compensate for more risk-taking.

Coming back to the portfolio term in column (5) of Table II.3, we can notice that it is negative in all income groups and all regions. Interestingly, it is increasing with income and as a consequence it reproduces the right income-group ranking in terms of flows. This effect is not originated in productivity catch-up, since we would expect it to vary negatively with the portfolio component. Indeed, high productivity growth implies a high beginning-of-period human wealth and therefore a low beginning-of-period capital share ϕ_0. The adjustment in the portfolio structure would then entail a diminution in the bond level and therefore lead to large capital inflows. In that case, high-income countries, which benefited from higher catch-up terms, should present a more negative portfolio component. But it is not the case. Rather, we should seek the explanation of this phenomenon in the size of the initial capital per efficient unit of labor $\tilde{k}_0$. This term has two counteracting effects. First, countries which are already highly capitalized in the beginning tend to have initially a large share of capital in their portfolio. The adjustment to a larger capital share in the long-term implies then a smaller diminution in bond holdings, and therefore less capital inflows. Second, the level of capital affects the scale of bond holdings adjustment consecutive to these adjustments in portfolio shares. This is simply because the magnitude of the bond adjustment consecutive to a change in portfolio structure depends on the size of the portfolio itself. The initial capital level $\tilde{k}_0$ has therefore a negative effect on capital inflows through its impact on the portfolio structure and a positive effect through the scale of the portfolio. Finally, it appears that the first effect dominates since high-income countries, which started on average with a higher level of capital, are supposed to get less capital inflows according to the portfolio term. This analysis is also consistent with the fact that Africa, which has the smallest level of initial capital among regions, has the more negative portfolio term. However, Asia and Latin America have a very close level of initial capital, while Asia is supposed to receive more capital. Here, higher productivity catch-up in Asia can explain the difference.

The last term, in column (6) of Table II.3, which sums up the adjustment in human wealth, is positive on average and in all country groups. This comes from the fact that human wealth is higher in the beginning than in the end of period : for a given portfolio structure, bond holdings must rise in order to compensate for the decrease in human wealth. This term is increasing with income and is higher in Asia than in the other regions. This is because high income countries and Asian economies have experienced larger TFP gains than the others on average during the period. Therefore, their initial human wealth is higher, so the implied rise in bond holdings is also more important.

Therefore, all the components reproduce the right pattern of flows (in terms of groups ranking) : the convergence, catch-up, portfolio and human wealth components.

Fig. II.5 – Actual capital outflows (as a share of initial GDP) against their predicted value, according to the portfolio approach, 1980-2000

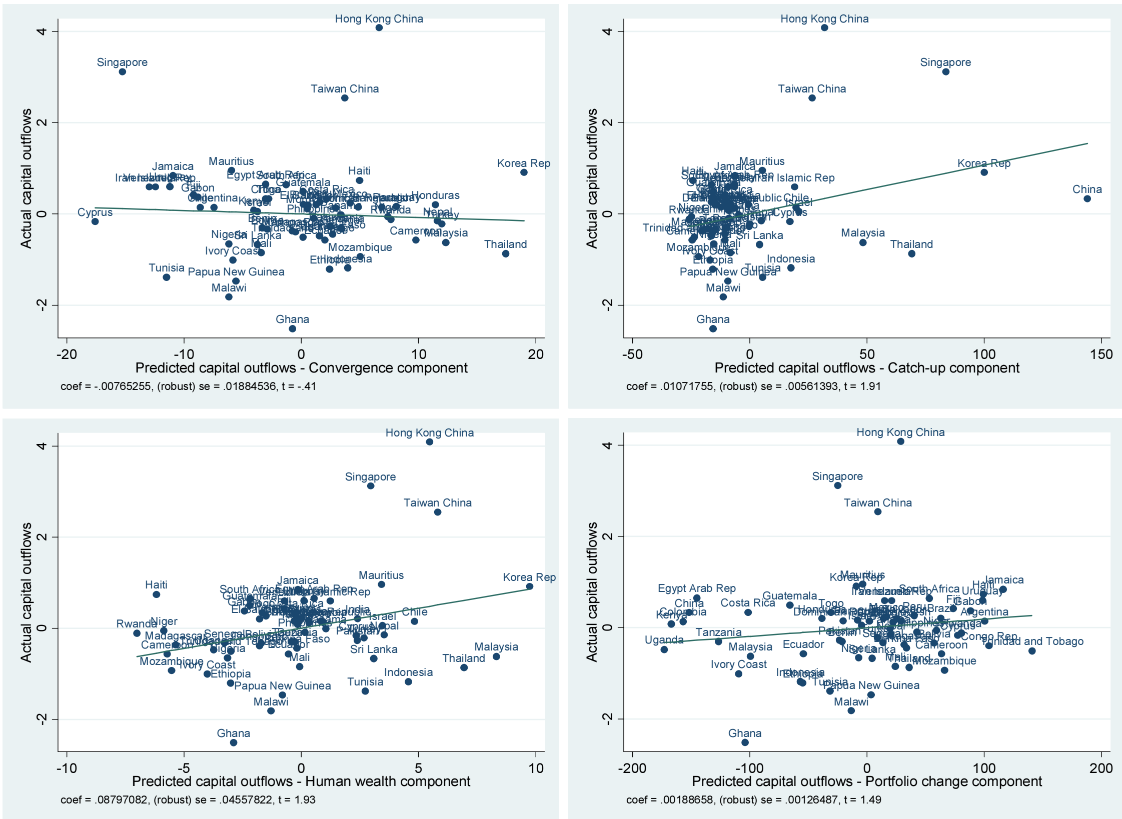


Source : Penn World Tables 6.2 (Heston *et al.*, 2006), Lane and Milesi-Ferretti (2006), author's calculations.

To conclude, the portfolio approach seems to be a better predictor, if not of the magnitude of flows, at least of their direction. Figure II.5 sums up this idea by plotting predicted flows against the actual ones. The upper and lower panels are constructed respectively by using the riskless and the portfolio approaches. While the upper graph shows a negative correlation between predicted and actual flows, a positive correlation is recovered in the lower graph. According to the previous analysis, this reversal may be due to the convergence, catch-up or portfolio terms.

To understand which components contribute to solving the puzzle, consider Figure II.6, which plots actual capital flows against the different components of predicted capital flows. It appears here that, on the sample of non-OECD countries, the convergence component does not seem correlated with actual capital flows, so it does not contribute to the positive correlation between actual and predicted flows. However, the graph confirms that the catch-up, portfolio and human wealth components are positively correlated with actual flows and thus contribute to solving the puzzle.

FIG. II.6 – Actual capital outflows (as a share of initial GDP), against the different components of predicted capital flows, 1980-2000 - Portfolio approach



Source : Penn World Tables 6.2 (Heston *et al.*, 2006), Lane and Milesi-Ferretti (2006), author's calculations.

Two characteristics of the portfolio approach contribute therefore to the resolution of the puzzle. (i) Long-term productivity catch-up has a positive effect on capital outflows in the portfolio approach, through the catch-up and human wealth component. As a consequence, the positive correlation between productivity growth and capital outflows (see Figure II.2), which was at the core of the puzzle in the riskless approach, contributes to solving the puzzle in the portfolio choice specification, as suggested by Proposition 3. (ii) A novel effect, specific to the portfolio approach, appears : the change in portfolio structure. Countries with a higher initial capital share in the portfolio are expected to receive less capital from abroad. This is the case in the data, as shown in Figure II.2.

4 Extensions

The main shortcoming of the portfolio approach is that it overestimates the magnitude of flows by several orders of magnitude. This section aims at diminishing this discrepancy by providing extensions to the portfolio approach : (i) sovereign risk, (ii) differing amounts of production risk σ in emerging countries and the rest of the world and (iii) the presence of hand-to-mouth workers. These extensions all aim at diminishing the portfolio change component, which is the main source of the discrepancy, in particular by affecting human wealth. This section does not seek quantitative relevance but tries to propose some potential directions for further research aiming at reconciling the magnitude of flows in the data and in the portfolio approach.

4.1 Sovereign risk

Sovereign risk is introduced through a risk premium on the country's bond liabilities. If the country is indebted, then it faces an interest rate equal to $R^*(1+\epsilon)$, where $\epsilon > 0$. The parameter ϵ is supposed to be common across developing countries and reflects the level of sovereign risk, that is the probability that the economy defaults on its debt. If the country has positive bond holdings, then it faces the world's interest rate R^* without risk premium. This assumption is made to illustrate the fact that there is no default risk on the rest of the world's bond liabilities, since it is composed mainly of industrial countries with sound institutions. The risk premium is introduced in an ad hoc way and it is supposed moreover that it does not depend on the amount of debt. This is justified since this extension does not target quantitative relevance but aims rather at showing whether the magnitude of flows is indeed reduced when introducing sovereign risk through a fixed premium on bond liabilities. The idea behind this is that a higher interest rate might reduce human wealth and therefore limit the ability of households to hold huge amounts of debt.

This extension does not require to change the baseline parameters. ϵ only has to be defined. It is set at 1% in order to satisfy the constraint $R^*(1+\epsilon) - \rho - g^* > 0$.

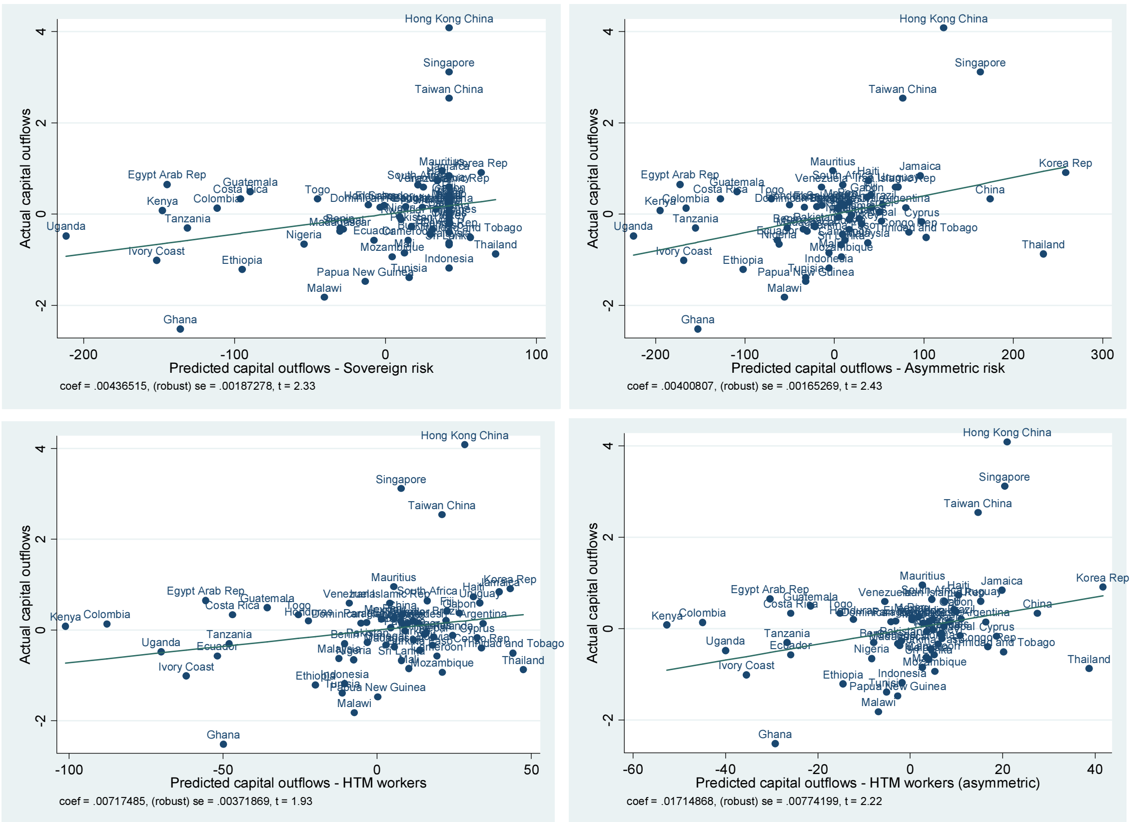
Tab. II.4 – Predicted and actual capital flows between 1980 and 2000 - Extensions of the portfolio approach

Capital flows	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(share of initial output)	$\frac{\Delta B}{Y_0}$	$\widehat{\frac{\Delta B}{Y_0}}$	$\widehat{\frac{\Delta B^c}{Y_0}}$	$\widehat{\frac{\Delta B^i}{Y_0}}$	$\widehat{\frac{\Delta B^p}{Y_0}}$	$\widehat{\frac{\Delta B^h}{Y_0}}$	Obs.
Baseline portfolio approach	-0,54	-101,54	-2,55	23,56	-138,42	15,80	66
Sovereign risk	-	-41,88	-8,65	79,97	-86,27	15,73	-
Asymmetric production risk	-	-57,00	-5,39	49,82	-117,24	15,80	-
HTM workers	-	-40,22	-0,82	7,54	-51,77	4,83	-
HTM workers (asymmetric)	-	-13,56	-0,82	7,54	-22,70	2,42	-

$\frac{\Delta B}{Y_0}$ is the observed ratio of net capital outflows to initial output, predicted capital flows $\widehat{\frac{\Delta B}{Y_0}}$ and its components $\widehat{\frac{\Delta B^c}{Y_0}}$, $\widehat{\frac{\Delta B^i}{Y_0}}$, $\widehat{\frac{\Delta B^p}{Y_0}}$ and $\widehat{\frac{\Delta B^h}{Y_0}}$ are given by (II.19).
The figures are unweighted country averages.Sample : Non-OECD countries, including also Korea, Mexico and Turkey.

Consider Table II.4. It represents the actual and predicted net capital outflows and their components, for the baseline portfolio approach and for the various extensions presented in this section. Despite the low sovereign risk premium, the mean predicted inflows in column (2) diminish by more than a half as compared to the baseline specification. This comes mainly from the increase in capital outflows implied by productivity catch-up (that is the catch-up component in column (3)) and the diminution of the capital inflows implied by portfolio change (that is the portfolio component in column (5)). The increase in the perceived interest rate on bonds has two effects that could explain this. First, the steady-state share of capital ϕ^* diminishes, which means that households want to hold more safe assets in the end of period. This magnifies the impact of productivity catch-up on bond holdings, which explains the effects on the catch-up component : an increase in capital is matched by a further increase in bond assets. Second, the initial level of human wealth $\tilde{h}_0$ diminishes because the discount factor increases, so the estimated initial share of capital ϕ_0 is higher. As a result, the share of safe assets in the beginning-of-period is lower. This implies a smaller decrease in bond holdings during the period, holding human wealth constant, which explains the smaller capital inflows reported in the portfolio component.

FIG. II.7 – Actual capital outflows (as a share of initial GDP), against the different components of predicted capital flows, 1980-2000 - Extensions of the portfolio approach



Source : Penn World Tables 6.2 (Heston *et al.*, 2006), Lane and Milesi-Ferretti (2006), author's calculations.

However, if the magnitude of flows is lower on average, this is not true when looking into details. Figure II.7 shows clearly that the dispersion of predicted flows is similar to the baseline case. This can be explained as follows. Sovereign risk might reduce the volatility of the portfolio term, but it increases the dispersion between countries with negative and positive catch-up because it magnifies the impact of capital accumulation on bond holdings.

4.2 Asymmetric production risk

In the baseline portfolio approach, the amount of idiosyncratic production risk has been assumed to be identical across countries. The parameter σ has been set to 0.3 in all countries, following microeconomic empirical studies in the US and Eurozone. The world interest rate R^* has been set in order to match the steady-state share of capital in the US ϕ^{*US}. Assuming identical risk implies that the share of capital in developing countries should catch-up with the US. However, financial markets are often less developed in developing than in industrial countries, and therefore less able to insure investors against their individual risk. We assume then, for illustrative purposes, that the amount of individual risk in developing countries is twice as high as in the US (that is, $\sigma = 0.6$). As a consequence, the corresponding steady-state share of capital in the portfolio ϕ^* is smaller, and the portfolio adjustment term, which was the main source of the excessive magnitude of predicted flows, should be less negative, because the adjustment in safe assets should be milder.

The increase in the level of idiosyncratic risk has similar effects as in the sovereign risk case. The diminution in ϕ^* has a positive impact on capital outflows due to productivity catch-up (column (4) of Table II.4) and a negative effect on capital inflows due to portfolio change (column (5) of Table II.4). As a result, the total predicted inflows are smaller than in the baseline case by a significant margin (a little more than one third). However, as in the sovereign risk extension, predicted outflows are still dispersed, as shown by Figure II.7.

4.3 Hand-to-mouth workers

We have assumed so far that all households had access to financial assets, capital and bonds. However, a significant share of the population holds no assets and has a limited ability to borrow. As in Angeletos and Panousi (2007), hand-to-mouth workers are introduced to capture in a crude way this heterogeneity among households. The population is composed of two groups : "investors", who supply labor, invest in productive capital and have access to the bond market ; and "hand-to-mouth workers", who supply labor but do not hold any asset, and consume their entire labor income at each period. A notable consequence of this extension is that investors hold only a fraction of the country's human wealth, which should reduce their amount of debt.

I follow Angeletos and Panousi (2007) in setting the proportion of hand-to-mouth workers in the US so that their share of aggregate consumption is equal to 50%. This gives a proportion of 70% : only 30% of the population have access to financial assets. This new calibration yields a higher initial and steady-state portfolio share of capital (respectively ϕ_0 and ϕ^*). Then, it is assumed in a first step that the proportion of investors in developing countries is identical to the US (symmetric case). In a second step, the proportion of investors is set at 15%, to represent the fact that financial markets are less accessible in developing countries (asymmetric case). This has no additional impact on the end-of-period share of capital in the portfolio ϕ^*. However, it will have an impact on the initial one, through the initial investors' human wealth. As a consequence, the portfolio change component should be less important in the asymmetric than in the symmetric case.

According to column (2) of Table II.4, the decrease in the predicted level of capital inflows in the symmetric case is of the same magnitude as in the extension with sovereign risk. This time, the diminution comes mainly from the portfolio term in column (5). The key element is the increase in the initial share of capital in portfolio ϕ_0 due to the diminution in the amount of human wealth held by investors.

The decrease in safe assets during the period is therefore mitigated. The diminution in the capital outflows due to human wealth adjustment (column (6)) comes simply from the fact that investors hold only a fraction of the country's human wealth. Contrary to the case with sovereign risk and asymmetric production risk, capital outflows due to productivity catch-up (column (4)) diminish, because ϕ^* increases. Households hold less bonds in their portfolio, so the impact of productivity catch-up on bond accumulation is alleviated. As a consequence, the dispersion of predicted flows is also diminished, while the correlation between actual and predicted flows is still significantly positive, as illustrated in Figure II.7.

In the asymmetric case, the predicted inflows decrease further, and are now one order of magnitude lower than in the baseline specification. The origin of this decrease lies again in the portfolio term, thanks to the further increase in the initial share of capital in the portfolio ϕ_0. As a consequence of the decline in the share of human wealth held by investors, the human wealth component decreases. The catch-up and convergence components do not change as compared to the symmetric case, since the steady-state share of capital ϕ^* is unaffected. As shown by Figure II.7, the cross-country dispersion of predicted flows is also diminished.

5 Conclusion

This chapter develops an extension of the traditional neoclassical growth model to risky investment that reverses the predictions in terms of capital flows, and therefore contributes to match the actual ones and to solve the puzzle highlighted by Gourinchas and Jeanne (2007). The advantage of this approach is that it does not constitute a great departure from the textbook model and therefore allows the adoption of a similar development accounting approach to Gourinchas and Jeanne (2007). The portfolio approach appears then more promising than the riskless one in explaining the allocation of capital flows among developing countries. This shows that international financial markets have to be considered not only as a financing source, but also as a way to provide insurance in the presence of domestic investment risk.

However, while the portfolio approach explains better the *direction* of flows than the riskless one, it fails to account for their *magnitude*, which is overestimated by several orders of magnitude. From that point of view, the portfolio approach fares worse than the riskless one. Still, this problem of magnitude in the portfolio choice model is commonly come across in the literature. It can be related to the findings of Kraay *et al.* (2005) on the magnitude of North-South bond position. In this chapter, some potential explanations have been proposed to enrich the model and account for the discrepancy between actual and predicted flows : sovereign risk, asymmetric production risk and the presence of hand-to-mouth workers. The extension with hand-to-mouth workers appears to be the more promising one because it reduces both the average amount of predicted capital inflows and their cross-country dispersion. A challenge for future research is to reconcile both the direction and the magnitude of flows. Another potential candidate is to model productivity growth as a random walk. This would have two effects : human wealth would be diminished since positive productivity shocks would be unanticipated, which would diminish the countries' ability to borrow ; bonds would constitute a larger share of the portfolio since it would be the only safe asset. This is left for future research.

Another direction for research consists in checking whether the portfolio approach can also account for the composition of flows. Extending the model to the possibility to trade equity could lead to predictions in terms of equity holdings. According to portfolio choice models, the more productive assets should constitute a higher share both in the domestic and foreign portfolio, which would explain why direct foreign investment is still positively correlated with productivity growth, as shown in Gourinchas and Jeanne (2007).

6 Appendix

Proof of Lemma 1

Maximizing U_t^i is equivalent to maximizing $V_t^i = U_t^i/N_t = E_t \int_t^\infty e^{-(\rho-n)(s-t)} \ln(c_s^i)ds$.

Indexes are now dropped for simplicity. Define ϕ such that $\phi = k/\omega$. The constraint of the maximization problem is therefore : $d\omega = [(r - R^*)\phi + R^*)\omega - c - n\omega]dt + \sigma\phi\omega dz$.

The Bellman equation for this problem is :

$$(\rho - n)V_t = \max_{c,\phi} \left\{ \ln(c_t) + \frac{\partial V_t}{\partial t} \right\}$$

Then, applying Ito's Lemma, we obtain :

$$(\rho-n)V(\omega,t) = \max_{c,\phi} \left\{ \ln(c) + \frac{\partial V(\omega,t)}{\partial t} + \frac{\partial V(\omega,t)}{\partial \omega} \left[((r - R^*)\phi + R^*)\omega - c - n\omega\right] + \frac{\partial^2 V(\omega,t)}{\partial \omega^2} \frac{1}{2}\phi^2\omega^2\sigma^2 \right\}$$

The first-order conditions of this problem are :

$$\frac{1}{c} - \frac{\partial V(\omega,t)}{\partial \omega} = 0$$

$$\frac{\partial V(\omega,t)}{\partial \omega}(r - R^*) + \frac{\partial^2 V(\omega,t)}{\partial \omega^2}\phi\omega\sigma^2 = 0$$

An educated guess for the general form of the value function is :

$$V(\omega,t) = \frac{\ln(\omega)}{\chi} + \psi$$

where χ and ψ have to be determined.

Substituting the derivatives of the value function into the first order conditions yields the solutions :

$$c = \chi\omega \qquad \text{and} \qquad \phi = \frac{r - R^*}{\sigma^2}$$

Plugging these expressions into the Bellman equation yields $\chi = \rho - n$ and $\psi = \ln(\rho - n) + (r - R^*)^2/2\sigma^2 + R^* - \rho$. This gives Equations (II.7) and (II.8).

Proof of Lemma 2

Proof of (i) :

(II.9) is derived as follows. Lemma 1 states that $c_t^i = (\rho - n)\omega_t^i$. Since every family has the same number of members, then the country's average wealth per capita is equal to the average of families' wealth per capita : $\omega_t = \int_0^1 \omega_t^i$. As a consequence, the country's consumption per capita is equal to a fraction of the country's wealth per capita : $c_t = (\rho - n)\omega_t$. This implies that they grow at the same rate : $\dot{c}_t/c_t = \dot{\omega}_t/\omega_t$. When aggregating across households, risk disappears and Equation (II.6) gives : $\dot{\omega}_t/\omega_t = \bar{R}_t - \rho$, where $\bar{R}_t = \phi r_t + (1 - \phi)R^*$ the average return on wealth. As a consequence, we can derive the aggregate Euler condition in per capita terms :

$$\frac{\dot{c}_t}{c_t} = \bar{R}_t - \rho \tag{II.20}$$

Now, using the definition of π_t (III.6), the growth rate of productivity $\dot{A}_t/A_t$ is equal to $\dot{\pi}_t + g^*$. Then , applying the definition of $\tilde{c}_t$, we obtain :

$$\frac{\dot{\tilde{c}}_t}{\tilde{c}_t} = \frac{\dot{c}_t}{c_t} - \frac{\dot{A}_t}{A_t} = \bar{R}_t - \rho - (\dot{\pi}_t + g^*)$$

Equation (II.10) is obtained as follows. From aggregating Equation (II.6) and rearranging terms, using the fact that $r_t k_t = (1 - \tau)\alpha F(k_t, A_t) - \delta k_t$, $w_t + z_t = (1 - \alpha + \tau\alpha)F(k_t, A_t)$, one obtains the following resource constraint of the economy in per capita terms :

$$\dot{k}_t + \dot{b}_t = F(k_t, A_t) - \delta k_t + R^* b_t - c_t - n(k_t + b_t)$$

The Wiener process disappears from the aggregate resource constraint since by assumption $\int_0^1 dv_t^i = 0$. Then, using $\dot{k}_t/k_t = \dot{\tilde{k}}_t/\tilde{k}_t + \dot{A}_t/A_t$, we obtain :

$$\dot{\tilde{k}}_t + \dot{\tilde{b}}_t = f(\tilde{k}_t) - \delta\tilde{k}_t + R^*\tilde{b}_t - \tilde{c}_t - (n + \dot{\pi}_t + g^*)(\tilde{k}_t + \tilde{b}_t)$$

Equation (II.11) is derived by aggregating the investment policy rule when $\sigma > 0$ (II.8) across households and using the definition of ω_t : $\omega_t = k_t + h_t + b_t$. Then, we obtain

$$k_t = \frac{\phi_t}{1 - \phi_t}(h_t + b_t)$$

Dividing each side by A_t yields Equation (II.11).

Equation (II.12) is derived in the same way as Equation (II.10), starting from the law of evolution of human wealth (II.4).

Proof of (ii) :

Consider Equation (II.8). When σ goes to zero, ϕ goes to infinity as long as $r_t > R^*$. The only possible equilibrium outcome when $\sigma = 0$ is therefore $r_t = R^*$.

When $\sigma = 0$, the same consumption policy rule (II.7) and the same budget constraint (II.6) hold. Therefore, the evolution of consumption obeys to the Euler conditions in efficient unit of labor and in per capita terms (II.9) and (II.20), only with $\bar{R}_t = R^*$. However, the investment rule obeys to the arbitrage condition $r_t = R^*$. By using $r_t = R^*$ and the definition of r_t, we obtain the optimal value of capital (II.13).

Proof of Proposition 1

Proof of (i) :

To obtain Equation (II.14), write Equation (II.9) for $\dot{\tilde{c}}/\tilde{c} = 0$ and $\dot{\pi} = 0$:

$$\bar{R} - \rho - g^* = 0$$

This implies, after replacing $\bar{R}$:

$$R^* - \rho - g^* + \phi(r - R^*) = 0$$

And after replacing ϕ and rearranging, we obtain :

$$\frac{(r-R)^2}{\sigma^2} = \rho + g^* - R^*$$

This implies that $R^* \leq \rho + g^*$ necessarily at steady state. Again, after replacing r and rearranging, we obtain Equation (II.14). Finally, in order to rule out $R^* = \rho + g^*$, notice that it would imply $\phi = 0$ at steady state, which means that $\tilde{k}^* = 0$. This is impossible since $\lim_{\tilde{k}\to 0} f'(\tilde{k}) = +\infty$, which contradicts Equation (II.14).

Equation (II.15) derives from the portfolio rule (II.11). We only have to determine $\tilde{h}$ at steady state. $\tilde{h}_t = \int_0^\infty e^{-R^* s} \frac{N_{t+s} A_t t+s}{N_t A_t t}(1-\alpha+\tau\alpha) f(\tilde{k}_{t+s}) ds = \int_0^\infty e^{-(R^*-(n+g^*))s+\pi_s-\pi_t}(1-\alpha+\tau\alpha) f(\tilde{k}_{t+s}) ds$. Equation (II.14) gives $\tilde{k}^*$, the steady-state value of $\tilde{k}$. We have also $\pi_t = \pi$ in the long run. Therefore,

$$\tilde{h}^* = \frac{(1-\alpha+\tau\alpha) f(\tilde{k}^*)}{R^* - (n+g^*)}$$

Replacing $\tilde{h}^*$ in Equation (II.11) yields Equation (II.15).

Proof of (ii) :

When $\sigma = 0$, Equation (II.9) becomes :

$$\frac{\dot{\tilde{c}}_t}{\tilde{c}_t} = R^* - \rho - (\dot{\pi}_t + g^*)$$

Applying the definition of steady state, this yields :

$$R^* = \rho + g^*$$

Equation (II.16) is only another way to write the arbitrage condition $r_t = R^*$ or

(II.13).

Equation (II.17) is inferred from the budget constraint (II.10) and the Euler condition (II.20) with $\bar{R}_t = R^*$. Equation (II.10) can be rewritten as follows :

$$\dot{\tilde{k}}_t + \dot{\tilde{b}}_t = (1 - \alpha + \tau\alpha))f(\tilde{k}_t) + R^*(\tilde{k}_t + \tilde{b}_t) - \tilde{c}_t - (n + \dot{\pi}_t + g^*)(\tilde{k}_t + \tilde{b}_t)$$

Write the Euler condition (II.20) when $R^* = \rho + g^*$:

$$\frac{\dot{c}_t}{c_t} = g^*$$

Therefore, $c_t = c_0 e^{g^* t}$, and $\tilde{c}_t = \tilde{c}_0 e^{g^* t} A_0 / A_t = \tilde{c}_0 e^{-\pi_t}$. As a consequence, we obtain at steady state : $\tilde{c}^* = \tilde{c}_0 e^{-\pi}$. We know also that $\tilde{k}_t = \tilde{k}^*$ always. We thus have at steady state :

$$\dot{\tilde{b}}_t = (1 - \alpha + \tau\alpha)f(\tilde{k}^*) + R^*(\tilde{k}^* + \tilde{b}_t) - \tilde{c}_0 e^{-\pi} - (n + g^*)(\tilde{k}^* + \tilde{b}_t)$$

Since $\rho > n$, then $R^* > n + g^*$, so the only non-explosive solution for $\tilde{b}_t$ is :

$$\tilde{b}_t = \tilde{b}^* = -\tilde{k}^* - \frac{(1 - \alpha + \tau\alpha)f(\tilde{k}^*) - \tilde{c}_0 e^{-\pi}}{R^* - (n + g^*)}$$

Hence the result. To derive $\tilde{c}_0$, we use the intertemporal budget constraint at $t = 0$:

$$\int_0^\infty e^{-R^* t} N_t c_t dt = \int_0^\infty e^{-R^* t} N_t (w_t + z_t) dt + N_0(k_0 + b_0)$$

Replacing $w_t + z_t$ by $(1 - \alpha + \tau\alpha)A_t f(\tilde{k}^*)$, using the fact that N_t grows at rate n, that $A_t = A_0 e^{\pi_t + g^* t}$ and that $c_t = c_0 e^{g^* t}$, we obtain :

$$\int_0^\infty e^{-(R^* - (n+g^*))t} c_0 dt = \int_0^\infty e^{-(R^* - (n+g^*))t + \pi_t} A_0 (1 - \alpha + \tau\alpha) f(\tilde{k}^*) dt + k_0 + b_0$$

which implies :

$$\frac{c_0}{R^* - (n+g^*)} = A_0 \left((1-\alpha+\tau\alpha) f(\tilde{k}^*) \int_0^\infty e^{-(R^*-(n+g^*))t+\pi_t} dt + k_0 + b_0 \right)$$

The final result is obtained by rearranging terms and replacing R^* by $\rho + g^*$.

Proof of Proposition 2

Notice that, with or without risk, when T is sufficiently large, the predicted capital flows must satisfy :

$$\frac{\Delta B}{Y_0} = e^{\pi+(n+g^*)T} \frac{\tilde{b}^*}{y_0} - \frac{\tilde{b}_0}{y_0} \tag{II.21}$$

Proof of (i) :

Replacing the expression for $\tilde{b}^*$ (II.17) in Equation (II.21) and substituting for $\tilde{c}_0$, we obtain :

$$\frac{\overline{\Delta B}}{Y_0} = \frac{\tilde{k}_0 - \tilde{k}^*}{\tilde{k}_0^\alpha} e^{(n+g^*)T} + \left(e^{(n+g^*)T} - 1\right) \frac{\tilde{b}_0}{\tilde{k}_0^\alpha} - (e^\pi - 1) \frac{\tilde{k}^*}{\tilde{k}_0^\alpha} e^{(n+g^*)T}$$

$$-e^{\pi+(n+g^*)T} (1-\alpha+\alpha\tau) f(\tilde{k}^*) \left(\frac{1}{\rho - n} - \int_0^\infty e^{-(\rho-n)t+\pi_t-\pi} dt \right)$$

Since $1/(\rho - n) = \int_0^\infty e^{-(\rho-n)t} dt$, this expression leads to Equation (II.18).

Proof of (ii) :

In order to derive Equation (II.19), we use Equation (II.21) where $\tilde{b}^*$ is replaced using Equation (II.15) and $\tilde{b}_0$ is given by the portfolio rule in $t = 0$:

$$\tilde{b}_0 = \frac{1-\phi_0}{\phi_0} \tilde{k}_0 - \tilde{h}_0$$

This yields :

$$\frac{\Delta B}{Y_0} = \frac{1-\phi}{\phi}\frac{\tilde{k}^* - \tilde{k}_0}{\tilde{k}_0^\alpha} + \frac{1-\phi}{\phi}\frac{\tilde{k}^*}{\tilde{k}_0^\alpha}\left(e^{\pi+(n+g^*)T} - 1\right) + \frac{\tilde{k}_0}{\tilde{k}_0^\alpha}\left(\frac{1}{\phi} - \frac{1}{\phi_0}\right) - \frac{e^{\pi+(n+g^*)T}\frac{(1-\alpha+\tau\alpha)f(\tilde{k}^*)}{R^*-(n+g^*)} - \tilde{h}_0}{\tilde{k}_0^\alpha}$$

Besides :

$$\tilde{h}_0 = \int_0^\infty e^{-R^*t}(1-\alpha+\tau\alpha)\frac{N_tA_t}{N_0A_0}f(\tilde{k}_t)dt$$

$$= \int_0^T e^{-R^*t}(1-\alpha+\tau\alpha)\frac{N_tA_t}{N_0A_0}f(\tilde{k}_t)dt + \int_T^\infty e^{-R^*t}(1-\alpha+\tau\alpha)\frac{N_tA_t}{N_TA_T}\frac{N_TA_T}{N_0A_0}f(\tilde{k}_t)dt$$

$$= \int_0^T e^{-(R^*-(n+g^*))t+\pi_t}(1-\alpha+\tau\alpha)f(\tilde{k}_t)dt + \int_T^\infty e^{-(R^*-(n+g^*))t}(1-\alpha+\tau\alpha)e^{(n+g^*)T+\pi}f(\tilde{k}^*)dt$$

$$= \int_0^T e^{-(R^*-(n+g^*))t+\pi_t}(1-\alpha+\tau\alpha)f(\tilde{k}_t)dt + e^{(n+g^*)T+\pi}\frac{(1-\alpha+\tau\alpha)f(\tilde{k}^*)}{R^*-(n+g^*)}$$

Hence the final result.

Chapitre III

Exchange Rate Volatility and Productivity Growth : the Role of Liability Dollarization

1 Introduction

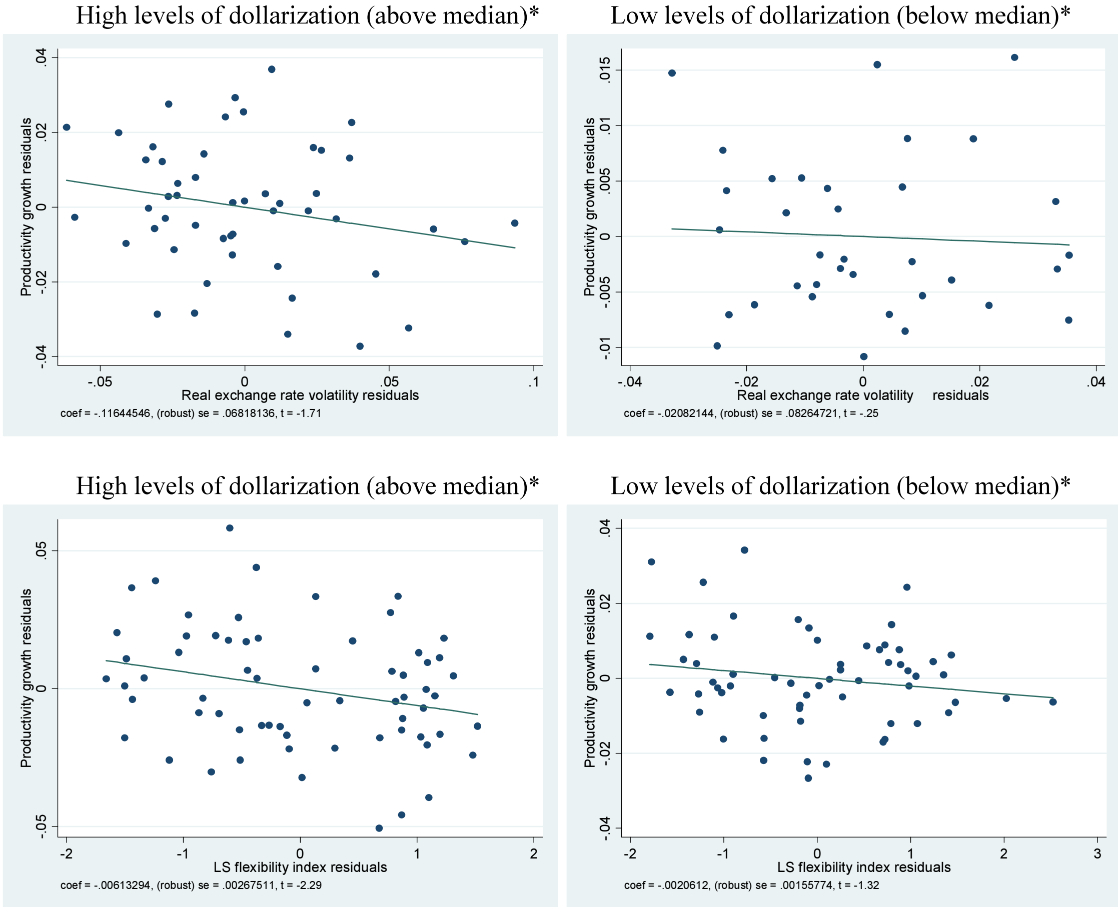
The choice of exchange rate regime and its impact on economic performance is among the most controversial issues in macroeconomic policy. The empirical works on the growth effect of exchange rate volatility conclude either on exchange rate neutrality, or on a different effect in industrial and developing countries. Baxter and Stockman (1989) were the first to bring this "instability puzzle" forward. The literature has since been inconclusive on the subject : Husain *et al.* (2005) find that exchange rate flexibility is growth-enhancing in industrial countries and neutral in developing economies, while Dubas *et al.* (2005), relying on an alternative exchange-rate classification, find that a fixed exchange rate has good growth performances in the latter while it is neutral in the former ; similarly, De Grauwe and Schnabl (2005) show that exchange rate stability is associated with higher growth in South-Eastern and Central European countries.

Some recent studies suggest that the failure of the empirical literature at bringing a stable, clear-cut effect of exchange volatility to the fore may be due to nonlinear effects : Razin and Rubinstein (2006) allow the exchange rate regime to have both a direct effect on short-term growth, and an indirect one that is channelled through the crisis probability, while Aghion *et al.* (2006a) introduce the interaction of the exchange rate regime with financial development. Using a sample of 83 countries spanning the years 1960-2000, they show that real exchange rate volatility can have a significant impact on the long-term rate of productivity growth, but the effect depends critically on the countries' level of financial development. For economies with relatively low levels of financial development, exchange rate volatility generally reduces growth, whereas for financially advanced countries, there is no significant effect. Their empirical result is consistent with the previous literature, in particular with the finding that exchange rate stability is more growth enhancing in developing than in industrial countries. Their theoretical model suggests that exchange rate flexibility exacerbates the volatility of firms' cash flows. As a consequence, exchange rate volatility makes the financing of innovations more difficult on average when financial development is low, that is when credit requirements are stricter, and results in lower growth. The main idea is that during slumps, the innovating capacity of firms is hampered while booms do not significantly foster the ability of firms to overcome the liquidity shock. The consequence of this asymmetry is that less volatility fosters growth.

In this chapter, the effect of exchange rate volatility on growth is related to the level of liability dollarization, also referred to as "original sin", that is the inability of developing countries to borrow in their own currency. As a preliminary evidence on the link between exchange rate volatility and growth for different levels of liability dollarization, consider Figure III.1. It presents productivity growth against measures of exchange rate volatility, both adjusted for some control variables[1], for low and

[1] The control variables include initial productivity, financial depth, secondary schooling, government expenditure, inflation, trade openness. These variables are defined in section 4.

FIG. III.1 – Real exchange rate volatility, exchange rate flexibility and productivity growth



* : Pooled regressions of productivity growth, real exchange rate volatility (standard deviation of real exchange rate changes) and exchange rate flexibility (LS classification of exchange rate management) are performed using five-year average data for 51 (upper graphs) to 75 (lower graphs) countries over 1995-2005. The control variables include initial productivity, financial depth, secondary schooling, government expenditure, inflation, trade openness. For each group, the regressions are performed and then the residuals of productivity growth are regressed on the residuals of real exchange rate volatility or exchange rate flexibility.
Source : CHELEM, World Bank, Barro and Lee (2000), Beck *et al.* (1999), Hausmann *et al.* (2001) and Levy-Yeyati and Sturzenegger (2002).

high levels of dollarization. In order to adjust for the set of controls, we take the residuals of pooled regressions of productivity growth and exchange rate volatility using five-year average data for 51 (upper graphs) or 75 (lower graphs) countries over 1995-2005. Low and high levels of dollarization are respectively those below and above the sample median. Two proxies are used to account for exchange rate flexibility : the standard deviations of the real effective exchange rate in the upper graphs and the Levy-Yeyati and Sturzenegger (2002) classification of exchange rate regimes in the lower graphs. The dollarization measure is the external ”original sin” taken from Hausmann *et al.* (2001) and Hausmann and Panizza (2003). High dollarization countries exhibit a significant negative relationship between exchange rate flexibility and growth, while the slope is not significantly different from zero in low dollarization countries. The contribution of the chapter is to provide a theoretical model that would predict this fact and to confirm the robustness of this preliminary evidence, using a panel of 77 countries over the period 1995-2004.

As in Aghion *et al.* (2006a), an open monetary economy model with wage stickiness, where exchange rate fluctuations affect the growth performance of credit-constrained firms is developed : on the one hand, to be able to innovate, firms have to finance a transitory liquidity shock ; on the other hand, exchange rate volatility affects cash flows volatility under wage stickiness and thus impairs the firms' financing capacities on average. But this framework is not sufficient to account for liability dollarization and is supplemented with two important features : 1) the production is split into tradable and nontradable goods while the liquidity cost is in tradable goods to allow a mismatch ; 2) the firms' cash flows are the profits net of debt repayments, whereas in Aghion *et al.* (2006a), the cash flows are made of the firms' gross profits. Holding everything equal, the value of nontradable production in terms of tradables would fall after a nominal depreciation while the value of the tradable output would remain constant under the law of one price. Since the liquidity cost is denominated in tradable goods, this would reduce the firms' financing capacities. But if the firms' debt is partially denominated in domestic currency, this depreciation would also alleviate debt repayments and thus limit the fall in the firms' cash flows. An a priori intuition is therefore that under complete debt dollarization, a fixed exchange rate regime is growth-enhancing as compared to a flexible exchange rate regime, and when the level of dollarization falls, the growth advantage of pegged regimes diminishes.

However, whether exchange rate flexibility destabilizes firms' production in terms of tradable goods under general equilibrium is not a trivial issue. According to Milton Friedman, a flexible exchange rate has a stabilizing effect on output when the source of shocks is external since a foreign shock that requires a real depreciation would imply a costless nominal depreciation while there would be a contractionary deflation under a fixed exchange rate. As a result, a flexible exchange rate has a stabilizing effect on output. However, the output *measured in foreign currency* depends on both the output in real terms and the real exchange rate. Therefore, firms' revenues in foreign currency can be better stabilized by a fixed exchange rate regime if its stabilizing effect on the real exchange rate compensates for its destabilizing effect on output. In the model presented here, with productivity shocks in the tradable sector, it is the case : because the nontradable sector is more labor-intensive than the tradable sector, the traditional contractionary deflation effect under a peg is present, but because the elasticity of substitution between the nontradable and tradable goods is lower than one (as is widely admitted in the literature), the net effect is mitigated under a peg.

To test the basic hypothesis that exchange rate flexibility has a more negative impact in dollarized countries, standard growth regressions are used (the baseline specification is taken from Levine *et al.* (2000)). Those standard growth regressions are augmented by a measure of exchange rate flexibility (as in Aghion *et al.* (2006a)), a measure of external dollarization and the interaction term of exchange rate flexibility and dollarization. The results are based on a dynamic panel of 77 countries between 1995 and 2004 described above. Both OLS and GMM methodologies are adopted and robust two-step standard errors are also computed using the method of Windmeijer (2004). The GMM methodology helps tackle the issue of endogeneity but suffers from the problem of weak instruments. The set of instruments is therefore carefully selected using both overidentification and underidentification tests. Afterwards, robustness checks are run.

The introduction of original sin to understand the impact of exchange rate on growth is motivated by the recurrent use of liability dollarization in the literature to understand emerging markets. In particular, while some dollarization may be required by exporters as a hedge against exchange rate fluctuations, widespread dollarization introduces a currency mismatch. This mismatch has been pointed to as a source of vulnerability by several authors.[2] Original sin is therefore a major candidate to explain the relative growth performances of exchange rate regimes in developing and industrial countries. Among the few empirical works on liability dollarization (Arteta, 2005; Calvo *et al.*, 2004; De Nicolo *et al.*, 2003; Reinhart *et al.*, 2003; Levy-Yeyati, 2006), only Levy-Yeyati (2006) have examined the overall growth impact of original sin, but none yet have considered its effect on aggregate productivity when interacted with exchange rate volatility.

Another reason for enriching the approach of Aghion *et al.* (2006a) is that an exchange rate depreciation has expansionary effects in their model : since firms produce only tradable goods and because of the law of one price, a depreciation is equivalent to inflation which leads to a decrease in the real wage. The negative effect of exchange rate volatility thus comes mainly from the appreciation episodes, which goes against the evidence, especially for developing countries. The introduction of a nontradable good sector which is more labor-intensive than the tradable good sector helps reverse this prediction, so that an exchange rate depreciation is contractionary.

Section 2 presents a stylized model of growth and monetary policy. Section 3 derives the empirical implications of the model concerning the link between growth and exchange rate volatility. Section 4 tests these empirical predictions.

[2] See, among others, Krugman (1999), Aghion *et al.* (2000), Aghion *et al.* (2004), and Cespedes *et al.* (2002).

2 A stylized monetary model

2.1 A small open economy with sticky wages and two sectors

Consider a small open economy with a continuum of firms, indexed by $i \in [0,1]$, that are owned in equal shares by a continuum of households indexed by $j \in [0,1]$. Households supply labor and start period t with a stock of monetary balances. Firms produce both tradable goods T, which are identical to the outside world good, and nontradable goods N. There are two currencies : the domestic currency (peso) and the foreign currency (dollar).

Firms are price-taker and competitive so that the law of one price applies in the sector of tradables :

$$P_t^T = S_t P_t^{T*}$$

where P_t^T and P_t^{T*} are respectively the domestic (peso) and foreign (dollar) price of tradable goods and S_t is the nominal exchange rate. P_t^{T*} is assumed to be constant and normalized to one. Thus $P_t^T = S_t$: dollars and tradables are one and unique good.

The timing within period t is the following :

1. Wages are preset.
2. The entrepreneurs borrow D_t to be able to innovate in period $t+1$: that is upgrade A_t, the level of productivity.
3. An aggregate productivity shock occurs in the tradable sector, firms hire labor L_t and produce $A_t Y_t^T$ and $A_t Y_t^N$, respectively the production of tradable and nontradable goods.
4. Firms repay their debt D_t, and pay the wages $A_t W_t L_t$, with $A_t W_t$ the wage rate and L_t aggregate labor.
5. Firm i, $i \in [0,1]$ faces a liquidity shock $A_t \Phi_t^i$ in dollars. If the liquidity shock

is financed, then the firm is able to innovate and recovers $A_t\Phi_t^i$. If it is not financed, then the firm cannot innovate and disappears at the end of the period.

6. Firms distribute profits to the household and consumption takes place.

We assume that there are no credit markets at step 5. This important assumption implies that the ability to innovate can be hampered because of a bad shock on cash flows. We also make the simplifying assumption that there is no intertemporal trading, so the analysis can be split into the within-period equilibrium and the evolution of productivity A_t, which depends on the equilibrium cash flow of period t. First, the process governing the evolution of productivity is presented to determine how growth depends on current cash flows and then a within-period analysis is run to determine how cash flows react to shocks under a flexible and fixed exchange rate regime.

2.2 The evolution of productivity

2.2.1 Innovation process

The innovation process is specified as follows : if the firm is able to overcome the liquidity shock of period t, then its $t+1$ productivity evolves according to :

$$A_{t+1} = \delta\rho_t A_t + (1-\rho_t)A_t$$

with $\delta > 1$ and ρ_t the proportion of innovating firms. The firm benefits from positive innovation externalities. Otherwise, the firm disappears and is replaced by a new firm that benefits from the new level of productivity. These assumptions are made to rule out heterogeneity among firms and to keep their number constant. The aggregate growth rate is therefore $g = (\delta - 1)\rho_t$.

2.2.2 Liquidity shocks and credit market imperfections

To be able to innovate, the firm has to pay a fixed cost $D_t = dA_t$ $(d > 0)$ in dollars at the beginning of period t (before the revelation of the aggregate shock), and pay an idiosyncratic liquidity cost $A_t\Phi_t^i$ in dollars at the end of period t, after paying the wage bill and repaying its debt, where Φ_t^i is independently and identically distributed across firms, with cumulative distribution function F. A_t is used to scale the fixed cost and the liquidity shock to ensure a balanced growth path.

Firms start the period without funds, so they must borrow D_t. For tractability, firms' indebtedness is introduced under the form of a fixed cost. It is also assumed for simplicity that the credit constraints are not binding at this stage and that the cost of borrowing is lower than the expected value of innovation, which implies that firms always choose to pay the fixed cost. This cost can be viewed as spending on R&D, learning expenses or investment in a new technology.

At the end of the period t, firm i faces the liquidity cost shock $A_t\Phi_t^i$. If they do not finance this cost, the firms cannot innovate and disappear at the end of the period. If firms meet this cost, they will recover $A_t\Phi_t^i$ at the end of the current period and pay back their creditors before the beginning of the next one. For simplicity, it is also assumed that the liquidity cost can be financed with a zero interest rate. As a consequence, the innovation cost is neutral regarding the net profit of the current period. Therefore, it is always profitable for the firms to finance the liquidity shock. $A_t\Phi_t^i$ can be viewed as the cost induced by a delay, typically in an equipment delivery, or any transitory shock that would ruin the business unless there is enough liquidity to overcome it.

It is assumed that there are no credit markets at this stage, so firms are able to overcome the transitory liquidity shock if and only if their cash flow is sufficient to meet the cost :

$$\Pi_t \geq \Phi_t^i$$

where Π_t is the cash flow of the firm expressed in dollars and scaled by A_t.

Firms have the same cash flows Π_t and differ only regarding the liquidity shock Φ_t^i. Therefore, ρ_t, the proportion of firms which are not constrained (and thus of innovating firms), is the proportion of firms whose liquidity shock is lower than Π_t :

$$\rho_t = P(\Phi_t^i < \Pi_t) = F(\Pi_t) \tag{III.1}$$

The aggregate growth rate depends directly on the level of cash flows Π_t. The purpose of the next subsection is to determine the behavior of Π_t depending on the exchange rate regime.

2.3 Within-period analysis

The purpose of this subsection is to examine the impact of exchange rate policy, which is implemented through a monetary instrument, in terms of transmission of shocks to prices and quantities, and therefore to firms' cash flows. For this purpose, the structure of the within-period model is specified. The presence of nominal rigidities (preset wages) implies that monetary policy has real consequences, in particular in terms of cash flows volatility. Some other key assumptions contribute to shape the model's predictions. First, the nontradable sector is more labor-intensive than the tradable one. This is empirically relevant, but it has also an important implication, which is that an output contraction is consistent with a real depreciation. As a result, the peso-denominated debt has hedging properties regarding cash-flows volatility in terms of dollars. Second, the elasticity of substitution between tradables and nontradables is lower than one, which is widely admitted in the literature, but is also key in ranking the flexible and fixed exchange rate regimes in terms of cash-flow volatility.

Finally, the level of dollarization is exogenous. Indeed, the fact that liability dollarization is imposed on developing countries is widely admitted in the literature. Eichengreen and Hausmann (1999), among others, support this view :

The problem is not that firms simply lack the foresight to match the maturity structure of their assets and liabilities ; it is that they find it impossible to do so.

The incompleteness of financial markets is thus at the root of financial fragility.

This financial markets incompleteness is often related to the lack of sound institutions and can therefore be regarded as exogenous.[3]

2.3.1 Firms

Production and growth

Final goods are produced using labour. Labour is differentiated across households, so that households have market power in wage setting. We can define the aggregate labor composite as :

$$L = \left[\int_0^1 (L^j)^{1-1/\delta} dj \right]^{\frac{1}{1-1/\delta}}$$

where L^j is employment of household j, and $\delta > 1$ is the elasticity of substitution between labor varieties.

Firms have identical technologies. A firm produces both tradable and nontradable goods. The tradable and nontradable productions of firm $i \in [0, 1]$ during period t are respectively denoted by $A_t Y_t^{Ti}$ and $A_t Y_t^{Ni}$ and :

$$Y_t^{Ti} = Y_t^T = e^{u_t} \tag{III.2}$$

$$Y_t^{Ni} = Y_t^N = \sqrt{L_t} \tag{III.3}$$

Y_t^{Ti} and Y_t^{Ni} are the firm's productions scaled by the level of productivity and u_t is the aggregate productivity shock in the tradable sector, with $Eu_t = 0$ and $V(u_t) = \sigma_u^2$. The labor demand is identical across firms because firms have the same technology. For simplicity, it is assumed that the production of nontradables requires

[3] Existing explanations point at time inconsistency problems related to the temptation to "default" on local currency debt through inflation (Calvo and Guidotti, 1989), the incidence of implicit debtor guarantees (Burnside *et al.*, 2001) and signaling problems (De la Torre *et al.*, 2003), among others. De Nicolo *et al.* (2003) provides evidence that the credibility of macroeconomic policy and the quality of institutions are both key determinants of cross-country variations in dollarization.

labor while the production of tradables involves no input. This specification has been chosen to capture the fact that the nontradable sector is more labor-intensive than the tradable sector.

Firms choose employment to maximize the nontradable profit $P_t^N\sqrt{L_t}-\int_0^1 W_t^j L_t^j dj$ with respect to L_t^j, $j \in [0,1]$, subject to the labor composite definition, where W_t^j is the wage set by household j in pesos, scaled by A_t, and P_t^N is the peso price of nontradable goods. We get the implicit labor demand function :

$$W_t^j = \frac{P_t^N}{2\sqrt{L_t}}\left(\frac{L_t^j}{L_t}\right)^{\frac{-1}{\rho}} \tag{III.4}$$

In a symmetric equilibrium, $W_t^j = W_t$ and $L_t^j = L_t$. We therefore get the optimal aggregate employment condition :

$$W_t L_t = \frac{P_t^N Y_t^N}{2} \tag{III.5}$$

Indebtment and dollarization

Firms borrow the fixed cost $D_t = dA_t$ to be able to innovate in period $t+1$. It is assumed that debt is contracted in nominal terms and is denominated either in foreign currency (dollars) or in local currency (pesos). An exogenous fraction α is denominated in dollars while the rest is denominated in pesos. α is the degree of dollarization.

r^*, the interest rate on dollar bonds, is fixed internationally. It is assumed that foreigners are risk neutral and value dollars so that r, the interest rate on peso bonds, satisfies the following no-arbitrage condition :

$$(1+r)E\frac{1}{P_t^T} = 1 + r^*$$

At the end of period t, the firm has therefore to repay in dollars :

$$\left(\alpha + \frac{1}{P_t^T E \frac{1}{P_t^T}}(1-\alpha)\right)(1+r^*)D_t$$

Cash flows

The liquidity shock occurs after the firm has paid the wage bill and repaid the debt, so the cash flow in terms of dollars and scaled by A_t is $\Pi_t = Y_t^T + \frac{P_t^N}{P_t^T} Y_t^N - \frac{W_t L_t}{P_t^T} - \left(\alpha + \frac{1}{P_t^T E\left(\frac{1}{P_t^T}\right)}(1-\alpha)\right)(1+r^*)d$. After replacing the wage bill using labor demand (III.5), one gets :

$$\Pi_t = \underbrace{Y_t^T + \frac{1}{2}\frac{P_t^N}{P_t^T} Y_t^N}_{\text{Gross profits}} - \underbrace{\left(\alpha + \frac{1}{P_t^T E\left(\frac{1}{P_t^T}\right)}(1-\alpha)\right)(1+r^*)d}_{\text{Debt repayments}} \tag{III.6}$$

The cash flows include gross profits, but to get the actual cash on hand, debt repayments must be substracted from them. Comparing the gross profit component and the debt component of cash flows will give the actual financing capacity of firms.

Because firms' revenues are partly in nontradable goods while the liquidity shock is denominated in tradables, firms face a *currency mismatch*. According to (III.6), firms' gross profits are sensitive to nominal exchange rate variations (changes in P_t^T). However, the peso-denominated fraction of firms' debt helps them hedge the variations in the nontradable value of their profits. For example, everything else equal, a nominal depreciation implies a fall in the value of gross profits in terms of tradables. If $\alpha = 1$, debt repayments, in terms of tradables, are immune to exchange rate variations, whereas if $\alpha < 1$, a nominal depreciation leads to a decrease in debt repayments in terms of tradables, which alleviates the overall impact of the depreciation on the cash flows. However, in order to generalize this intuition, the model needs to be closed.

2.3.2 Households

The households maximize their utility : $\log(A_tC_t) + \log\left(\frac{A_tM_t}{P_t}\right) - v(L_t^j)$, $v' > 0$, $v'' > 0$, with respect to C_t, their consumption basket and M_t, their nominal money balances, both scaled by the level of productivity A_t :

$$C_t = \left[\gamma^{\frac{1}{\theta}} C_t^{T\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} C_t^{N\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}} \tag{III.7}$$

subject to their -scaled- budget constraint :

$$P_t^T C_t^T + P_t^N C_t^N + M_t = \Pi_t + W_t^j L_t^j + T_t + M_{t-1}A_{t-1}/A_t \tag{III.8}$$

where C_t^T and C_t^N are respectively the consumptions of tradables and nontradables, and T_t are monetary transfers from the government, all scaled by A_t. $M_{t-1}A_{t-1}$ is the initial stock of monetary balances. The households use the dividends (firms' net profits), their wage, government transfers and their begining-of-period money balances to finance their consumption in tradables and nontradables and their current money balances. θ is the elasticity of substitution between tradable and nontradable goods. It is assumed that $\theta < 1$, which means that goods are weakly substitutable. This is a standard assumption concerning tradables and nontradables. $0 < \gamma < 1$ is the weight of tradables in the consumption basket.

The program yields the relative demand for tradables and nontradables :

$$\frac{P_t^N}{P_t^T} = \left(\frac{1-\gamma}{\gamma}\frac{C_t^T}{C_t^N}\right)^{\frac{1}{\theta}} \tag{III.9}$$

and the demand for money :

$$\frac{1}{P_tC_t} = \frac{1}{M_t} \tag{III.10}$$

The general price index associated to the household maximization program is the following :

$$P_t = \left(\gamma P_t^{T1-\theta} + (1-\gamma)P_t^{N1-\theta}\right)^{\frac{1}{1-\theta}} \tag{III.11}$$

2.3.3 Wage setting

To model wage stickiness, we assume that nominal wages are preset ex ante. Household j sets the wage W_t^j in order to maximize his expected utility subject to his budget constraint (III.8) and to the implicit labor demand (III.4). Since each household possesses a small fraction of the firms, he does not internalize the effect of his wage on the dividends. In a symmetric equilibrium, this yields :

$$W_t = \frac{\rho}{\rho - 1} \frac{E(L_t v'(L_t))}{E\left(\frac{L_t}{P_t C_t}\right)} \tag{III.12}$$

2.3.4 Monetary policy

The monetary policy targets either the stability of the general price index - flexible exchange rate :

$$P_t = \bar{P} \tag{III.13}$$

or the stability of the nominal exchange rate - fixed exchange rate :

$$P_t^T = \bar{P^T} \tag{III.14}$$

where $\bar{P}$ and $\bar{P^T}$ are exogenous. The government's instrument is a nominal transfer T_t, which is the amount of banknotes that are created by the government and distributed to the households. The outside world has a zero net demand for money balances. The government's budget constraint therefore yields :

$$M_t - M_{t-1} A_{t-1} / A_t = T_t \tag{III.15}$$

2.3.5 Equilibrium

The aggregate equilibrium budget constraint (balanced current account[4]), scaled by A_t, is given by :

$$P_t^T Y_t^T + P_t^N Y_t^N - \left(\alpha P_t^T + (1-\alpha) \frac{1}{E\left(\frac{1}{P_t^T}\right)} \right) (1+r^*) d = P_t^T C_t^T + P_t^N C_t^N$$

Since nontradables cannot be traded internationally :

$$Y_t^N = C_t^N \qquad \text{(III.16)}$$

which also yields :

$$Y_t^T - \left(\alpha + (1-\alpha) \frac{1}{P_t^T E\left(\frac{1}{P_t^T}\right)} \right) (1+r^*) d = C_t^T \qquad \text{(III.17)}$$

This means that both current accounts, in tradables and nontradables, are balanced : the nontradable output is entirely consumed and the tradable consumption is what remains from the tradable production after repaying the debt. Nominal exchange rate movements have therefore an impact on tradable consumption : if $\alpha < 1$, a depreciation enables the household to consume more tradable goods by alleviating the burden of the peso debt.

Definition : For each period t, given A_{t-1} and A_t, a symmetric equilibrium is defined by a set of prices $\left\{P_t^N, P_t^T, P_t, W_t\right\}$ and allocations $\left\{Y_t^N, Y_t^T, C_t^N, C_t^T, C_t, L_t, M_t, T_t\right\}$ that solves the supply of nontradable and tradable goods (III.2) and (III.3), the

[4] The current account is balanced because we have assumed that there is no intertemporal trading, that is no asset trade. This assumption simplifies the analysis but is not crucial. Qualitatively, the results would be unchanged if we introduced intertemporal trade in bonds. This is because, as long as there is imperfect risk sharing, a productivity shock leads households to alter their consumption, which is at the origine of the mechanisms of the model. Trade in bonds only limits the impact of productivity shocks on consumption by sharing their effect between current and future consumption ; it does not suppress it. The difference with the model without trade in bonds is only quantitative and does not alter the comparison between regimes.

aggregate labor demand (III.5), the consumption basket (III.7) the relative demand for tradable and nontradable goods (III.9), the demand for money (III.10), the price index (III.11), the symmetric wage setting (III.12), one of the two monetary policies (III.13) or (III.14), the government budget constraint (III.15) and the equilibrium conditions on the tradable and nontradable markets (III.16) and (III.17).

If the equilibrium productions and prices are determined, the values of firms' cash flows Π_t can be inferred from (III.6).[5]

Appendix A shows that the non-stochastic solution (without aggregate shock in the tradable sector) for $\left\{Y_t^N, Y_t^T, C_t^N, C_t^T, C_t, L_t, P_t^N, P_t^T, P_t, W_t\right\}$ is unique and constant across regimes. This defines the steady-state equilibrium of the model. Let X denote the steady-state value for X_t.

The empirical predictions of the model are derived in the next section by log-linearizing the model around the non-stochastic steady state and by studying the transmission mechanisms under both regimes.

3 Model's empirical implications

In this section, we study the differential impact of aggregate shocks on the quantities and prices under both regimes by using a reduced-form log-linearized model and then derive some conclusions on exchange rate regimes on growth.

3.1 The log-linearized, reduced-form model

Let x_t denote the deviation from the non-stochastic steady state of X_t : $x_t = \frac{X_t - X}{X} \backsimeq \ln(X_t) - \ln(X)$.

We are interested in the behavior of π (time subscripts are dropped for

[5] To obtain the value of the aggregate variables in absolute terms, multiply $\left\{Y_t^N, Y_t^T, C_t^N, C_t^T, C_t, W_t, M, T_t\right\}$ by A_t ($\left\{L_t, P_t^N, P_t^T, P_t\right\}$ are already in absolute terms).

simplicity). We thus log-linearize (III.6) and use the labor demand (III.5) to infer :

$$\pi = \underbrace{(1-\kappa)(\eta+1)y^T + \kappa(p^N - p^T + y^N)}_{\text{Gross profit effect}} + \underbrace{(1-\kappa)\eta(1-\alpha)p^T}_{\text{Debt valuation effect}}$$

where $\kappa = \frac{\frac{P^{N2}}{2P^T W}}{1-(1+r^*)d+\frac{P^{N2}}{2P^T W}}$ denotes the steady-state share of nontradables in the cash flows and $\eta = \frac{(1+r^*)d}{1-(1+r^*)d}$ denotes the steady-state ratio of debt repayments over the tradable consumption (tradable profit minus debt repayments). We have $0 < \kappa < 1$ and $\eta > 0$. The first and second terms of π represent respectively the tradable and nontradable gross profits valued in terms of tradables (or dollars). The last term represents the effect of the debt currency composition on the financing capacities of firms. For example, everything equal, a nominal exchange rate depreciation (appreciation), that is a rise in p^T (a fall) leads to a depreciation (appreciation) in the value of the nontradable gross profits, but it also alleviates (increases) the peso-denominated part of the debt when $\alpha < 1$. If $\alpha = 1$, debt repayments in terms of tradables are immune to nominal exchange rate variations and cannot hedge the variations in the tradable value of profits. However, one needs to consider how y^T, y^N, p^T and p^N vary jointly. To know how π reacts to the productivity shock u, it is then sufficient to know the behavior of production and prices, which we can derive from the following reduced-form model.

The log-linearization of the relative demand for tradables and nontradables (III.9) ($p^N - p^T = \frac{1}{\theta}(c^T - c^N)$) and the equilibrium conditions (III.16) ($c^N = y^N$) and (III.17) ($c^T = (\eta+1)y^T + \eta(1-\alpha)p^T$) gives :

$$p^N - p^T = \frac{1}{\theta}[(\eta+1)y^T + \eta(1-\alpha)p^T - y^N] \qquad \text{(III.18)}$$

The relative price of nontradables in terms of tradables has to fall either if the production of nontradables rises or if the production of tradables falls. This also happens if $\alpha < 1$ and the nominal exchange rate appreciates (p^T falls), because this makes the peso-denominated debt increase which leaves less tradable goods to consume for the household.

Besides, the log-linearization of supply of nontradables (III.3) ($y^N = \frac{l}{2}$) and the labor demand (III.5) ($p^N + y^N = l$) yields :

$$y^N = p^N \tag{III.19}$$

Here we see that a deflation in p^N has a contractionary effect on y^N. This is because nominal wages are preset. As a consequence, a deflation in p^N depresses the production of nontradables through the rise of the real wage.

Moreover, by log-linearizing the supply for tradables (III.2), we obtain :

$$y^T = u \tag{III.20}$$

Finally, the two possible policy choices are the following :

- Flexible exchange rate :

  $$p = 0$$

  Besides, according to (III.11) ($p = \gamma p^T + (1-\gamma)p^N$) the flexible rule reduces to :

  $$p^T = \frac{-(1-\gamma)}{\gamma} p^N \tag{III.21}$$

- Fixed exchange rate :

  $$p^T = 0 \tag{III.22}$$

With only (III.18), (III.19), (III.20) and one of the two monetary rules (III.21) or (III.22), π can be inferred.

3.2 Reactions of quantities and prices to shocks

The reduced form model composed of (III.18), (III.19), (III.20) and one of the two monetary rules (III.21) or (III.22) is solved to obtain the following Lemma :

Lemma 1

– *Under a flexible exchange rate,*

$$p^{Nflex} = \frac{\gamma(\eta+1)u}{\theta+\gamma+(1-\gamma)\eta(1-\alpha)}, \quad p^{Tflex} = \frac{(1-\gamma)(\eta+1)u}{\theta+\gamma+(1-\gamma)\eta(1-\alpha)}$$

$$p^{Nflex} - p^{Tflex} = \frac{(\eta+1)u}{\theta+\gamma+(1-\gamma)\eta(1-\alpha)}$$

$$y^{Nflex} = \frac{\gamma(\eta+1)u}{\theta+\gamma+(1-\gamma)\eta(1-\alpha)}, \quad y^{Tflex} = u$$

– *Under a fixed exchange rate,*

$$p^{Nfix} = \frac{(\eta+1)u}{\theta+1}, \quad p^{Tfix} = 0, \quad p^{Nfix} - p^{Tfix} = \frac{(\eta+1)u}{\theta+1}$$

$$y^{Nfix} = \frac{(\eta+1)u}{\theta+1}, \quad y^{Tfix} = u$$

Lemma 1 is used to establish the following proposition :

Proposition 1 *(proof in Appendix A) :*

After an identical negative productivity shock in the tradable sector :

– *If $\alpha = 1$, the production of nontradables (y^N) falls more under a peg than under a float. However, the relative price of nontradables ($p^N - p^T$) (henceforth the real exchange rate) experiences a higher depreciation under a float.*

– *When α diminishes, the fall in the production of nontradables and in the real exchange rate is mitigated under a float.*

The intuition is the following : a negative shock on the productivity of the tradable sector requires a real depreciation (a fall in $p^N - p^T$) which results in a contractionary deflation in the nontradable sector under both regimes, as illustrated in Figure III.2. This negative effect is accentuated under the fixed exchange rate regime because the real depreciation occurs only through a deflation in p^N while under a flexible regime it is shared between a rise in p^T and a fall in p^N. However, precisely because of the further contraction in y^N, the real exchange rate depreciation is milder under a peg because it compensates for the fall in y^T. But when α falls, the consumption of tradables is stabilized under a float thanks to the hedging effect of the peso-denominated debt, which mitigates the required real depreciation and the consecutive adjustment in y^N, as Figure III.2 shows.

As a result, the comparative impact of a negative shock on the nontradable production valued in terms of tradables seems ambiguous. But the following proposition can be established :

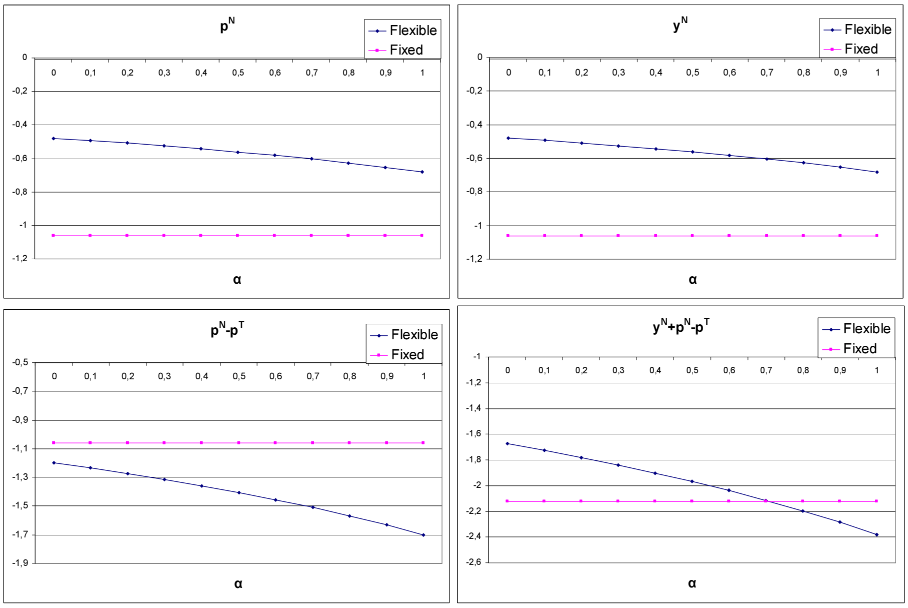
Proposition 2 *(proof in Appendix A) :*

After an identical negative productivity shock in the tradable sector :

- *If $\alpha = 1$, the fall in the nontradable production valued in terms of tradables ($y^N + p^N - p^T$) is higher under a float than under a peg.*
- *When α diminishes, this fall is mitigated under a float.*

Since tradable and nontradable goods are weakly substitutable ($\theta < 1$), prices move more than quantities. As a result, when $\alpha = 1$, the additional fall in the relative price of nontradables under a float offsets the additional fall in nontradable output under a peg. The production of nontradables expressed in tradables therefore falls more under a float than under a peg. When α diminishes, the stabilizing effect of the peso debt on the consumption of tradables makes the response of nontradable production in terms of tradables smoother under a float, because it stabilizes both the production and the real exchange rate, according to Proposition 1. This is illustrated by the behavior of $y^N + p^N - p^T$ in Figure III.2.

FIG. III.2 – The effect of a negative shock in the tradable sector ($u = -1$)



Assumptions : $\theta = 0.6$, $\gamma = 0.4$, $\kappa = 0.6$, $\eta = 0.7$.

3.3 Comparing regimes

The non-stochastic steady-state cash flows Π are the same under both regime. However, uncertainty affects the distribution of Π_t through two main channels : the level of the stochastic steady state $E\Pi_t$, which differs from the non-stochastic steady state because of the presence of risk premia, and the volatility around $E\Pi_t$. These two channels are affected by the nature of the regime. Finally, the proportion of innovating firms $E\rho_t = EF(\Pi_t)$ depends on the distribution of Π_t, so $E\rho_t$ depends on the exchange rate regime. To make the comparison between exchange rate regimes tractable, we focus on small productivity shocks u_t.

Lemma 2 *(proof in Appendix A) :*

If F sufficiently concave around $u = 0$ and $\sigma^2 = 0$, then when u and σ^2 close to 0, $EF(\Pi_t^{flex}) - EF(\Pi_t^{fix})$ is of the same sign as $V(\pi^{fix}) - V(\pi^{flex})$.

Assuming that F is sufficiently concave insures that the effect of σ on the volatility around the steady state has a higher impact on growth than its effect on the stochastic steady state itself. In this case, more volatility around Π implies that in a boom, where Π_t is high, only a few more firms are able to overcome the liquidity shocks, whereas in slumps, where Π_t is low, many more firms are prevented from innovating. It then follows that the regime that results in more volatile cash flows Π_t yields a lower innovating probability. If this is not the case, then there is the possibility that more volatility could stimulate innovation and productivity growth in expansions. The empirical section suggests that this latter effect is dominated. In what follows, it is then admitted that lower volatility yields higher growth.

3.4 The impact of exchange rate regimes on growth

Once we admit that lower cash-flow volatility yields higher growth through a higher innovating probability, it is possible to infer what regime is preferred in terms of growth.

Proposition 3 *(proof in Appendix A) :*

– *If $\alpha = 1$, a peg yields higher growth than a float.*

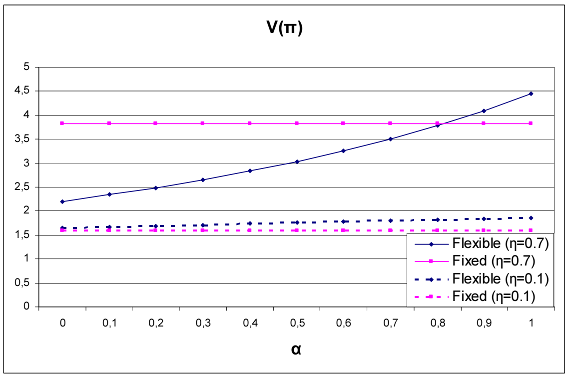
– *When α decreases, the growth differential between a peg and a float decreases.*

– *If $\frac{\kappa(1-\theta)}{\eta[1+\kappa+(1-\kappa)\theta]} < 1$, there exist values of $\alpha > 0$ such that a float yields higher growth than a peg.*

The first point of Proposition 3 is derived directly from Proposition 2. The second and third points come from the fact that the peso-denominated debt has two stabilizing effects on firms' cash flows under a float : 1) a direct stabilizing effect through the hedging role of debt repayments in pesos, 2) an indirect stabilizing effect through the stabilization of the nontradable gross profits expressed in terms of tradables (Proposition 2). Thus, under a flexible exchange rate regime, the level of dollarization has a negative impact on growth because it annihilate the hedging properties of the peso-denominated debt.

If the level of dollarization is high, then a fixed exchange rate regime is always better for growth. Indeed, in that case, the potential gross profit effects dominate the potential debt valuation effects and therefore a peg stabilizes the cash flow better. But if the indebtment level η and the elasticity of substitution θ are high and if the share of nontradable production κ is low, then when the level of dollarization is low, debt valuation effects can be high enough compared to profit effects to make a float more growth-enhancing than a peg for low values of dollarization.

FIG. III.3 – The variance of firms' cash flows



Assumptions : $\theta = 0.6$, $\gamma = 0.4$, $\kappa = 0.6$.

Figure III.3 shows the behavior of the variance of firms' cash flows under fixed and flexible exchange rate regimes for some parameter values. The dashed lines are constructed under the assumption that $\eta = 0.1$ (low level of debt) and the solid lines are drawn under the assumption that $\eta = 0.7$ (high level of debt). Besides, the elasticity of substitution θ has been set at 0.6, which is a standard estimate of the elasticity of substitution between tradable and nontradable goods (Lorenzo *et al.*, 2005), and the weight of tradable goods in the consumption basket γ as well as in cash flows $1 - \kappa$ are set to 0.4 (Mendoza, 2001). It appears clearly that the volatility of cash flows under a float increases with the level of dollarization under both parameters' configuration. Under the first hypothesis (low debt), the volatility of cash flows with the flexible exchange rate regime is always higher than with the fixed regime, whereas under the second hypothesis (high debt), the volatility becomes lower with the flexible exchange rate regime for small values of α.

As a conclusion, the testable empirical implication of this model is that fixed exchange rates are growth-enhancing as compared to flexible exchange rates in countries with high liability dollarization and that the growth differential is decreasing as the level of dollarization falls. Whether there are values of dollarization for which flexible exchange rate regimes become more growth-enhancing than fixed exchange rate regimes depend on parameters values.

4 Empirical Analysis

In this section, the prediction that the level of dollarization conditions the impact of exchange rate regimes on growth is tested. The basic hypothesis is that exchange rate flexibility has a more negative impact in dollarized countries. Some authors have already studied the impact of dollarization on growth : Reinhart *et al.* (2003) compare average growth rates for low and high dollarization economies, with mixed results, and Levy-Yeyati (2006) evaluates the effect of dollarization, showing that growth is sensibly smaller in financially dollarized economies. The effect of dollarization has never been assessed for different levels of exchange rate flexibility.

To do so, standard growth regressions are used (the baseline specification is taken from Levine *et al.* (2000)). Those standard growth regressions are augmented by a measure of exchange rate flexibility (as in Aghion *et al.* (2006a)), a measure of external dollarization and the interaction term of exchange rate flexibility and dollarization. First, the data and methodology are presented and then the results based on a dynamic panel of 77 countries between 1995 and 2004 are discussed.

4.1 Data and methodology

As is common in the growth empirical literature, we work on non-overlapping five-year averages. This transformation aims at filtering business cycles fluctuations and so allows us to focus on long-run effects only.

4.1.1 The dependent variable

The explained variable is the average growth rate of productivity on a five-year period. Productivity is defined as the ratio of real output per worker. Real GDP is in 1995 PPP-adjusted US dollars. The work force and GDP data come respectively from the World Bank (World Development Indicators database) and CEPII (CHELEM database).

4.1.2 The dollarization variable

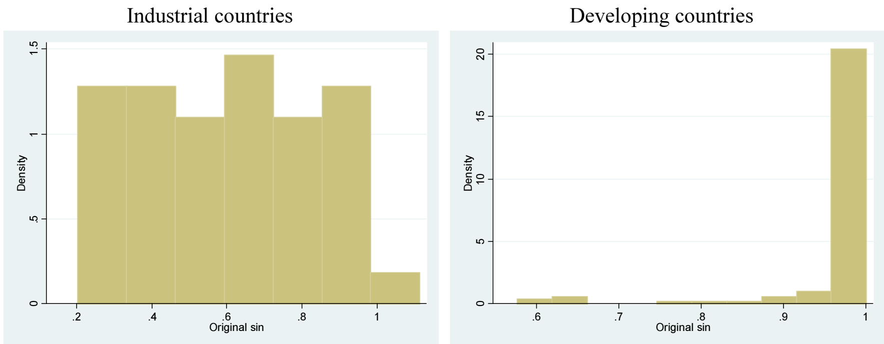
The most important and most problematic variable is the liability dollarization measure. It is difficult to find a measure which is both accurate and encompassing, because the currency breakdown of domestic and external liabilities is often not available.

The data provided by Hausmann *et al.* (2001) and Hausmann and Panizza (2003) are used to construct a proxy for liability dollarization. They provide measures of "original sin", that is the inability of an economy to borrow internationally in its own currency. Their dataset covers 90 industrial and developing countries. They rely on -non public- BIS data of the currency breakdown of foreign banks' assets and liabilities vis-à-vis industrial and developing countries and construct three indicators of original sin.

Those measures are restricted *de facto* to external dollarization and have a small time coverage, but they encompass industrial countries and thus allow a substantial variability in the dollarization index. Their advantage is that they give a good picture of the currency composition of the world's banking sector's assets in the economy, especially for debt securities. The problem is that they ignore domestic dollarization and do not distinguish the public from the private sector. However, first, domestic dollarization is likely to be correlated with external dollarization and second, the dollarization of the public sector has probably a similar impact as that of the private sector, since it prevents the government from subsidizing firms and helping them invest in the bad states. The original sin measures are provided as averages for 1993-1998 and 1999-2001, which allows to use only two 5-year sequences, 1995-1999 and 2000-2004. The dollarization index used in this chapter is computed as the average of the three indicators. It ranges from 0 to 1.

Figure III.4 presents the distribution of original sin in industrial and developing countries. It appears that it is concentrated on its maximum value in developing countries, while in industrial countries it is lower on average and shows more variability. Besides, it is noteworthy that the original sin index varies only in 20% of the countries between 1993-1998 and 1999-2001. Those characteristics of the dollarization variable, that is high persistence and concentration on high values in developing countries, have to be born in mind when choosing the methodology and running the robustness checks.

FIG. III.4 – Distribution of original sin in industrial and developing countries



Source : Hausmann *et al.* (2001).

4.1.3 Exchange rate flexibility variables

Two alternative measures of exchange rate flexibility are considered. The first measure is the volatility of the index of real effective exchange rate provided by the World Bank. Volatility is measured as the standard deviation of annual changes in the logarithm of the index, calculated over five years.

The second measure is an index of exchange rate flexibility based on the Levy-Yeyati and Sturzenegger (2002) (henceforth LS) classification of exchange rate regimes. They define exchange rate regimes according to the behavior of three classification variables : changes in the nominal exchange rate, the volatility of these changes, and the volatility of international reserves. Since originally this index is a measure of rigidity, exchange rate regimes are reordered from the more rigid to the more flexible : $\{1, 2, 3, 4\} = \{\text{fix, crawling peg, dirty float, float}\}$. This index is averaged over five years.

While the first is a measure of *de facto* exchange rate volatility, the second is more a measure of exchange rate management. According to the prediction of the model, they are positively correlated (see Appendix C) : a more flexible exchange rate regime results in a higher real exchange rate volatility.

4.1.4 Other variables

The set of control variables follows Levine *et al.* (2000) and Aghion *et al.* (2006a) : financial development measured as in Beck *et al.* (1999) by the amount of credit provided by banks and other financial institutions to the private sector (as a share of GDP), education measured as the average years of secondary schooling (Barro and Lee, 2000), inflation and the size of government measured by governement consumption as a percentage of GDP and trade openness measured by the share of exports and imports in GDP (World Bank). Finally, the usable dataset covers 77 countries and two periods : 1995-1999 and 2000-2004. When real exchange rate volatility is used, this sample reduces to 51 countries, among which 12 have only one observations, and when the LS flexibility index is used, it reduces to 75 countries, among which 17 have only one observation. Appendix B gives the exhaustive list of countries present in both samples and Appendix C provides some descriptive statistics.

4.1.5 Methodology

The benchmark specification follows Levine *et al.* (2000) and Aghion *et al.* (2006a). But, instead of interacting exchange rate flexibility and financial development as Aghion *et al.* (2006a) do, I interact exchange rate flexibility and dollarization. The estimated equation is the following :

$$\Delta y_t^i = y_t^i - y_{t-1}^i = (\alpha - 1)y_{t-1}^i + \gamma_1 Flex_t^i + \gamma_2 OSIN_t^i + \gamma_3 Flex_t^i * OSIN_t^i + \beta' Z_t^i + d_t + \epsilon_t^i \tag{III.23}$$

where y_t^i is the logarithm of real output per worker in country i at the end of period t, $t = 1995 - 1999, 2000 - 2004$, $Flex_t^i$ is the exchange rate flexibility measure, $OSIN_t^i$ is the measure of original sin, Z_t^i is the set of control variables, d_t is a time effect and ϵ_t^i is the error term.

$\gamma_1 + \gamma_3 OSIN_t^i$ describes the overall effect of exchange rate flexibility on growth. γ_1 (the linear term) and $\gamma_1 + \gamma_3$ (which is provided as complementary information) can be interpreted respectively as the effect of exchange rate flexibility in low dollarization countries (original sin=0) and in high dollarization countries (original sin=1). The threshold original sin for which the sign of the overall impact of exchange rate flexibility changes is $\frac{-\gamma_1}{\gamma_3}$. The estimate for $\frac{-\gamma_1}{\gamma_3}$ is provided along with its significance test as complementary information in the regressions. Besides, a Wald test for the significance of exchange rate total effect is run.

The main hypothesis to test is whether exchange rate volatility has a more negative effect on growth when the level of dollarization increases. This would be validated by the data if γ_3 is found significantly negative. Otherwise, the model would be rejected. The second hypothesis is that the threshold original sin $\frac{-\gamma_1}{\gamma_3}$ is between 0 and 1. This would mean that the impact of exchange rate risk on growth switches from positive to negative within the actual range of the original sin measure. The validation of this hypothesis would shed some light on the exchange rate instability puzzle, which could then be explained by the presence of this kind of non-linearities.

First OLS are run with time effects to estimate this model. However, since it is a dynamic model, country effects are necessarily correlated with y^i_{t-1}. The GMM dynamic panel data estimator developed by Arellano and Bond (1991) and Arellano and Bover (1995) is implemented. The persistence of the dollarization data justifies the use of the extended system-GMM estimator elaborated by Blundell and Bond (1998) and Blundell and Bond (2000). Robust two-step standard errors are also computed by following the method of Windmeijer (2004). Using this approach, the issue of the endogeneity of the lagged explained variable is addressed, with different assumptions about the status of the other explanatory variables : strict exogeneity, predetermination and endogeneity. Original sin can only be considered as predetermined because higher lags are not available. Robustness checks are then considered by adding other controls.

4.2 The role of financial dollarization

4.2.1 OLS

Table III.1 shows the results of the OLS regression of productivity growth on the set of explanatory variables described earlier, using equation (III.23).

Consider the impact of exchange rate flexibility and original sin on growth. The literature has underscored several times the absence of *linear* long-run effects of exchange rate flexibility on productivity growth. Regressions (1) and (4) confirm this fact again : the impact of exchange rate flexibility on growth is not significant, whether it is measured by the standard deviation of the real exchange rate (column (1)) or by the LS measure of exchange rate flexibility (column (4)). When the sample is restrained to data points for which the original sin measure is available (columns (2) and (5)), this effect becomes significantly negative. This is because the size of the sample has diminished and it does not challenge the results of previous literature. It confirms that the impact of exchange rate flexibility is sample-sensitive.

Importantly, as column (3) shows, liability dollarization makes the impact of real exchange rate volatility on growth more negative, as conjectured. This is illustrated

TAB. III.1 – Growth effects of the flexibility of Exchange Rate Regime - OLS with robust standard errors and time effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Initial prod. per worker	-0.013**	-0.010	-0.006	-0.004	-0.011**	-0.008	-0.005
	(2.17)	(1.37)	(0.81)	(1.11)	(2.04)	(1.40)	(0.74)
Fin. dev.	0.002	-0.001	-0.001	0.001	-0.002	-0.001	0.001
	(0.35)	(0.34)	(0.31)	(0.28)	(0.44)	(0.23)	(0.28)
O. sin			0.034**			0.043**	0.018*
			(2.15)			(2.41)	(1.83)
REER vol.	-0.077	-0.211***	0.203				
	(1.53)	(3.17)	(1.15)				
REER vol.*O. sin			**-0.461****				
			(2.02)				
LS index of ER flex.				-0.002	-0.005***	0.007**	
				(1.37)	(2.73)	(2.22)	
LS Flex.*O. sin						**-0.014*****	
						(2.84)	
REER Depreciation							-0.006
							(0.03)
REER Dep.*O. sin							**-0.444***
							(1.72)
Control variables							
Education	0.021**	0.032***	0.030***	0.009	0.031***	0.027***	0.018*
	(2.40)	(3.26)	(3.10)	(1.54)	(3.66)	(3.36)	(1.72)
Trade openness	0.006	0.003	0.003	0.005*	0.004	0.005	0.002
	(1.40)	(0.72)	(0.62)	(1.66)	(1.12)	(1.16)	(0.56)
Inflation	-0.033	-0.049*	-0.039	-0.016**	-0.071***	-0.067***	-0.126***
	(1.63)	(1.91)	(1.59)	(1.98)	(3.02)	(2.89)	(4.63)
Government burden	-0.001	-0.023***	-0.024***	-0.003	-0.009	-0.008	-0.017***
	(0.23)	(3.67)	(3.75)	(0.59)	(1.40)	(1.31)	(2.78)
Intercept	0.052	0.049	-0.011	0.020	0.017	-0.040	0.022
	(1.17)	(0.89)	(0.17)	(0.60)	(0.37)	(0.90)	(0.46)
Wald test (F-statistic) :							
H_0 : ER flex./dep.							
total effect = 0			5.67***			4.56**	4.48***
Threshold O. sin			0.44			0.50	-0.01
H_0 : Thres. = 0 (F-stat.)			5.70**			28.38***	0.00
H_0 : Thres. = 1 (F-stat.)			61.00***			250.68***	4.42**
Observations	177	90	90	261	129	129	89
R-squared	0.249	0.420	0.437	0.131	0.282	0.308	0.500

Robust t statistics in parentheses
* significant at 10% ; ** significant at 5% ; *** significant at 1%.

by the fact that the coefficient of the interaction term of original sin and real exchange rate volatility is significantly negative (at the 5% level). Similarly, the results of column (6) suggest that a higher level of dollarization makes exchange rate flexibility significantly more costly in terms of growth (at the 1% level) when it is measured by the LS index.

As conjectured, the threshold level is between 0 and 1 : respectively 0.44 when using real exchange rate volatility and 0.50 when using the LS flexibility index. As a consequence, on the one hand, the impact of exchange rate flexibility is significantly negative in both specifications when original sin is equal to 1. On the other hand, exchange rate flexibility has a positive impact on growth in low dollarization countries (the coefficient of the linear term is positive), but this impact is not significant when using real exchange rate volatility. In both specifications, the total effect of exchange rate flexibility is significant.

Column (7) gives a clue about how the impact of exchange rate volatility on growth is channeled. It includes the mean real exchange rate depreciation rate and its interaction with original sin. It shows that a real exchange rate depreciation has a negative impact on growth, and that this negative impact is magnified by the level of dollarization (the interaction term is negative and significant at the 10% level). This confirms the prediction of the model that a real depreciation hampers growth by disrupting firms' balance sheets when their level of dollarization is high. This also suggests that the negative effect of exchange rate volatility on growth comes mainly from the depreciation episodes. Note also that a real exchange rate depreciation is never growth enhancing (the threshold level is not significantly different from zero).

4.2.2 GMM

In order to avoid the shortcomings of OLS, the GMM methodology is implemented.

Table III.2 reports the results of the GMM regressions. These results are drawn under the following assumption : all the explanatory variables except initial income are predetermined and they are uncorrelated with fixed effects. This assumption about the explanatory variables has been chosen after excluding more restrictive ones which suffered from weak instruments issues according to the Anderson and

Tab. III.2 – Growth effects of the flexibility of Exchange Rate Regime - 2-step system-GMM estimation with Windmeijer (2004) small sample robust correction and time effects

	(1)	(2)	(3)
Initial prod. per worker	0.002	0.003	-0.013
	(0.24)	(0.35)	(1.32)
Fin. dev.	-0.004	-0.004	0.002
	(0.81)	(0.57)	(0.63)
O. sin	0.037**	0.041*	0.008
	(2.08)	(1.93)	(0.53)
REER vol.	0.223		0.008
	(1.18)		(0.53)
REER vol.*O. sin	**-0.429***		
	(1.90)		
LS index of ER flex.		0.006*	
		(1.87)	
LS Flex.*O. sin		**-0.011****	
		(2.19)	
REER Depreciation			0.103
			(0.64)
REER Dep.*O. sin			**-0.546****
			(2.64)
Control variables			
Education	0.023**	0.018	0.026**
	(2.17)	(1.22)	(2.16)
Trade openness	0.003	0.008	0.005
	(0.66)	(1.38)	(1.11)
Inflation	-0.049	-0.066**	-0.128***
	(1.55)	(2.18)	(5.41)
Government burden	-0.021***	-0.012*	-0.018***
	(2.96)	(1.68)	(2.87)
Intercept	-0.081	-0.119*	0.060
	(1.10)	(1.84)	(0.83)
Wald test (F-statistic) :			
H_0 : ER flex./dep. total effect = 0	6.21***	2.45*	8.60***
Threshold O. sin	0.52	0.55	0.19
H_0 : Thres. = 0 (F-stat.)	7.92***	21.47***	0.63
H_0 : Thres. = 1 (F-stat.)	67.80***	164.50***	11.59***
Hansen overidentification test			
H_0 Valid instruments (Prob > chi2)	0.520	0.327	0.315
Anderson underidentification test			
H_0 Underidentification (Prob > chi2)	0.0000	0.0000	0.0000
Cragg-Donald underidentification test			
H_0 Underidentification (Prob > chi2)	0.0000	0.0000	0.0000
Observations	90	129	89
Number of countries	51	75	50

Robust t statistics in parentheses
* significant at 10% ; ** significant at 5% ; *** significant at 1%

Cragg-Donald tests of underidentification.[6] These tests assess whether the equation is identified and whether the instruments give sufficient information to identify the effect of the variables of interest. As shown in Table III.2, these tests reject underidentification in all columns. Therefore, this set of instruments does not show weak instruments problems. According to the Hansen test, it can also be considered as globally valid, despite the use of a large number of instruments. Moreover, difference-in-Sargan tests can help evaluate the exogeneity of subsets of instruments. After running some of those tests, it appears that neither the predetermination of regressors nor the absence of correlation between the latter and fixed effects can be rejected at the 10% level.

The results of columns (1) and (2) of Table III.2 are again in line with the main model's prediction, which is that the impact of exchange rate flexibility on growth is more negative when the level of dollarization is higher, according to the coefficients of the interaction terms. Both regressions provide the same - significant - threshold original sin (respectively 0.52 and 0.55). The second conjecture is again satisfied since it is in the right range. As a result, consider the two extreme cases : when original sin is maximal, exchange rate rigidity is significantly better for growth while exchange rate flexibility is preferred when original sin is minimal, but not necessarily in a significant fashion (the coefficient of the linear term of exchange rate flexibility is not significant when using real exchange rate volatility (column (1)). Column (3) confirms the negative impact of a real depreciation, especially in highly dollarized countries. The effect is even stronger in absolute value and in term of significance than with the OLS methodology.

To illustrate the magnitude of these effects, consider South Africa : between the end of the nineties and the beginning of the 2000s, its index of original sin moved from 0.78 to 0.58. Considering its real exchange rate volatility (0.16) and its LS index (4) during 200-2004, its growth gain is respectively 1.3 or 0.9 percentage point

[6] This assumption has also been chosen for practical reasons. Because of data scarcity, it is impossible to use second order lags of original sin. It can be therefore considered at best as predetermined. But, as highlighted by Aghion *et al.* (2006a), the interaction term is less vulnerable to potential endogeneity issues than the corresponding linear terms.

per year, depending on the specification. Similarly, an entirely dollarized emerging country (original sin index equal to 1) with a rather high exchange rate flexibility like Colombia during 2000-2004 (real exchange rate volatility equal to 0.10 and flexibility index equal to 4) would gain 1.8 percentage point of annual growth according to both models.

Up to this stage, the hypothesis of the existence of a nonlinear effect of exchange rate volatility on growth is not rejected by the data when using the OLS methodology and some reasonable GMM specifications. More specifically, exchange rate rigidity is found to be growth-enhancing in high dollarization countries. The fact that exchange rate flexibility promotes growth in low dollarization countries is also suggested by the data but is less robust. The remainder of the section explores further robustness issues. The next regressions will also be run using the GMM methodology and under the assumption of predetermined regressors and absence of correlation with fixed effects.

4.3 Robustness checks

Table III.3 reports the results of the same regressions as before, using the two-stage system-GMM and Windmeijer (2004) small sample robust standard errors, but with additional variables to control for potential simultaneity. Columns (1) and (5) incorporate the average of Kaufmann *et al.* (1999) Governance indicators, which is taken as a proxy for institutional quality. Columns (2) and (6) include the logarithm of net external debt over GDP and column (3) and (7) present the results with both additional controls.

One surprising outcome is that the coefficient of financial development is significantly negative in columns (2) and (3), that is when real exchange rate volatility is used as a measure of flexibility and net debt is introduced, which is not in line with Levine *et al.* (2000) and Aghion *et al.* (2006a). This might be explained by the fact that the dataset used here is smaller and more subject to

TAB. III.3 – Growth effects of the volatility of Exchange Rate Regime with additional controls - 2-step system-GMM estimation with Windmeijer (2004) small sample robust correction and time effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Initial prod. per worker	-0.007	0.005	-0.004	-0.006	-0.020	0.002	-0.016
	(0.54)	(0.59)	(0.75)	(0.73)	(1.18)	(0.21)	(1.53)
Fin. dev.	-0.004	-0.008**	-0.009***		-0.005	-0.006	-0.006
	(0.79)	(2.46)	(3.18)		(0.66)	(1.07)	(1.29)
O. sin	0.031	0.032**	0.024*	0.020	0.037*	0.031	0.026
	(1.50)	(2.14)	(1.78)	(1.58)	(1.68)	(1.60)	(1.48)
REER vol.	0.195	0.344**	0.329**	0.187			
	(0.93)	(2.31)	(2.21)	(1.63)			
REER vol.*O. sin	**-0.433***	**-0.592*****	**-0.566****	**-0.361****			
	(1.71)	**(3.06)**	**(2.62)**	**(2.46)**			
LS index of ER flex.					0.005	0.007**	0.005*
					(1.45)	(2.53)	(1.78)
LS flex.*O. sin					**-0.010****	**-0.011****	**-0.008**
					(2.28)	**(2.38)**	**(1.61)**
Control variables							
Education	0.023**	0.021*	0.019***	0.018**	0.028**	0.021	0.029***
	(2.28)	(1.83)	(2.74)	(2.51)	(2.53)	(1.63)	(3.65)
Trade openness	0.004	0.009*	0.008*	0.008**	0.004	0.012**	0.010*
	(0.81)	(1.96)	(1.88)	(2.02)	(0.84)	(2.15)	(1.92)
Inflation	-0.040	-0.042*	-0.043	-0.027	-0.064***	-0.068***	-0.058***
	(1.33)	(1.70)	(1.43)	(1.39)	(2.81)	(3.13)	(2.78)
Government burden	-0.019**	-0.023***	-0.019**	-0.019***	-0.011	-0.012*	-0.011
	(2.26)	(2.71)	(2.53)	(3.17)	(1.49)	(1.74)	(1.59)
Additional control variables							
Governance index	0.001		0.001	0.001	0.003		0.002
	(0.92)		(1.31)	(0.60)	(1.21)		(1.47)
Net external debt		-0.002	-0.004	-0.005		-0.002	-0.005*
		(0.56)	(1.13)	(1.35)		(0.72)	(1.68)
Intercept	-0.002	-0.115*	-0.029	0.007	0.071	-0.136**	0.008
	(0.02)	(1.70)	(0.59)	(0.10)	(0.42)	(2.54)	(0.08)
Hansen test (Prob > chi2)	0.373	0.810	0.908	0.541	0.173	0.571	0.344
Observations	90	77	77	84	129	113	113
Number of countries	51	44	44	46	75	66	66

Robust t statistics in parentheses
* significant at 10% ; ** significant at 5% ; *** significant at 1%

colinearity problems. Indeed, the correlation matrix provided in Appendix C shows a high negative correlation between financial development and original sin on the one hand and financial development and external debt on the other. To show whether this colinearity problem drives the main results, the financial development variable is removed in column (4).

As for the effect of original sin and the real exchange rate volatility, consider the first four columns : the inclusion of additional controls does not change the results. The additional controls themselves do not appear significant. The impact of the interaction term is negative, even when financial development is removed (column (4)). When the LS index of exchange rate flexibility is used (last three columns), the results are less robust, especially when both the institutional variable and net external debt are included : in column (7), the coefficient of the interaction term is not significant at the conventional levels, though it still has a negative sign. Nevertheless, it is worth noticing that its level of significance is 11%, which is close to the conventional ones. The Kaufmann governance index has a positive but often non significant impact, and net external debt has a negative, non-significant impact on growth, which may be explained by the growth costs of debt defaults.

In the theoretical model, the firms' vulnerability is caused mainly by the volatility of the price of nontradables in terms of tradables. However, the view that the volatility of the real exchange rate is mainly driven by the volatility of the price of nontradables is controversial. On the one hand, Engel (1999) shows that the variability of the relative price of tradable goods accounts for most of the real exchange rate volatility in the United States. On the other hand, Mendoza (2000) provides evidence that the variance decomposition of real exchange rate variations between variations in the relative price of tradable goods and variations in the price of nontradables in terms of tradables is unstable across countries and across periods, and depends on the exchange rate regime. Table III.4 introduces terms of trade volatility and its interaction with original sin to control for the volatility of the relative price of tradable goods. The interaction of the exchange rate flexibility measure and original sin remains significantly negative at the 10% level when using the real exchange rate volatility (columns (1) to (3)). In column (1) and (2), the financial development variable appears with a negative sign, so it is excluded in

TAB. III.4 – Growth effects of the volatility of Exchange Rate Regime, controlling for terms of trade volatility - 2-step system-GMM estimation with Windmeijer (2004) small sample robust correction and time effects

	(1)	(2)	(3)	(4)	(5)
Initial prod. per worker	0.003	0.004	-0.000	-0.017	-0.018
	(0.55)	(0.73)	(0.03)	(1.35)	(1.41)
Fin. dev.	-0.009**	-0.010***		-0.007*	-0.006
	(2.65)	(2.96)		(1.75)	(1.33)
O. sin	0.035**	0.028	0.034***	0.004	0.006
	(2.12)	(1.50)	(2.89)	(0.15)	(0.28)
REER vol.	0.284	0.258	0.249		
	(1.43)	(1.24)	(1.59)		
REER vol.*O. sin	**-0.573***	**-0.514***	**-0.543****		
	(1.99)	**(1.79)**	**(2.56)**		
LS index of exchange rate flexibility				0.004	0.004
				(0.99)	(1.18)
LS flex.*O. sin				**-0.008**	**-0.008***
				(1.30)	**(1.74)**
Terms of trade vol.	0.004	0.000	-0.001	-0.004	-0.003
	(1.22)	(0.03)	(0.08)	(0.52)	(0.18)
Terms of trade vol.*O. sin		0.004	0.005		0.000
		(0.30)	(0.46)		(0.01)
Control variables					
Education	0.024**	0.023*	0.024**	0.018	0.018
	(2.43)	(1.86)	(2.04)	(1.43)	(1.38)
Trade openness	0.005	0.005	0.006	0.007	0.007
	(0.84)	(0.74)	(1.53)	(0.99)	(0.99)
Inflation	-0.048	-0.044	-0.028	-0.064**	-0.066**
	(1.54)	(1.42)	(0.74)	(2.37)	(2.17)
Government burden	-0.023***	-0.028***	-0.026***	-0.011	-0.012
	(3.40)	(3.30)	(4.37)	(1.37)	(1.64)
Constant	-0.067	-0.049	-0.053	-0.140*	-0.150*
	(0.79)	(0.50)	(1.02)	(1.83)	(1.85)
Hansen test (Prob > chi2)	0.600	0.670	0.553	0.546	0.558
Observations	68	68	74	87	87
Number of countries	43	43	44	60	60

Robust t statistics in parentheses
* significant at 10% ; ** significant at 5% ; *** significant at 1%

column (3). Despite this, The interaction term is still significantly negative. When using the LS flexibility measure, and when only the linear terms-of-trade volatility term is introduced, the interaction term has a negative impact on growth, but not in a significant fashion (column (4)). However, when introducing the interaction of terms-of-trade volatility term with original sin, it becomes significant (column (5)).

TAB. III.5 – Growth effects of the flexibility of Exchange Rate Regime, excluding currency crisis episodes - 2-step system-GMM estimation with Windmeijer (2004) small sample robust correction and time effects

	(1)	(2)
Initial prod. per worker	-0.001	-0.006
	(0.06)	(0.70)
Fin. dev.	-0.006	-0.008
	(0.71)	(1.49)
O. sin	0.020	0.024
	(1.27)	(1.47)
REER vol.	0.162	
	(0.97)	
REER vol.*O. sin	**-0.339***	
	(1.74)	
LS index of ER flex.		0.006**
		(2.21)
LS flex.*O. sin		**-0.010****
		(2.17)
Control variables		
Education	0.022*	0.032***
	(1.86)	(2.90)
Trade openness	0.006	0.010**
	(1.39)	(2.15)
Inflation	-0.061**	-0.072**
	(2.30)	(2.54)
Government burden	-0.018**	-0.011*
	(2.25)	(1.78)
Constant	-0.055	-0.092
	(0.49)	(1.52)
Hansen test (Prob > chi2)	0.467	0.437
Observations	84	124
Number of countries	49	73

Robust t statistics in parentheses
* significant at 10% ; ** significant at 5% ; *** significant at 1%

Table III.5 presents further robustness checks. The question tackled here is the role of currency crises. Currency crisis episodes are eliminated from the sample to check whether the negative growth effect of the interaction between original sin and exchange rate volatility is limited to episodes of financial turmoil. A currency crisis episode is defined by the two following conditions :

– There is a substantial depreciation : the nominal exchange rate change within one year is greater than 25% and exceeds by at least 10% the exchange rate change of the previous year, which is the definition of a currency crisis suggested by Frankel and Rose (1996).

– The depreciation follows a peg. The periods of pegged exchange rate are determined by referring to the classification of LS. Besides, the year of the depreciation must not be classified by LS as a peg.

The currency crisis episodes are defined so as to detect temporary and substantial disruptions of pegs that result in exchange rate volatility and thus could be misleadingly taken as the outcome of a flexible exchange rate regime. It is essential to remove them to confirm the relative benefit of fixed exchange rate regimes. Again, the control variables have the expected signs or, at worst, are not significant. As for the variables of interest, the results remain robust : when considering real exchange rate standard deviations, the interaction term is significant at the 10% level, and when considering the LS index of exchange rate flexibility, it is significant at the 5% level. This shows that the particularly negative impact of flexible exchange rate regimes in dollarized countries highlighted before is not due to financial turmoil episodes.

Table III.6 tries to answer a legitimate question : are the results due to the fact that original sin is very high in developing countries and low in industrial economies in general ? Then the results could reflect only the fact that exchange rate flexibility is bad for growth in emerging economies as other authors have already shown, without proving necessarily the role of dollarization. This objection is justified by the observation that original sin is very correlated with the fact of being a developing or industrial country (see Figure III.4 and the correlation between initial productivity and original sin in Appendix C). A dummy for industrial countries and its interaction with exchange rate flexibility measures are thus added. The results are robust : when using the standard deviation of the real exchange rate (columns (1) and (2)), the coefficient of the interaction term remains negative at the 10% level even when the

TAB. III.6 – Growth effects of the flexibility of Exchange Rate Regime, industrial versus developing countries - 2-step system-GMM estimation with Windmeijer (2004) small sample robust correction and time effects

	(1)	(2)	(4)	(5)
Initial prod. per worker	0.000	-0.003	0.006	0.007
	(0.04)	(0.23)	(0.52)	(0.58)
Fin. dev.	-0.004	-0.005	-0.005	-0.004
	(0.91)	(0.97)	(0.64)	(0.56)
O. sin	0.036**	0.056	0.036*	0.042
	(2.17)	(1.53)	(1.74)	(1.36)
REER vol.	0.225	0.597		
	(1.21)	(1.39)		
REER vol.*O. sin	**-0.435***	**-0.801***		
	(1.89)	**(1.71)**		
LS index of exchange rate flexibility			0.006	0.009
			(1.66)	(1.09)
LS flex.*O. sin			**-0.011****	**-0.014***
			(2.02)	**(1.76)**
Industrial country	0.002	0.028	-0.008	-0.003
	(0.20)	(1.36)	(0.59)	(0.13)
ER vol.*Industrial country		-0.314		
		(1.12)		
ER flex.*Industrial country				-0.002
				(0.47)
Control variables				
Education	0.024**	0.023*	0.018	0.018
	(2.43)	(1.86)	(1.43)	(1.38)
Trade openness	0.005	0.005	0.007	0.007
	(0.84)	(0.74)	(0.99)	(0.99)
Inflation	-0.048	-0.044	-0.064**	-0.066**
	(1.54)	(1.42)	(2.37)	(2.17)
Government burden	-0.023***	-0.028***	-0.011	-0.012
	(3.40)	(3.30)	(1.37)	(1.64)
Constant	-0.067	-0.049	-0.140*	-0.150*
	(0.79)	(0.50)	(1.83)	(1.85)
Hansen test (Prob > chi2)	0.550	0.608	0.284	0.212
Observations	90	90	129	129
Number of countries	51	51	75	75

Robust t statistics in parentheses
* significant at 10% ; ** significant at 5% ; *** significant at 1%

interaction of the industrial country dummy and volatility is added. When using the LS index of exchange rate flexibility (columns (3) and (4)), the significance of the interaction term remains significant at the 5% or 10% level. The significance of the interaction term certainly declines with both measures, but remains at reasonable levels considering the sample size and the high correlation between the industrial country dummy and original sin.

As a conclusion, the nonlinear effect of exchange rate flexibility and original sin on growth is globally robust to the inclusion of institutional quality, indebtment measures, and terms-of-trade volatility : exchange rate volatility has a more negative impact on productivity growth in dollarized than in non-dollarized countries. Besides, this additional negative effect is not due to exchange rate crisis episodes. Finally, the correlation between the industrial country dummy and original sin is not enough to explain the significance of the interaction term : there is still enough volatility in the original sin index to identify a significant nonlinear effect. The threshold original sin is still significantly between 0 and 1.

5 Conclusion

As Aghion *et al.* (2006a), this chapter challenges the conventional view that there is no significant difference in the growth performances of fixed and flexible exchange rate regimes. This view has been misleadingly vehicled by the empirical literature because usually the specificity of emerging markets financial systems is not taken into account. But, whereas Aghion *et al.* (2006a) highlight the role of financial development, this chapter focuses on original sin, which is another prominent feature of the developing world. A theoretical model is developed, in which the higher the share of foreign currency in external debt, the more exchange rate volatility is detrimental to growth, which is in line with the empirical results of section 4 : the interaction of exchange rate flexibility with original sin has a negative impact. It also appears that exchange rate flexibility is growth-reducing in highly dollarized countries and growth-enhancing in low dollarization countries (but this last effect is not always significant). Consistently, the threshold original sin above which exchange rate risk becomes detrimental to growth is estimated to be significantly between 0 and 1. This sheds some light on the instability of the effect of exchange rate volatility on growth in previous literature.

It is also shown that these predictions are robust to the inclusion of institutional quality, net external debt and terms-of-trade volatility, and are not the mere reflect of the heterogeneity between developing and industrial countries. Besides, they are robust to the elimination of exchange rate crisis episodes. However, further robustness checks were prevented by the lack of data : the GMM methodology could not be used to tackle the possible contemporaneous endogeneity of original sin since only two five-year averages were available. It was not possible either to study the three-way interaction of exchange rate flexibility, liability dollarization and financial development, because of the lack of data. An extension of this work would therefore have to rely on broader datasets, either by extending the time coverage or by using firm or industry-level information.

The study of the impact of exchange rate flexibility on growth can help address the issue of the choice of monetary framework in a setting of financial openness and growing cross-country capital flows. The available choices are delimited by the "trilemma" (Obstfeld *et al.*, 2005) : under capital mobility, policymakers cannot attain simultaneously exchange rate stability and domestically-oriented monetary policy. Typically, adopting an exchange rate peg entails the sacrifice of the shock absorption capacity of exchange rate flexibility when nominal prices and wages are sticky. This is indeed the case in this chapter's framework. However, liability dollarization makes it more difficult for the emerging countries that embrace financial globalization to adopt floating exchange rates (Obstfeld, 2008; Obstfeld *et al.*, 2008) and explains why they exhibit "fear of floating" (Calvo and Reinhart, 2002). This study sheds some additional light on the reasons why developing economies find it hard to find a comfortable resolution of the trilemma.

6 Appendix

Appendix A : Proofs

Derivation of the non-stochastic steady-state equilibrium

The non-stochastic steady-state equilibrium (for $u = 0$) is derived as follows. Take the labor demand (III.5) and the supply of nontradable goods (III.3) and derive the expression for Y^N :

$$Y^N = \frac{P^N}{2W} \tag{III.24}$$

We have also :

$$Y^T = 1 \tag{III.25}$$

Use then the relative demand for tradable and nontradable goods (III.9), where the consumptions for tradables and nontradables are replaced using the equilibrium equations in the tradable and nontradable markets (III.16) and (III.17) and where Y^N and Y^T are replaced using (III.24) and (III.25), to derive :

$$\left(\frac{P^N}{W}\right)^{1+\frac{1}{\theta}} = \frac{P^T}{W}\left(\frac{1-\gamma}{\gamma}2\left(1-(1+r^*)d\right)\right)^{\frac{1}{\theta}} \tag{III.26}$$

For (III.26) to be well-defined, we must assume that $1-(1+r^*)d > 0$.

P^N/W is implicitely defined by (III.26) as an increasing function of P^T/W.

The non-stochastic wage setting equation, derived from (III.12), gives :

$$W = \frac{\rho}{\rho-1}v'(L)PC \tag{III.27}$$

Using the labor demand (III.5), the supply of nontradables and tradables (III.24) and (III.2), the consumption basket (III.7), and the price index (III.11), (III.27) yields :

$$\frac{1}{[\gamma(P^T/W)^{1-\theta}/+(1-\gamma)(P^N/W)^{1-\theta}]^{\frac{1}{1-\theta}}}$$

$$= \frac{\rho}{\rho - 1} v' \left(\left[\frac{P^N}{2W} \right]^2 \right) \left[\gamma^{\frac{1}{\theta}} (1 - (1 + r^*) d)^{\frac{\theta - 1}{\theta}} + (1 - \gamma)^{\frac{1}{\theta}} \left(\frac{P^N}{2W} \right)^{\frac{\theta - 1}{\theta}} \right]^{\frac{\theta}{\theta - 1}} \quad \text{(III.28)}$$

(III.28) defines an implicit decreasing relation between P^N/W and P^T/W. We show below that (III.26) and (III.28) admit a unique solution for P^N/W and P^T/W which do not depend on the exchange rate regime.

Using one of the two monetary rules (III.13) or (III.14), along with the price index (III.11), one can derive W, P^T, P^N and P.

Once P^T, P^N and W are determined, we can infer Y^N using (III.24). Then, C^N can be determined using (III.16) and C^T using (III.17). Finally, C can be derived from (III.7). So there is a unique solution for $\left\{ Y^N, Y^T, C^N, C^T, C, L, P^N, P^T, P, W \right\}$. Notice that since P^N/W does not depend on the exchange rate regime, neither does Y^N. As a consequence, with no uncertainty, the allocations and relative prices are the same under both regimes.

Π can then be derived from (III.6). Finally, the amount of nominal monetary balances required to satisfy the policy objective is derived from C, P and the demand for money (III.10). T must then satisfy the steady-state version of the government budget constraint (III.15) $gM/(1+g) = PT$, with $A_{t+1} = (1+g)A_t$ and g the steady-state growth rate.

Existence and unicity of the steady-state equilibrium

P^N/W is implicitely defined by (III.26) as a function of P^T/W. Denote by $P_1^N(.)$ this function.

The LHS of (III.28) is decreasing in $\frac{P^N}{W}$ and $\frac{P^T}{W}$ while the RHS is increasing in $\frac{P^N}{W}$. (III.28) defines another implicit relation between P^N/W and P^T/W. Denote this implicit function of P^T/W as $P_2^N(.)$. P_2^N is strictly decreasing in P^T/W with $P_2^N(0) > 0$ and $(P_2^N)^{-1}(0) > 0$. Since $P_1^N(.)$ is continuous and strictly increasing, with $\lim P_1^N(P^T)_{P^T \to 0} = 0$ and $\lim P_1^N(P^T)_{P^T \to \infty} = \infty$, there exists only one positive intersection of P_1^N and P_2^N. This intersection defines P^N/W and P^T/W. P^N/W and P^T/W do not depend on the exchange rate regime.

Under a fixed exchange rate regime, P^T is fixed. We can then infer $W = P^T \frac{1}{P^T/W}$ and then $P^N = W\frac{P^N}{W}$. P is then derived from the price index (III.11).

Under a flexible exchange rate regime, P/W can be derived using the price index (III.11). Since P is fixed, we can derive $W = P\frac{1}{P/W}$, and from it $P^T = W\frac{P^T}{W}$ and $P^N = W\frac{P^N}{W}$.

Proof of Proposition 1

– From Lemma 1, if $u < 0$:
  $y^{Nflex} > y^{Nfix} \Leftrightarrow \gamma(\theta+1) < \theta+\gamma+(1-\gamma)\eta(1-\alpha) \Leftrightarrow (1-\gamma)[\theta+\eta(1-\alpha)] > 0$: always true.
  $p^{Nflex} - p^{Tflex} < p^{Nfix} - p^{Tfix} \Leftrightarrow \theta+1 > \theta+\gamma+(1-\gamma)\eta(1-\alpha) \Leftrightarrow \alpha > 1-\frac{1}{\eta}$, true for $\alpha = 1$.
– From Lemma 1, y^{Nflex} and $p^{Nflex} - p^{Tflex}$ are both decreasing in $(1-\alpha)$.

Proof of Proposition 2

– From Lemma 1, we derive :

$$y^{Nflex}+p^{Nflex}-p^{Tflex} = \frac{\kappa(1+\gamma)(\eta+1)u}{\theta+\gamma+(1-\gamma)\eta(1-\alpha)} < y^{Nfix}+p^{Nfix}-p^{Tfix} = \frac{2\kappa(\eta+1)u}{\theta+1}$$

  if $u < 0$:

$$\Leftrightarrow \frac{(\kappa(1+\gamma)(\eta+1)}{\theta+\gamma+(1-\gamma)\eta(1-\alpha)} > \frac{2\kappa(\eta+1)}{\theta+1}$$

$$\Leftrightarrow \kappa(1+\gamma)(\theta+1) > 2\kappa[\theta+\gamma+(1-\gamma)\eta(1-\alpha)]$$

  after rearranging :

$$\Leftrightarrow \alpha > 1-\frac{\kappa(1-\theta)}{\eta}$$

  true for $\alpha = 1$ since $\theta < 1$

– $y^{Nflex} + p^{Nflex} - p^{Tflex}$ decreasing in $(1-\alpha)$.

Proof of Lemma 2

Consider $F(\Pi(u,\sigma^2))$ and take a second-order expansion around $u = 0$ and $\sigma^2 = 0$:

$$F(\Pi(u,\sigma^2)) = F(\Pi(0,0)) + \frac{\partial F(\Pi)}{\partial u}(0,0)u + \frac{\partial F(\Pi)}{\partial \sigma^2}(0,0)\sigma^2$$

$$+\frac{1}{2}\frac{\partial^2 F(\Pi)}{\partial u \partial \sigma^2}(0,0)u\sigma^2 + \frac{1}{2}\frac{\partial^2 F(\Pi)}{\partial u^2}(0,0)u^2 + \frac{1}{2}\frac{\partial^2 F(\Pi)}{(\partial \sigma^2)^2}(0,0)\sigma^4$$

Its expected value can be approximated by (terms of higher order than σ^2 are neglected) :

$$EF\Pi(\sigma^2) = F(\Pi(0,0)) + \left[\frac{\partial F(\Pi)}{\partial \sigma^2}(0,0) + \frac{1}{2}\frac{\partial^2 F(\Pi)}{\partial u^2}(0,0)\right]\sigma^2$$

We have :

$$\frac{\partial F(\Pi)}{\partial \sigma^2}(0,0) = f(\Pi(0,0))\frac{\partial \Pi}{\partial \sigma^2}(0,0)$$

$$\frac{\partial^2 F(\Pi)}{\partial u^2}(0,0) = f(\Pi(0,0))\frac{\partial \Pi}{\partial u^2}(0,0) + f'(\Pi(0,0))\left(\frac{\partial \Pi}{\partial u}(0,0)\right)^2$$

So, if $|f'|$ sufficiently high, then :

$$EF\Pi(\sigma^2) = \frac{1}{2}f'(\Pi(0,0))\left(\frac{\partial \Pi}{\partial u}(0,0)\right)^2$$

When u small, $\Pi(u,0) = \Pi(\pi+1)$ with $\pi = \bar{\pi}u$, so $\frac{\partial \Pi}{\partial u}(0,0) = \Pi\bar{\pi}$

As a consequence, since $f'(\Pi^{flex}(0,0)) = f'(\Pi^{fix}(0,0)) = f'(\Pi(0,0))$:

$$EF(\Pi^{fix}) - EF(\Pi^{flex}) = \frac{1}{2}f'(\Pi(0,0))\Pi[(\bar{\pi}^{fix})^2 - (\bar{\pi}^{flex})^2]\sigma^2$$

We have $V(\pi) = \bar{\pi}^2\sigma^2$, so :

$$EF(\Pi^{fix}) - EF(\Pi^{flex}) = \frac{1}{2}f'(\Pi(0,0))\Pi[V(\pi^{fix}) - V(\pi^{flex})]$$

So, if $f' < 0$ (F concave), then $EF(\Pi^{fix}) - EF(\Pi^{flex})$ is of the same sign as $V(\pi^{flex}) - V(\pi^{fix})$.

Proof of Proposition 3

From Lemma 1, we derive :

$$\pi^{flex}(u) = \frac{[\theta + \gamma + \kappa(1-\theta)](\eta+1)}{\theta + \gamma + (1-\gamma)\eta(1-\alpha)} u$$

$$\pi^{fix}(u) = \frac{[\theta + 1 + \kappa(1-\theta)](\eta+1)}{\theta + 1} u$$

Thus :

$$V(\pi^{flex}) = \frac{[\theta + \gamma + \kappa(1-\theta)]^2(\eta+1)^2}{[\theta + \gamma + (1-\gamma)\eta(1-\alpha)]^2}\sigma^2 = \left(\frac{\partial \pi^{flex}}{\partial u}\right)^2 \sigma^2$$

$$V(\pi^{fix}) = \frac{[\theta + 1 + \kappa(1-\theta)]^2(\eta+1)^2}{(\theta+1)^2}\sigma^2 = \left(\frac{\partial \pi^{fix}}{\partial u}\right)^2 \sigma^2$$

– $V(\pi^{flex}) > V(\pi^{fix}) \Leftrightarrow [\theta + \gamma + \kappa(1-\theta)](\theta+1) > [\theta + 1 + \kappa(1-\theta)][\theta + \gamma + (1-\gamma)\eta(1-\alpha)]$

$\Leftrightarrow \alpha > 1 - \frac{\kappa(1-\theta)}{\eta[1+\kappa+(1-\kappa)\theta]}$: true for $\alpha = 1$ since $\theta < 1$.

– $\frac{\partial(V(\pi^{fix}) - V(\pi^{flex}))}{\partial \alpha} = \frac{-\partial V(\pi^{flex})}{\partial \alpha}$

$\frac{\partial V(\pi^{flex})}{\partial \alpha}$ is of the same sign as $\frac{\partial \pi^{flex}}{\partial u \partial \alpha}$, which is positive, so $\frac{\partial(V(\pi^{fix}) - V(\pi^{flex}))}{\partial \alpha} < 0$.

– $V(\pi^{fix}) > V(\pi^{flex}) \Leftrightarrow \alpha > 1 - \frac{\kappa(1-\theta)}{\eta[1+\kappa+(1-\kappa)\theta]}$ and $1 - \frac{\kappa(1-\theta)}{\eta[1+\kappa+(1-\kappa)\theta]} > 0 \Leftrightarrow \frac{\kappa(1-\theta)}{\eta[1+\kappa+(1-\kappa)\theta]} < 1$

Appendix B : Countries in sample

Asia

China
Hong Kong, China*
India*
Indonesia*
Korea, Rep.*
Malaysia
Pakistan
Philippines
Sri Lanka*
Thailand*

Transition countries

Bulgaria
Czech Republic
Cyprus (only 95-99)
Estonia*
Hungary (only 00-04)
Kazakhstan (only 00-04)*
Latvia*
Lithuania*
Moldova (only 95-99)
Poland
Romania (only 00-04)
Slovak Republic
Slovenia*
Turkey*
Ukraine 95-99
Ukraine 00-04**

Latin America

Argentina*
Bolivia (only 95-99)
Brazil*
Chile
Colombia
Costa Rica
Dominican Republic
Ecuador
El Salvador*
Guatemala*
Jamaica*
Mexico*
Nicaragua
Panama (only 95-99)*
Papua New Guinea (only 95-99)
Peru*
Trinidad and Tobago 95-99**
Trinidad and Tobago 00-04
Uruguay
Venezuela, RB (only 95-99)

Middle East and North Africa

Algeria (only 95-99)
Bahrain (only 95-99)
Egypt, Arab Rep. (only 00-04)*
Israel
Oman (only 95-99)*
Morocco**
Tunisia

Sub-Saharan Africa

Kenya (only 95-99)*
Mauritius*
South Africa
Zimbabwe (only 95-99)*

Industrial countries

Australia
Austria (only 00-04)
Belgium (only 00-04)
Canada
Denmark
Finland
France (only 00-04)
Germany
Greece
Ireland
Italy
Japan
Netherlands (only 00-04)
New Zealand
Norway
Portugal
Spain
Sweden
Switzerland
United Kingdom
United States

* : Not in the REER volatility sample.

** : Not in the LS flexibility index sample.

Appendix C : Descriptive statistics

Summary statistics 1995-2004 (data in five-year averages)

Variable	Observations	Mean	Std. Dev.	Min	Max
Productivity growth	134	0,02	0,02	-0,05	0,10
Initial productivity	134	26413,24	18668,75	2172,53	70091,68
Financial development	134	0,53	0,39	0,03	1,63
Education	134	83,79	28,43	14,00	158,76
Trade openness	134	81,38	46,03	18,11	322,35
Inflation	134	0,08	0,11	-0,02	0,78
Government burden	134	15,87	5,17	5,52	29,21
Kaufman governance index	134	3,19	4,83	-7,06	11,69
Net external debt	134	0,24	0,42	-2,15	1,88
REER vol.	90	0,06	0,04	0,01	0,19
LS Index of ER flex.	129	2,40	1,18	1,00	4,00
Original sin	134	0,86	0,22	0,20	1,00

Sample correlations 1995-2004 (data in five-year averages)

	Prod. growth	Initial prod.	Fin. dev.	Education	Trade open.	Inflation	Gov. Burden	gov. index	Net external debt	REER vol.	LS Index of ER flex.
Prod. growth	-										
Initial prod.	0,13	-									
Fin. dev.	0,19	0,61	-								
Education	0,22	0,74	0,51	-							
Trade open.	0,11	-0,05	0,00	0,01	-						
Inflation	-0,44	-0,44	-0,48	-0,34	-0,01	-					
Gov. burden	-0,09	0,50	0,20	0,62	0,06	-0,20	-				
Gov. index	0,29	0,84	0,63	0,80	0,02	-0,48	0,44	-			
Net ext. debt	-0,24	-0,39	-0,36	-0,22	-0,24	0,18	0,01	-0,31	-		
REER vol.	-0,51	-0,37	-0,31	-0,25	-0,07	0,59	-0,16	-0,42	0,11	-	
LS Index of ER flex.	-0,22	-0,18	-0,21	-0,06	-0,30	0,10	-0,07	-0,16	0,09	0,26	-
O. sin	-0,02	-0,68	-0,65	-0,50	0,24	0,35	-0,23	-0,59	0,31	0,17	0,00

Chapitre IV

Conclusion Générale et Orientations de Recherche

Dans cette thèse, nous avons étudié l'impact du risque de liquidité et de production sur le lien entre flux de capitaux et croissance d'une part, entre politique de change et croissance d'autre part. Ainsi, nous avons pu proposer des explications à certains paradoxes de la finance internationale : le paradoxe de l'allocation et le paradoxe du régime de change. Plus précisément, ces paradoxes font référence, pour le premier, à la relation "perverse" entre croissance et flux de capitaux ; pour le deuxième, à l'absence de relation stable entre régimes de change et performances économiques.

Les deux premiers chapitres sont consacrés au paradoxe des flux de capitaux. Le premier tente d'expliquer comment croissance de la productivité globale des facteurs (PGF) et sorties de capitaux peuvent être associés de manière endogène. Il peut ainsi mettre en relation les récents déséquilibres mondiaux avec la croissance des pays émergents. Le deuxième, quant à lui, applique une démarche comptable, où ce ne sont pas tant les liens de causalité entre flux et croissance qui sont étudiés que leur cohérence dans la dimension inter-pays. En effet, dans chaque pays, la croissance de la productivité, quelle que soit sa source, endogène ou exogène, implique un certain montant de sorties ou entrées de capitaux. Le deuxième chapitre tente ainsi de réconcilier les flux prédits par le modèle de croissance néoclassique avec les flux observés.

Dans le modèle du premier chapitre, l'intégration financière entre deux pays ayant des niveaux de développement financier différents permet de reproduire les faits stylisés observés depuis les années 1990, à savoir : les déséquilibres mondiaux et la croissance relative des pays émergents, cette dernière ayant pour origine à la fois une augmentation relative de la PGF et du capital. La source de la croissance de la PGF réside dans une meilleure allocation du capital entre deux technologies, l'une plus productive que l'autre mais soumise à des chocs de liquidité (capital de long terme), tandis que l'autre peut être utilisée comme "réserve" pour faire face à ces chocs (capital de court terme). Le mécanisme du modèle est le suivant. Dans le pays émergent, dont le développement financier est faible, le défaut d'assurance des chocs de liquidité se traduit par des contraintes financières : les entreprises doivent sur-investir dans les actifs liquides (titres de dette et capital de court terme). Ceux-ci constituent une épargne de précaution. En conséquence, les ressources disponibles pour investir dans le capital de long terme sont moindres. En autarcie, la demande nette de titres de dette est nulle, donc c'est le capital de court terme qui constitue l'épargne de précaution du pays émergent. Lorsque le marché des titres s'ouvre, le pays industriel, dont le secteur financier est plus développé, peut offrir des titres au pays émergent avec un rendement plus élevé, car les ressources y sont mieux allouées. Cette augmentation du taux d'intérêt a deux effets sur le pays émergent : (i) au sein de son épargne de précaution, le titre de dette est substitué au capital de court terme ; (ii) des ressources supplémentaires sont dégagées, permettant d'investir plus dans le capital de long terme. Le modèle statique implique donc à la fois une augmentation de la dette du pays industriel et de la PGF dans le pays émergent, grâce à une meilleure allocation du capital. La calibration d'un modèle à horizon infini montre que ces deux phénomènes sont étalés dans le temps, ce qui concorde avec les données. Il peut aussi rendre compte de l'augmentation du stock de capital agrégé dans le pays émergent.

Le deuxième chapitre s'appuie sur le modèle de croissance néoclassique afin d'expliquer la relation positive entre flux de capitaux et croissance. Le point de départ est la démarche de Gourinchas and Jeanne (2007), qui consiste à (i) reconstituter le niveau de flux compatible avec la croissance observée, notamment telle qu'elle se décompose entre croissance du capital par tête et croissance de la PGF, puis à (ii) comparer ces flux prédits aux flux observés. Gourinchas and Jeanne (2007) trouvent une corrélation négative entre ces derniers, ce qui constitue le "paradoxe de l'allocation". En particulier, le modèle de croissance néoclassique prédit que les pays où la croissance de la PGF a été la plus forte auraient dû recevoir plus de capitaux. Or, ils en ont reçu moins.

Nous tentons d'expliquer ce paradoxe de l'allocation par la présence d'un risque d'investissement individuel non assurable. Ainsi, le modèle de croissance néoclassique est enrichi d'un choc sur le rendement du capital. On distingue alors "l'approche du portefeuille", où la part d'actifs sans risque dans le portefeuille importe, de "l'approche sans risque", correspondant au modèle de Gourinchas and Jeanne (2007). Dans l'approche du portefeuille, les investisseurs s'auto-assurent contre leur risque individuel en détenant des titres sans risque. Ainsi, un pays ayant une croissance de la productivité élevée investit plus dans sa production domestique, mais il augmente ainsi son niveau de risque. Les agents domestiques cherchent donc à s'auto-assurer en détenant des titres sans risque à l'étranger. Les flux entrants prédits sont donc négativement corrélés à la croissance de la PGF, contrairement à l'approche sans risque, et conformément à ce qu'on observe. On retrouve alors une corrélation positive entre flux prédits et flux observés, sur le même échantillon que Gourinchas and Jeanne (2007), à savoir 66 pays entre 1980 et 2000. C'est donc la croissance de la PGF, qui était à la source du paradoxe dans l'approche sans risque, qui contribue à le résoudre dans l'approche du portefeuille. Il faut ajouter à cela une autre raison du succès de l'approche du portefeuille : les pays ayant une faible part de capital dans leur portefeuille en début de période doivent substituer des titres sans risque à du capital, et doivent donc recevoir des entrées de capitaux, selon le modèle. Or, on observe bien une corrélation négative entre la part de capital dans le portefeuille en début de période et les entrées de capitaux, ce qui contribue également à résoudre le paradoxe.

Enfin, le troisième chapitre s'intéresse au choix de régime de change et à son impact sur la croissance. La littérature empirique sur la question n'a pas mis en évidence de lien robuste entre la flexibilité du taux de change et la croissance. En particulier, la stabilité du taux de change ne semble avoir d'impact positif que dans les pays en développement. Aghion *et al.* (2006a) expliquent ce phénomène par des niveaux de développement financier différents dans les pays émergents et industriels. Lorsque les agents font face à des contraintes de crédit, leur capacité d'innovation réagit de manière asymétrique aux chocs sur leur collatéral. Dans ces conditions, la volatilité du collatéral a un impact négatif sur l'innovation et la croissance. Ainsi, le régime de change fixe, en stabilisant le collatéral des entreprises, favorise la croissance dans les pays où les contraintes de crédit sont fortes. Ce chapitre tient compte de la dollarisation de la dette et de son impact déstabilisateur sur le collatéral des pays en développement subissant des fluctuations de taux de change. Nous montrons théoriquement et empiriquement que le péché originel est une source d'hétérogénéité qui permettrait d'expliquer l'impact positif de la fixité du taux de change sur la croissance dans les pays émergents. La prédiction du modèle, à savoir que la stabilité du taux de change est d'autant plus bénéfique pour la croissance que la pays est dollarisé, est confirmée sur un panel de 77 pays entre 1995 et 2004.

Ces résultats suggèrent de nouvelles orientations de recherche.

Tout d'abord, le premier chapitre évoque un canal inédit par lequel l'intégration financière affecte la PGF : l'accès à des actifs liquides qui permettent de réallouer le capital vers des activités plus productives mais moins liquides. Dans cette étude, ce canal n'est qu'une explication suggérée, une interprétation des faits stylisés. Il serait intéressant de l'identifier de manière plus précise, en étudiant l'impact de la libéralisation financière sur la structure de l'investissement dans les pays en développement au niveau macroéconomique. La difficulté principale de cet exercice est de mesurer la structure de l'investissement. Une solution serait d'utiliser la stratégie d'Aghion *et al.* (2006b), qui utilisent la décomposition des importations en biens d'équipement intégrant différents niveaux de R&D. L'idée est que les biens d'équipement sont en général produits par les pays industriels, et que les importations sont donc une mesure fiable de l'investissement en biens d'équipement dans les pays émergents. De même, au niveau microéconomique, il existe encore peu d'études étudiant l'impact de la libéralisation financière sur la productivité des firmes.[1] Il serait instructif d'examiner si ce nouveau canal joue un rôle dans la répartition des activités dans l'entreprise et entre secteurs.

Ensuite, un approfondissement de la démarche du deuxième chapitre est nécessaire pour améliorer les performances de l'approche du portefeuille. En effet, si l'approche du portefeuille permet de mieux expliquer la direction des flux que l'approche sans risque, elle péche lorsqu'il s'agit d'expliquer leur magnitude, qui est surestimée de plusieurs ordres de grandeur dans le modèle. Des extensions visant à diminuer ces ordres de grandeur sont proposées dans le chapitre (risque souverain, risque d'investissement asymétrique, travailleurs n'ayant pas accès aux marchés financiers), mais elles ne résolvent pas le problème de manière satisfaisante et doivent être approfondies. Au final, expliquer à la fois la magnitude et la direction des flux reste un défi à relever. Les explications qui se fondent sur l'approche du portefeuille devront expliquer pourquoi, dans les faits, les agents ne peuvent pas emprunter à hauteur de la richesse intertemporelle impliquée par le modèle. Par exemple, en prenant en compte d'autres frictions sur le marché des titres, notamment l'accès limité de certains agents aux marchés financiers, ou en diminuant cette richesse intertemporelle en modélisant la dynamique de la PGF comme une marche aléatoire.

Une autre direction de recherche consisterait à vérifier si l'approche du portefeuille peut aussi rendre compte de la composition des flux de capitaux entre

[1] Celles-ci incluent Galindo *et al.* (2002), Gupta and Yuan (2006) et Levchenko *et al.* (forthcoming).

titres de dette d'une part et actions de l'autre. La possibilité d'investir dans la production étrangère a en effet des implications en termes de détention d'actions. Selon les modèles de portefeuille, les actifs les plus productifs constituent une part plus importante à la fois des portefeuilles domestique et étranger. Cela pourrait expliquer pourquoi les investissements directs, contrairement aux flux de capitaux agrégés, sont positivement corrélés avec la croissance de la PGF (Gourinchas and Jeanne, 2007).

Le deuxième chapitre a également pour limite qu'il suppose la croissance de la PGF exogène. Cette hypothèse est certes adaptée à la démarche comptable qui est adoptée, mais elle laisse sous silence l'impact que peuvent avoir les flux de capitaux sur la croissance. Cependant, comme le suggère le premier chapitre, mais aussi d'autres études, notamment Aghion *et al.* (2006b), Dooley *et al.* (2004), Dooley *et al.* (2005b) et Dooley *et al.* (2005a), les sorties de capitaux peuvent avoir des effets bénéfiques sur la productivité. Le modèle du premier chapitre pourrait ainsi être étendu à un modèle de croissance endogène, où par exemple l'investissement de long terme aurait des externalités positives sur la productivité globale. Ce type d'extension pourrait donner lieu à des équilibres multiples et pourrait ainsi expliquer pourquoi les pays qui bénéficient d'une forte croissance (l'Asie) sont ceux qui connaissent des sorties de capitaux tandis que les pays dont la croissance est plus faible sont ceux qui connaissent des entrées de capitaux (l'Amérique Latine et l'Afrique).

Quant au troisième chapitre, ses résultats empiriques sont limités par les données. A cause de l'étroitesse du panel de pays et des problèmes de colinéarité qui y sont associés, il n'est pas possible de faire interagir le développement financier avec le niveau de dollarisation et la flexibilité du taux de change dans les régressions. Il n'est donc pas possible d'étudier de manière plus approfondie le rôle respectif de la dollarisation et du développement financier. Il n'est pas non plus possible de traiter plus avant de la possible endogénéité de la dollarisation, car cette variable n'est disponible que pour deux périodes consécutives et peut être considérée au mieux comme prédéterminée. L'accès à des données plus détaillées et plus étendues pourrait permettre de résoudre ces problèmes. En particulier, l'accès à des données sectorielles ou de firmes pourrait limiter les problèmes de colinéarité, mais aussi fournir une plus grande variabilité de la mesure d'accès au financement externe, qui ne dépend pas seulement du développement financier, mais aussi du secteur. Notamment, on pourrait recourir aux mesures de dépendance financière de Rajan and Zingales (1998).

L'accès à des données désagrégées ne permettrait pas seulement d'approfondir les résultats obtenus sur un panel de pays, mais aussi de vérifier les hypothèses qui sont à la base des prédictions du modèle, à savoir l'impact asymétrique des chocs de revenu sur la capacité des firmes à innover. En effet, c'est à cause de cette asymétrie que l'impact de volatilité sur la croissance n'est pas nul en moyenne. Or, s'il est vrai qu'en l'absence de contraintes de crédit, les chocs n'ont pas d'effet sur l'innovation et que par conséquent la volatilité a un impact neutre, il n'est pas certain qu'en présence de contraintes de crédit les chocs aient des effets asymétriques. Par exemple, si les firmes sont très contraintes, un choc positif sur leur revenus leur dégage autant de marge de manoeuvre qu'un choc négatif ne leur en enlève : les chocs ont des effets symétriques. Ainsi, dans le cas extrême où les firmes sont très contraintes, la volatilité ne devrait pas avoir d'impact sur la croissance. C'est lorsque les contraintes de crédit auxquelles elles font face sont modérées que les firmes souffrent de la volatilité. Dans ce cas, elles ne saturent leur contrainte de crédit que lorsqu'elles font face à des chocs négatifs. L'impact de la volatilité macroéconomique n'est dans ce cas pas neutre. Celle-ci n'a donc d'effet que pour des niveaux intermédiaires de restriction d'accès au crédit. L'impact agrégé dépend aussi de la distribution des firmes en fonction de l'accès au crédit. Seules des données microéconomiques permettraient d'examiner ces questions importantes pour l'étude de l'impact de la volatilité sur la croissance.

Bibliographie

ACEMOGLU, D. and ZILIBOTTI, F. (1997), "Was Prometheus Unbound by Chance ? Risk, Diversification and Growth", *Journal of Political Economy*, vol. 105 n° 4 : pp. 709–51.

AGHION, P. and MARINESCU, I. (2007), "Cyclical budgetary policy and growth : what do we learn from OECD panel data ?", NBER Macro Annual 2007.

AGHION, P., BACCHETTA, P. and BANERJEE, A. (2000), "A simple model of monetary policy and currency crises", *European Economic Review*, vol. 44 n° 4-6 : pp. 728–738.

AGHION, P., BACCHETTA, P. and BANERJEE, A. (2004), "A corporate balance-sheet approach to currency crises", *Journal of Economic Theory*, vol. 119 : pp. 6–30.

AGHION, P., ANGELETOS, G.-M., BANERJEE, A. and MANOVA, K. (2005), "Volatility and Growth : Credit Constraints and Productivity-Enhancing Investment", NBER Working Paper No 11349.

AGHION, P., BACCHETTA, P., RANCIÈRE, R. and ROGOFF, K. (2006a), "Exchange Rate Volatility and Productivity Growth : The Role of Financial Development", NBER Working Paper No 12117.

AGHION, P., COMIN, D. and HOWITT, P. (2006b), "When Does Domestic Saving Matter for Economic Growth", NBER Working Paper No 12275.

AGHION, P., ASKENAZY, P., BERMAN, N., CETTE, G. and EYMARD, L. (2007), "Credit Constraints and the Cyclicality of R&D Investment : Evidence from

France", Working Paper 2007-4, Weatherhead Center for International Affairs, Harvard University.

Aiyagari, S. R. (1994), "Uninsured Idiosyncratic Risk and Aggregate Saving,"", *Quarterly Journal of Economics*, vol. 109 : pp. 659–84.

Aizenman, J. and Pinto, A., B.and Radziwill (2007), "Sources for Financing Domestic Capital : Is Foreign Saving a Viable Option for Developing Countries ?", *Journal of International Money and Finance*, vol. 26 n° 5 : pp. 682–702.

Angeletos, G.-M. (2007), "Uninsured idiosyncraticinvestment risk and aggregate saving", *Review of Economic Dynamics*, vol. 11 n° 1.

Angeletos, G.-M. and Calvet, L.-M. (2006), "Idiosyncratic production risk, growth and the business cycle", *Journal of Monetary Economics*, vol. 53 : pp. 1095–1115.

Angeletos, G.-M. and Panousi, V. (2007), "Revisiting the supply-side effects of government spending under incomplete markets", mimeo.

Aoki, K., Benigno, G. and Kiyotaki, N. (2006), "Adjusting to Capital Liberalization", Unpublished Working Paper, London Scool of Economics.

Arellano, M. and Bond, S. (1991), "Some tests of specification for panel data : Monte Carlo Evidence and an application to employment equations", *Quarterly Journal of Economics*, vol. 120 n° 1 : pp. 173–222.

Arellano, M. and Bover, O. (1995), "Another look at the instrumental-variable estimation of error components models", *Journal of Econometrics*, vol. 68 : pp. 29–51.

Arestis, P. and Demetriades, P. (1997), "Financial Development and Growth : Assessing the Evidence", *Economic Journal*, vol. 107 : pp. 783–99.

Arteta, C. (2005), "Exchange Rate Regimes and Financial Dollarization : Does Flexibility Reduce Currency Mismatches in Bank Intermediation ?", *Topics in Macroeconomics*, vol. 5 n° 1 : pp. 1226–1226, available at : http ://www.bepress.com/bejm/topics/vol5/iss1/art10.

Atje, R. and Jovanovic, B. (1993), "Stock Markets and Development", *Oxford Development Studies*, vol. 26 n° 2 : pp. 153–69.

Attanasio, O. and Davis, S. (1996), "Relative Wage Movements and the Distribution of Consumption", *Journal of Political Economy*, vol. 104 n° 6 : pp. 1227–62.

Attanasio, O. P., Picci, L. and E., S. A. (2000), "Saving, Growth and Investment : A Macroeconomic Analysis Using a Panel of Countries", *The Review of Economics and Statistics*, vol. 182 n° 2 : pp. 182–211.

Backus, D. K., Kehoe, P. J. and Kydland, F. E. (1992), "International Real Business Cycles", *Journal of Political Economy*, vol. 100 : pp. 745–75.

Banerjee, A. and Duflo, E. (2005), "Growth Theory through the Lens of Development Economics", in *Handbook of Economic Growth*, P. Aghion and S. Durlauf (ed.).

Barro, R., Mankiw, G. and Sala-I-Martin, X. (1995), "Capital Mobility in Neoclassical Models of Growth", *American Economic Review*, vol. 85 n° 1 : p. 103–15.

Barro, R. J. and Lee, J.-W. (2000), "International Data on Educational Attainment : Updates and Implications", .

Barro, R. J. and Sala-i Martin, X. (1995), *Economic Growth*, McGraw Hill, New York.

Bartelsman, E., Haltiwanger, J. and Scarpetta, S. (2006), "Cross-Country Differences in Productivity : The Role of Allocative Efficiency", Manuscript, University of Maryland.

Baxter, M. and Stockman, A. (1989), "Business cycles and the exchange rate regime", *Journal of Monetary Economics*, vol. 23 n° 3.

Beck, T., Demirguc-Kunt, A. and Levine, R. (1999), "A new database on financial developement and structure", World Bank Policy Research Working Paper No 2146.

Beck, T., Levine, R. and Loayza, N. (2000), "Finance and the Sources of Growth", *Journal of Financial Economics*, vol. 58 : pp. 261–300.

Bekaert, G., Harvey, C. R. and Lundblad, C. (2006), "Growth Volatility and Equity Market Liberalization", *Journal of International Money and Finance*, vol. 25 n° 3 : pp. 370–403.

Bencivenga, V. R. and Smith, B. D. (1991), "Financial Intermediation and Endogenous Growth", *Review of Economic Studies*, vol. 58 n° 2 : pp. 195–209.

Bencivenga, V. R., Smith, B. D. and Starr, R. M. (1995), "Transaction Costs, Technological Choices, and Endogenous Growth", *Journal of Economic Theory*, vol. 67 n° 1 : pp. 53–77.

Bernanke, B. (2005), "The Global Saving Glut and the U.S. Current Account", Remarks at the Sandridge Lecture, Virginia Association of Economics, Richmond, VA, March 10.

Blundell, R. and Bond, S. (1998), "Initial conditions and moment conditions in dynamic panel data models", *Journal of Econometrics*, vol. 87 : pp. 115–143.

Blundell, R. and Bond, S. (2000), "GMM Estimation with Persistent Panel Data : An Application to Production Functions", *Econometric Reviews*, vol. 19 : pp. 321–340.

Bordo, M. and Helbling, T. (2003), "Have National Business Cycles Become More Synchronized ?", NBER Working Paper No 10130.

Bottazi, L., Pesenti, P. and van Wincoop, E. (1996), "Wages, Profits and the international portfolio puzzle", *European Economic Review*, vol. 40 : pp. 219–54.

Boyd, J. H. and Smith, B. D. (1997), "Capital Market Imperfections, International Credit Markets, and Non-Convergence", *Journal of Economic Theory*, vol. 73 n° 2 : pp. 335–64.

Burnside, C., Eichenbaum, M. and Rebelo, S. (2001), "Hedging and Financial Fragility in Fixed Exchange Rate Regimes", *European Economic Review*, vol. 45 n° 7 : pp. 1151–93.

Caballero, R. J., Farhi, E. and Gourinchas, P.-O. (2008), "An Equilibrium Model of "Global Imbalances" and Low Interest Rates", *American Economic Review*, vol. 98 n° 1 : pp. 358–93.

Calvo, G. and Guidotti, P. (1989), "Credibility and Nominal Debt : Exploring the Role of Maturity in Managing Inflation", IMF Working Paper No 89/73.

Calvo, G., Izquierdo, A. and Mejia, L.-F. (2004), "On The Empirics of Sudden Stops : The Relevance of Balance-Sheet Effects", .

Calvo, G. A. and Reinhart, C. M. (2002), "Fear of Floating", *Quarterly Journal of Economics*, vol. 117 : pp. 379–408.

Campbell, J., Lettau, M., Malkiel, B. and Xu, Y. (2001), "Have Individual Stocks Become More Volatile ? An Empirical Exploration of Idiosyncratic Risk", *Journal of Finance*, vol. 56 n° 1 : pp. 1–43.

Carroll, C. and Summers, L. (1991), "Consumption growth parallels income growth : some new evidence", in B. D. Bernheim and J.B. Shoven, eds., *National saving and economic performance*, Chicago : Chicago University Press.

Carroll, C. and Weil, D. (1994), "Saving and growth : a reinterpretation", *Carnegie-Rochester Conference Series on Public Policy*, vol. 40 : pp. 133–92.

Carroll, C., Overland, J. and Weil, D. (2000), "Saving and growth with habit formation", *American Economic Review*, vol. 90 n° 3 : pp. 341–55.

Caselli, F. (2004), "Accounting for cross-country income differences", NBER Working Paper No 10828.

Caselli, F. and Wilson, D. (2004), "Importing Technology", *Journal of Monetary Economics*, vol. 51 : pp. 1–32.

Cespedes, L. F., Chang, R. and Velasco, A. (2002), "Balance Sheets and Exchange Rate Policy", *American Economic Review*, vol. 94 n° 4 : pp. 1183–93.

Chan, K., Covrig, V. M. and Ng, L. K. (2005), "What Determines the Domestic and Foreign Bias ? Evidence from Mutual Fund Equity Allocations Worldwide", *Journal of Finance*, vol. 60 : pp. 1495–1534.

CHINN, M. and ITO, H. (2005), "Current Account Balances, Financial Development and Institutions : Assaying the World 'Saving Glut", NBER Working Paper No 11761.

CHINN, M. and ITO, H. (2007), "A New Measure of Financial Openness", mimeo.

CHRISTOPOULOS, D. K. and TSIONAS, E. G. (2004), "Financial Development and Economic Growth : Evidence from Panel Unit Root and Cointegration Tests", *Journal of Development Economics*, vol. 73 : pp. 55–74.

COEURDACIER, N. (2008), "Do Trade Costs in Goods Markets Lead to Home Bias in Equities ?", mimeo, London Business School.

COEURDACIER, N., KOLLMANN, R. and MARTIN, P. (2007), "International Portfolios with Supply, Demand and Redistributive Shocks", NBER Working Paper No 13424.

COVAS, F. (2006), "Uninsured idiosyncratic production risk with borrowing constraints", *Journal of Economic Dynamics and Control*, vol. 30 : pp. 2167–90.

DE GRAUWE, P. and SCHNABL, G. (2005), "Exchange rate stability, inflation and growth in (South) Eastern and Central Europe", Mimeo.

DE NICOLO, G., HONOHAN, P. and IZE, A. (2003), "Dollarization of the banking system : good or bad ?", Policy Research Working Paper Series 3116, The World Bank.

DEMIRGÜÇ-KUNT, A. and MAKSIMOVIC, V. (1998), "Law, Finance, and Firm Growth", *Journal of Finance*, vol. 53 : pp. 2107–37.

DEVEREUX, M. B. and SMITH, G. W. (1994), "International Risk Sharing and Economic Growth", *International Economic Review*, vol. 35 n° 3 : pp. 535–550.

DEVEREUX, M. B., GREGORY, A. and SMITH, G. W. (1992), "Realistic Cross-Country Consumption Correlations in a Two-Country, Equilibrium, Business-Cycle Model", *Journal of International Money and Finance*, vol. 11 : pp. 3–16.

DIAMOND, D. W. and DYBVIG, P. H. (1983), "Bank Runs, Deposit Insurance and Liquidity", *Journal of Political Economy*, vol. 91 : pp. 401–19.

Dooley, M. P., Folkerts-Landau, D. and Garber, P. (2004), "The Revived Bretton Woods System", *International Journal of Finance and Economics*, vol. 9 n° 4 : pp. 307–313.

Dooley, M. P., Folkerts-Landau, D. and Garber, P. (2005a), "Direct investment, rising real wages and the absorption of excess labor in the periphery", Proceedings, Federal Reserve Bank of San Francisco, Issue Feb.

Dooley, M. P., Folkerts-Landau, D. and Garber, P. (2005b), "The US current account deficit and economic development : Collateral for a total return swap", Proceedings, Federal Reserve Bank of San Francisco, Issue Feb.

Dubas, J., Lee, B.-J. and Mark, N. (2005), "Effective exchange rate classifications and growth", NBER Working Paper No 11272.

Easterly, W. and Levine, R. (2001), "It's not Factor Accumulation : Stylized Facts and Growth Models", *World Bank Economic Review*, vol. 15 n° 2 : p. 177–219.

Eberly, J., Rebelo, S. and Vincent, N. (2008), "Investment and Value : A Neoclassical Benchmark", NBER Woking Paper No 13866.

Eichengreen, B. and Hausmann, R. (1999), "Exchange rates and financial fragility", NBER Working Paper No 7418.

Eichengreen, B. and Mussa, M. (1998), "Capital Account Liberalization : Theoretical and Practical Aspects", Occasional Paper No. 172, International Monetary Fund, Washington, DC.

Engel, C. (1999), "Accounting for U.S. Real Exchange Rate Changes", *Journal of Political Economy*, vol. 107 n° 3 : pp. 507–38.

Engel, C. and Matsumoto, A. (2006), "Portfolio Choice in a Monetary Open-Economy DSGE Model", NBER Working Paper No 12214.

Fischer, S. (1998), "Capital Account Liberalization and the Role of the IMF", in *Should the IMF Pursue Capital-Account Convertibility ?*, Vol. 207 (Princeton, NJ :

Essays in International Finance, Department of Economics, Princeton University) 1–10.

FORBES, K. (2008), "Why do Foreigners Invest in the United States ?", NBER Working Paper No 13908.

FRANKEL, J. and ROSE, A. K. (1996), "Currency Crashes in Emerging Markets : An Empirical Treatment", *Journal of International Economics*, vol. 41 : pp. 351–66.

FRENCH, K. R. and POTERBA, J. M. (1991), "Investor Diversification and International Equity Markets", *American Economic Review*, vol. 81 n° 2 : pp. 222–26.

GALINDO, A., MICCO, A. and ORDOÑEZ, G. (2002), "Financial Liberalization : Does It Pay to Join the Party ?", *Economia*, vol. 3 : pp. 231–252.

GERTLER, M. and ROGOFF, K. (1990), "North-South Lending and Endogenous Domestic Capital Market Inefficiencies", *Journal of Monetary Economics*, vol. 26 : pp. 245–66.

GILCHRIST, S. and SIM, J. W. (2007), "Investment during the Korean Financial Crisis : A Structural Econometric Analysis", NBER Working Paper No 13315.

GOLDSMITH, R. W. (1969), *Financial Structure and Development*, New Haven, CT : Yale University Press.

GORDON, R. H. and BOVENBERG, A. L. (1996), "Why is capital so Immobile Internationally ? Possible Explanations and Implications for Capital Income Taxation", *American Economic Review*, vol. 86 : pp. 1057–75.

GOURINCHAS, P.-O. and JEANNE, O. (2006), "The Elusive Gains from International Financial Integration", *Review of Economic Studies*, vol. 73 : pp. 715–41.

GOURINCHAS, P.-O. and JEANNE, O. (2007), "Capital Flows to Developing Countries : The Allocation Puzzle", NBER Working Paper No 13602.

GRENWOOD, J. and JOVANOVIC, B. (1990), "Financial Development, Growth, and the Distribution of Income", *Journal of Political Economy*, vol. 5 n° 1 : pp. 1076–1107.

GRUBER, J. and KAMIN, S. (2007), "Explaining the global pattern of current account imbalances", *Journal of International Money and Finance*, vol. 26 n° 4 : pp. 500–22.

GUPTA, N. and YUAN, K. (2006), "On the Growth Effects of Stock Market Liberalizations", mimeo, Indiana University and University of Michigan.

HALL, R. E. and JONES, C. I. (1999), "Why do some countries produce so much more output than others ?", *The Quarterly Journal of Economics*, vol. 114 n° 1 : pp. 83–116.

HAUSMANN, R. and PANIZZA, H. (2003), "On the determinants of Original Sin : an Empirical Investigation", *Journal of International Money and Finance*, vol. 22 n° 7.

HAUSMANN, R., PANIZZA, H. and STEIN, E. (2001), "Why do countries float the way they float ?", *Journal of Development Economics*, vol. 2 n° 66.

HAYASHI, F., ALTONJI, J. and KOTLIKOFF, L. (1996), "Risk-Sharing between and within Families", *Econometrica*, vol. 64 n° 2 : pp. 261–94.

HESTON, A., SUMMERS, R. and ATEN, B. (2006), "Penn World Table Version 6.2", Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.

HOLMSTROM, B. and TIROLE, J. (1998), "Private and Public supply of Liquidity", *Journal of Political Economy*, vol. 106 : pp. 1–40.

HSIEH, C.-T. and KLENOW, P. (2007), "Misallocation and Manufacturing TFP in China and India", NBER Working Paper No 13290.

HUGGETT, M. (1997), "The One-Sector Growth Model With Idiosyncratic Shocks", *Journal of Monetary Economics*, vol. 39 : pp. 385–403.

Husain, A. M., Mody, A. and Rogoff, K. (2005), “Exchange rate regime durability and performance in developing versus advanced economies”, *Journal of Monetary Economics*, vol. 52 n° 1.

Imbs, J. (2006), “The Real Effect of Financial Integration”, *Journal of International Economics*, vol. 68 n° 2 : pp. 296–324.

Jayaratne, J. and Strahan, P. E. (1996), “The Finance-Growth Nexus : Evidence from Bank Branch Deregulation”, *Quarterly Journal of Economics*, vol. 111 : pp. 639–70.

Jones, L., Manuelli, R., Siu, H. and Stacchetti, E. (2005), “Fluctuations in convex models of endogenous growth I : Growth effects”, *Review of Economic Dynamics*, vol. 8 : pp. 780–804.

Jorgenson, D. W. (1995), *Productivity. Volume 2 : International Comparison of Economic Growth*, MIT Press.

Ju, J. and Wei, S.-J. (2006), “A Solution to Two Paradoxes of International Capital Flows”, NBER Working Paper No 12668.

Ju, J. and Wei, S.-J. (2007), “Domestic Institutions and the Bypass Effect of Financial Globalization”, NBER Working Paper No 13148.

Juillard, M. (1996), “Dynare : A program for the resolution and simulation of dynamic models with forward variables through the use of a relaxation algorithm”, CEPREMAP, Couverture Orange, 9602.

Kaufmann, D., Kraay, A. and Zoido-Lobaton, P. (1999), “Aggregating Governance Indicators”, World Bank Policy Research Working Paper No 2195.

Kearney, C. and Poti, V. (2006), “Have European Stocks Become More Volatile ? An Empirical Investigation of Idiosyncratic and Market Risk in the Euro Area”, The Institute for International Integration Studies Discussion Paper Series iiisdp132, IIIS.

King, R. G. and Levine, R. (1993a), “Finance and Growth : Schumpeter Might Be Right”, *Quarterly Journal of Economics*, vol. 108 : pp. 717–38.

KING, R. G. and LEVINE, R. (1993b), "Finance, Entrepreneurship, and Growth : Theory and Evidence", *Journal of Monetary Economics*, vol. 32 n° 3 : pp. 513–42.

KOSE, M. A., PRASAD, E. S. and TERRONES, M. E. (2003), "How Does Globalization Affect the Syncronization of Business Cycles ?", *American Economic Review*, vol. 93 n° 2 : pp. 57–63.

KRAAY, A. and VENTURA, J. (2000), "Current Accounts in Debtor and Creditor Countries", *The Quarterly Journal of Economics*, vol. 115 n° 4 : pp. 1137–1166.

KRAAY, A., LOAYZA, N., SERVEN, L. and VENTURA, J. (2005), "Country portfolios", *Journal of the European Economic Association*, vol. 3 n° 4 : pp. 914–945.

KREBS, T. (2003), "Human capital risk and economic growth", *Quarterly Journal of Economics*, vol. 118 : pp. 709–44.

KRUGMAN, P. (1999), *International Finance and Financial Crises*, Kluwer Academic Publishers, chapter Balance Sheets, the Transfer Problem and Financial Crises, p. isard, a. razin and a. rose edition.

KRUSELL, P. and SMITH, A. (1998), "Income and Wealth Heterogeneity in the Macroeconomy", *Journal of Political Economy*, vol. 106 : pp. 867–96.

LA PORTA, R., LOPEZ-DE SILANEZ, F., SCHLEIFER, A. and VISHNY, R. W. (1998), "Law and Finance", *Journal of Political Economy*, vol. 106 : pp. 1113–55.

LANE, P. R. and MILESI-FERRETTI, G. M. (2006), "The External Wealth of Nations Mark II : Revised and Extended Estimates of Foreign Assets and Liabilities for Industrial and Developing Countries, 1970-2004", *IMF Working Paper*, n° 69.

LEVCHENKO, A. A., RANCIÈRE, R. and THOENIG, M. (forthcoming), "Growth and Risk at the Industry Level : the Real Effects of Financial Liberalization", *Journal of Development Economics*.

LEVINE, R. (1991), "Stock Markets, Growth and Tax Policy", *Journal of Finance*, vol. 46 n° 4 : pp. 1445–65.

LEVINE, R. (1998), "The Legal Environment, Banks, and Long-run Economic Growth", *Journal of Money, Credit and Banking*, vol. 30 : pp. 596–613.

LEVINE, R. (1999), "Law, Finance, and Economic Growth", *Journal of Financial Intermediation*, vol. 8 : pp. 36–67.

LEVINE, R. (2005), "Finance and Growth : Theory and Evidence", in Aghion, P. and Durlauf, S. (editors), *Handbook of Economic Growth*, Elsevier, vol. 1, chapter 12.

LEVINE, R. and ZERVOS, S. (1998), "Stock Markets, Banks, and Economic Growth", *American Economic Review*, vol. 88 : pp. 537–58.

LEVINE, R., LOAYZA, N. and BECK, T. (2000), "Financial Intermediation and Growth : Causality and Causes", *Journal of Monetary Economics*, vol. 46 n° 1 : pp. 31–77.

LEVY-YEYATI, E. (2006), "Financial Dollarization : Evaluating the Consequences", *Economic Policy*, n° january : pp. 61–118.

LEVY-YEYATI, E. and STURZENEGGER, F. (2002), "Classifying Exchange Rate Regimes : Deeds vs. Words", Mimeo, Universidad Torcuato Di Tella available at www.utdt.edu/ fsturzen.

LEWIS, K. (1999), "Trying to Explain Home Bias in Equities and Consumption", *Journal of Economic Literature*, vol. 37 n° 2 : pp. 571–608.

LORENZO, F., ABOAL, D. and OSIMANI, R. (2005), "The Elasticity of Substitution in Demand for Non-Tradable Goods in Uruguay", Inter-American Development Bank Research Network Working paper No R-480.

LUCAS, R. E. (1988), "On the Mechanisms of Economic Development", *Journal of Monetary Economics*, vol. 22 : pp. 3–42.

LUCAS, R. E. J. (1990), "Why Doesn't Capital Flow from Rich to Poor Countries ?", *American Economic Review*, vol. 80 : pp. 92–96.

MANKIW, G. N. (1995), "The Growth of Nations", *Brooking Paper on Economic Activity*, vol. 1 : pp. 275–326.

MANZOCCHI, S. and MARTIN, P. (1997), "Are Capital Flows Consistent with the Neoclassical Growth Model ? Evidence from a Cross-section of Developing Countries", *Economie Internationale*, vol. 72 : pp. 7–24.

MATSUYAMA, K. (2004), "Financial Market Globalization, Symmetry-Breaking, and Endogenous Inequality of Nations", *Econometrica*, vol. 72 : pp. 853–84.

MATSUYAMA, K. (2005), "Credit Market Imperfections and Patterns of International Trade and Capital Flows", *Journal of the European Economic Association*, vol. 3 n° 2-3 : pp. 714–723.

MATSUYAMA, K. (2007), "Credit traps and credit cycles", *American Economic Review*, vol. 97 n° 1 : pp. 503–516.

MCKINNON, R. I. (1973), *Money and Capital in Economic Development*, Washington, DC : Brookings Institutions.

MENDOZA, E. (2000), "On the Instability of Variance Decompositions of the Real Exchange Rate Across Exchange- Rate-Regimes : Evidence from Mexico and the United States", NBER Working Paper No 7768.

MENDOZA, E. G. (2001), "Credit, Prices and Crashes : Business Cycles With a Sudden Stop", NBER Working Paper No 8338.

MENDOZA, E. G., QUADRINI, V. and RIOS-RULL, J.-V. (2007a), "Financial Integration, Financial Deepness and Global Imbalances", NBER Working Paper No 12909.

MENDOZA, E. G., QUADRINI, V. and RIOS-RULL, J.-V. (2007b), "On the welfare implications of financial globalization without financial development", NBER Working Paper No 13412.

MODIGLIANI, F. (1986), "Life-Cycle, Individual Thrift, and the Wealth of Nations", *American Economic Review*, vol. 76 n° 3 : pp. 297–313.

OBSTFELD, M. (1994), "Risk-Taking, Global Diversification, and Growth", *American Economic Review*, vol. 84 n° 5 : pp. 1310–29.

OBSTFELD, M. (2006), "International Risk Sharing and the Costs of Trade", Ohlin Lecture, Stockholm School of Economics.

OBSTFELD, M. (2008), "International Finance and Growth in Developing Countries : What Have We Learned ?", mimeo, University of California, Berkeley.

OBSTFELD, M., SHAMBAUGH, J. C. and TAYLOR, A. M. (2005), "The Trilemma in History : Tradeoffs Among Exchange Rates, Monetary Policies, and Capital Mobility", *Review of Economics and Statistics*, vol. 87 n° 3 : pp. 423–38.

OBSTFELD, M., SHAMBAUGH, J. C. and TAYLOR, A. M. (2008), "Financial Stability, the Trilemma, and International Reserves", NBER Working Paper No 14217.

PATRICK, H. T. (1966), "Financial Development and Economic Growth in Underdeveloped Countries", *Economic Developement and Cultural Change*, vol. 14 : pp. 174–89.

PRASAD, E., ROGOFF, K., WEI, S.-J. and KOSE, A. (2003), "Effects of Financial Globalization on Developing Countries : Some New Evidence", IMF Occasional Paper No 220.

PRASAD, E., RAJAN, R. and SUBRAMANIAN, A. (2007), "Foreign Capital and Economic Growth", *Brookings Papers on Economic Activity*, vol. 1 n° 2007-1 : pp. 153–230.

RAJAN, R. G. and ZINGALES, L. (1998), "Financial Dependence and Growth", *American Economic Review*, vol. 88 : pp. 559–86.

RANCIÈRE, R. and JEANNE, O. (2006), "The Optimal Level of International Reserves for Emerging Market Countries : Formulas and Applications", IMF Working Paper No. 06/229.

RAZIN, A. and RUBINSTEIN, Y. (2006), "Evaluation of Currency Regimes : the Unique Role of Sudden Stops", *Economic Policy*, vol. 46 : pp. 119–152.

REINHART, C. M., ROGOFF, K. S. and SAVASTANO, M. (2003), "Addicted to dollars", NBER Working Paper No 10015.

RESTUCCIA, D. and ROGERSON, R. (2007), "Policy Distortions and Aggregate Productivity with Heterogeneous Plants", NBER Working Paper No 13018.

ROBINSON, J. (1952), "The Generalization of the General Theory", *The Rate of Interest and Other Essays*, London : MacMillan.

RODRIK, D. (2006), "Industrial Development : Stylized Facts and Policies", Mimeo, Kennedy School of Government.

RODRIK, D. (2007), "The real exchange rate end economic growth : Theory and evidence", Mimeo, Kennedy School of Government.

SAINT-PAUL, G. (1992), "Technological Choice, Financial Markets and Economic Development", *European Economic Review*, vol. 36 : pp. 763–81.

SCHLEIFER, A. and WOLFENZON, D. (2002), "Investor Protection and Equity Markets", *Journal of Financial Economics*, vol. 66 : pp. 3–21.

SCHUMPETER, J. A. (1911), *The Theory of Economic Development*, Cambridge, MA : Harvard University Press.

STOCK, J. H. and WATSON, M. W. (2003), "Understandfing Changes in INternational Business Cycles", NBER Working Paper No 9859.

TESAR, L. L. and WERNER, I. M. (1995), "Home Bias and High Turnover", *Journal of International Money and Finance*, vol. 14 n° 4 : pp. 467–92.

DE LA TORRE, A., LEVY YEYATI, E. and SCHMUKLER, S. L. (2003), "Living and Dying with Hard Pegs : The Rise and Fall of Argentina's Currency Board", *Economia*, vol. 3 n° 2 : pp. 43–99.

VERDIER, G. (2008), "What drives long-term capital flows A theoretical and empirical investigation", *Journal of International Economics*, vol. 74 n° 1 : pp. 120–142.

VISSIN-JØRGENSEN, A. (2002), "Limited Asset Market Participation and the Elasticity of Intertemporal Substitution", *Journal of Political Economy*, vol. 110 : pp. 825–53.

WINDMEIJER, F. (2004), "A finite sample correction for the variance of linear two-step GMM estimator", *Journal of Econometrics*, vol. 126 n° 1 : pp. 25–51.

WOODFORD, M. (1986), "Stationary Sunspot Equilibria in a Financed Constrained Economy", *Journal of Economic Theory*, vol. 40 : pp. 128–37.

XU, Z. (2000), "Financial Development, Investment, and Growth", *Economic Inquiry*, vol. 38 : pp. 331–44.

Résumé

Dans cette thèse, nous étudions l'impact du risque de liquidité et de production sur le lien entre flux de capitaux et croissance d'une part, entre politique de change et croissance d'autre part. Ainsi, nous avons pu proposer des explications à certains paradoxes de la finance internationale : le paradoxe de l'allocation et le paradoxe du régime de change. Plus précisément, ces paradoxes font référence, pour le premier, à la relation "perverse" entre croissance et flux de capitaux ; pour le deuxième, à l'absence de relation stable entre régimes de change et performances économiques.

Les deux premiers chapitres sont consacrés au paradoxe des flux de capitaux. Le premier tente d'expliquer comment croissance de la productivité globale des facteurs et sorties de capitaux peuvent être associés de manière endogène. Il peut ainsi mettre en relation les récents déséquilibres mondiaux avec la croissance parallèle des pays émergents. Le deuxième, quant à lui, applique une démarche comptable, où ce ne sont pas tant les liens de causalité entre flux et croissance qui sont étudiés que leur cohérence dans la dimension inter-pays. Dans les deux cas, la présence de risque non assurable au niveau des firmes, qu'il s'agisse de risque de production ou de risque de liquidité, explique la relation positive entre croissance et sorties de capitaux.

Enfin, le troisième chapitre s'intéresse au choix de régime de change et à son impact sur la croissance. C'est le risque de liquidité et l'accès imparfait au crédit qui justifie l'idée que la volatilité peut avoir un impact sur la croissance. Plus particulièrement, ce chapitre établit au niveau théorique et empirique que la dollarisation de la dette conditionne cet impact. Il permet d'expliquer ainsi la faible robustesse des précédentes études empiriques sur la question.

Discipline : Sciences Economiques (05).

Mots-clés :
Croissance, Finance internationale, Risque de production, Risque de liquidité, Choix de portefeuille, Choix technologiques, Épargne de précaution, Régimes de change, Dollarisation de la dette, Effets de bilan.

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