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On the links between capital flows and monetary policies

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Introduction

0.1 Version française

0.1.1 Le contexte internationale

Dans les années 90, a émergé un consensus au sujet de la libéralisation des comptes de capitaux. Le principe était le suivant, en libérant leurs comptes de capitaux, les pays augmenteraient leur croissance économique. Néanmoins, de nombreuses études ont révélé qu'un tel mécanisme n'était pas si évident (voir e.g. Rodrick (1998) et Stiglitz (2004)). Une libéralisation prématurée des comptes de capitaux peut être génératrice d'effets déstabilisateurs dans les pays en développement. En effet, comme mis en avant par de nombreuses études, avant d'ouvrir leurs comptes de capitaux, les pays en développement devraient s'assurer d'avoir un secteur financier suffisamment développé. Les crises Mexicaine (1994), Asiatique (1997), Russe (1998) et Argentine (2001) sont de tristes exemples de l'effet que peut avoir l'exposition prématurée des pays en développement à la libéralisation des comptes de capitaux.

La liberté des capitaux dans les pays en développement soulève le problème que peut amener un niveau d'emprunt trop élevé. En toute logique, l'accroissement des stocks de capitaux va conduire les pays en développement à emprunter plus afin d'accroître l'investissement, soulevant la question de l'évaluation du risque de ces emprunts. Une sous évaluation du risque des emprunts contractés n'est pas exclue, ce qui place les pays en développement dans une position fragile et instable. D'autre part, cet accroissement de l'emprunt est financé par des capitaux étrangers, ce qui a conduit à l'émergence d'une dette en devises étrangères. La détention d'une telle dette expose les pays en développement à d'importants risques (voir Mishkin (1999)). Ces risques étaient particulièrement importants en Amérique latine. En effet l'Argentine et le Mexique expérimentaient une politique d'ancrage au dollar américain. Ce qui ne leur laissaient aucune marge de manoeuvre quant à la stabilisation de leur taux de change. Il n'est donc pas surprenant que ces deux pays aient vu leurs devises s'effondrer durant la crise. Les devises des autres pays frappés par des crises n'ont pas échappé à de fortes dépréciations. De tels constats mettent en avant l'importance de la stabilisation des taux de change (voir e.g. Demiroglu and Karagoz (2016)).

Évoluant dans un tel contexte international, les économistes ont commencé à s'intéresser de prés à l'évolution des taux de change. De toute évidence, la compréhension des dynamiques de taux de change représente une étape primordiale quant à la stabilisation du système financier dans son ensemble. Le fait est qu'à l'heure actuelle, aucun modèle économique n'est à même de prédire l'évolution du taux de change plus précisément qu'une marche aléatoire. Étant donné que les déterminants théoriques du taux de change sont une des motivations du premier chapitre de cette thèse, les avancées récentes concernant la modélisation du taux de change vont être rapidement énumérées ici afin de mettre l'accent sur les contributions apportées par ce chapitre.

De plus en plus de pays ont adoptés un régime de change flexible, ce qui a conduit un grand nombre d'économistes à s'intéresser aux déterminants des taux de change. Par exemple, Bacchetta and Wincoop (2010), Engel and West (2003) et Molodtsova and Papell (2009) ont modélisé les taux de change à partir des fondamentaux macroéconomiques. Cependant, dans tous ces modèles, de taux de change, une partie de celui-ci reste inexpliquée.

Nous allons maintenant nous pencher sur la partie inexpliquée du taux de change. La façon dont les agents anticipent et commettent des erreurs concernant ces anticipations semble être un bon départ pour comprendre la part non expliquée des taux de change. De toute évidence, les décisions prises par les investisseurs sur les marchés financiers influencent les dynamiques des taux de change; ainsi la façon dont les agents forment leurs anticipations va affecter à son tour les taux de change. Il peut être établi un lien entre ces anticipations et l'énigme du "forward premium". Afin de comprendre ce qu'est cette énigme, il est nécessaire de faire référence aux parités couvertes et non couvertes des taux d'intérêt. En effet, la combinaison de ces deux théories affirme que le taux de change "forward" est un prédicteur parfait du taux de change futur. Cette hypothèse est formalisée par l'équation suivante :

$$F_t = E_t s_{t+1},$$

avec F_t, le taux "forward" et $E_t s_{t+1}$, le taux de change anticipé. Cette équation n'étant pas validée empiriquement, apparait l'énigme du "forward premium" mentionnée plus haut. En d'autres termes, le taux "forward" n'est pas un prédicteur parfait du taux de change futur. A ce sujet, Chakraborty and Evans (2008) ont démontré que l'apprentissage adaptatif était plus enclin à expliquer cette énigme que l'hypothèse d'anticipations rationnelles. En d'autres termes, la façon dont les agents forment leurs anticipations est à même d'expliquer une part de l'énigme du "forward premium". Ce résultat est de première importance dans le sens où il suggère clairement de modéliser le taux de change en prenant compte de la façon dont les agents forment leurs anticipations. A partir d'un tel constat, il sera question, à travers un modèle théorique, de générer des co-mouvements de long terme entre les taux de change de deux petites économies ouvertes. L'importance d'une telle problématique tient au fait qu'une compréhension des dynamiques de taux de change dans le long terme est une étape cruciale quant à la stabilisation du système financier. Comme mentionné précédemment, les fondamentaux macroéconomiques, ont pour partie, un pouvoir explicatif du taux de change, d'où leur présence dans notre modèle.

Se référant à la parité des taux d'intérêt non couverte, les variables les plus importantes concernant la modélisation du taux de change sont les taux d'intérêt domestiques et étrangers. Cette théorie est primordiale en finance internationale, elle est aussi connue sous le nom de condition de non arbitrage et elle est utilisée dans de nombreux modèles de taux de change. Plus précisément, cette théorie stipule que les variations attendues du taux de change vont annuler le gain potentiel d'un différentiel d'intérêt positif. Théoriquement, la parité des taux d'intérêt non couverte est définie comme suit :

$$1 + r_t = \frac{E_t s_{t+1}}{s_t}(1 + r_t^*),$$

avec r_t le taux d'intérêt domestique et r_t^* le taux d'intérêt étranger. Cette équation montre clairement que la devise à fort rendement tend à se déprécier, annulant les bénéfices potentiels provenant d'un arbitrage. Néanmoins, depuis l'article bien connu de Fama (1984), nous savons que la parité des taux d'intérêt non couverte n'est pas vérifiée empiriquement. De fait, nombreux sont les auteurs ayant étudié une telle déviation de la parité des taux d'intérêt non couverte et ces derniers ont montré que la devise à fort rendement avait tendance à s'apprécier plutôt que l'inverse stipulé théoriquement. Ce point est crucial concernant les "carry trades" et sera détaillé plus tard. Pour l'instant, concentrons nous sur le premier chapitre dans lequel le taux de change est modélisé à partir de règles de Taylor basées sur les fondamentaux. De façon similaire à Molodtsova and Papell (2009), deux règles de Taylor sont définies, une pour le pays domestique et une pour le pays étranger. Ensuite, en supposant que la parité des taux d'intérêt non couverte est respectée, nous obtenons une équation du taux de change entre ces deux pays. Un point important de notre modèle est le fait que le petit pays ne veut pas que son taux de change dévie de la parité des pouvoirs d'achat. Pour ce faire, nous supposons que la banque centrale de la petite économie à une cible de taux de change effectif réel. Ce taux de change effectif réel est un panier de devises composé d'euros et de dollars Américains. Dans une telle modélisation, il semble important de reproduire le fait stylisé selon lequel il existe des déviations à la parité des taux d'intérêt non couverte dans le court terme. Étant donné que nous faisons l'hypothèse d'apprentissage adaptatif, notre modèle est capable de reproduire ce fait stylisé. En effet, grâce à cette hypothèse, dans le court terme, les agents ont une perception de l'économie différente de la perception qu'ils auraient de l'économie en supposant des anticipations rationnelles (évolution réelle de l'économie). Comme présenté ci-dessus, l'apprentissage adaptatif est une hypothèse convenable pour modéliser le taux de change.

Cette hypothèse tient au fait que les agents sont des économètres. Plus précisément, les agents ont une perception de l'économie qui peut être fausse, cependant, à partir de ce qu'ils observent de l'économie et de leurs erreurs passées, ils sont capables de se corriger et d'apprendre la véritable évolution de l'économie. Ainsi dans le long terme, le système converge vers l'équilibre d'anticipations rationnelles, ce qui signifie que les agents connaissent la véritable évolution de l'économie dans le long terme. Cette hypothèse est en accord avec ce qu'il se produit réellement en finance internationale. En effet, les fonds d'investissement et les grandes banques embauchent des économètres afin de prédire ce qu'il va se passer sur les marchés financiers. Ainsi l'hypothèse d'apprentissage adaptatif est en accord avec ce qu'il se produit sur les marchés financiers, ce qui en fait une hypothèse cruciale lorsqu'il est question de finance internationale.

Rappelons que la non validation de la parité des taux d'intérêt non couverte amène les investisseurs à faire de l'arbitrage, ce qui a conduit à l'apparition des "carry trades".

0.1.2 L'émergence des "carry trades"

La non validation empirique de la parité des taux d'intérêt non couverte a conduit les investisseurs à parier contre celle-ci. Un tel investissement sur devise est bien connu en finance internationale et se nomme "carry trade". Le but de ce type d'investissement est d'emprunter dans une devise à faible rendement pour investir dans une devise à rendement élevé, à travers cette opération, les investisseurs cherchent à gagner le différentiel d'intérêt ajusté des variations du taux de change. Ce type d'investissement a bénéficié d'un large écho dans le monde académique depuis l'article de Burnside et al. (2006a) qui a révélé que ces investissements présentaient un ratio de Sharpe plus élevé que celui du marché boursier américain. Leurs résultats mettent aussi en avant le fait que les rendements des "carry trades" ne sont pas corrélés avec ceux du marché boursier américain. Une caractéristique importante des "carry trades" est le fait qu'ils peuvent affecter l'économie dans son ensemble à travers le risque de renversement qui leur est inhérent. Suite à ce qu'on appelle un renversement des "carry trades", la devise du pays ciblé va connaître une forte dépréciation. Plus précisément, l'effet des "carry trades" sur l'économie est le suivant : ces investissements engendrent des afflux de capitaux qui vont apprécier la devise du pays cible, ce qui va amener les investisseurs à anticiper un rendement futur plus élevé et générer de nouveaux afflux de capitaux à travers des "carry trades". Néanmoins, les investisseurs ne vont pas anticiper indéfiniment une appréciation de la devise du pays cible, ainsi à un certain moment, les investisseurs vont s'attendre à une dépréciation de cette devise cible, les conduisant à la vendre en masse. Ces nouvelles positions des investisseurs vont avoir pour effet de déprécier fortement la devise du pays cible. Évidemment, ce risque est d'autant plus important que le pays en question dépend de capitaux étrangers.

Cette thèse voue une importance particulière au fait que les "carry trades" soient étroitement liés à la politique monétaire. En effet, le rendement d'un "carry trades" peut-être formalisé de la manière suivante :

$$z_{t+1} = r_t - r_t^* + E_t s_{t+1} - s_t, \tag{0.1}$$

avec r_t et r_t^* les taux d'intérêt domestiques et étrangers respectivement et $E_t s_{t+1}$ et s_t, les taux de change anticipé et courant respectivement. Comme présenté dans l'équation 0.1, les taux d'intérêts domestiques et étrangers qui sont fixés par les banques centrales sont une partie du rendement d'un "carry trade". En se référant au papier de Clarida et al. (1998), une fonction de réaction traditionnelle peut être définie comme suit :

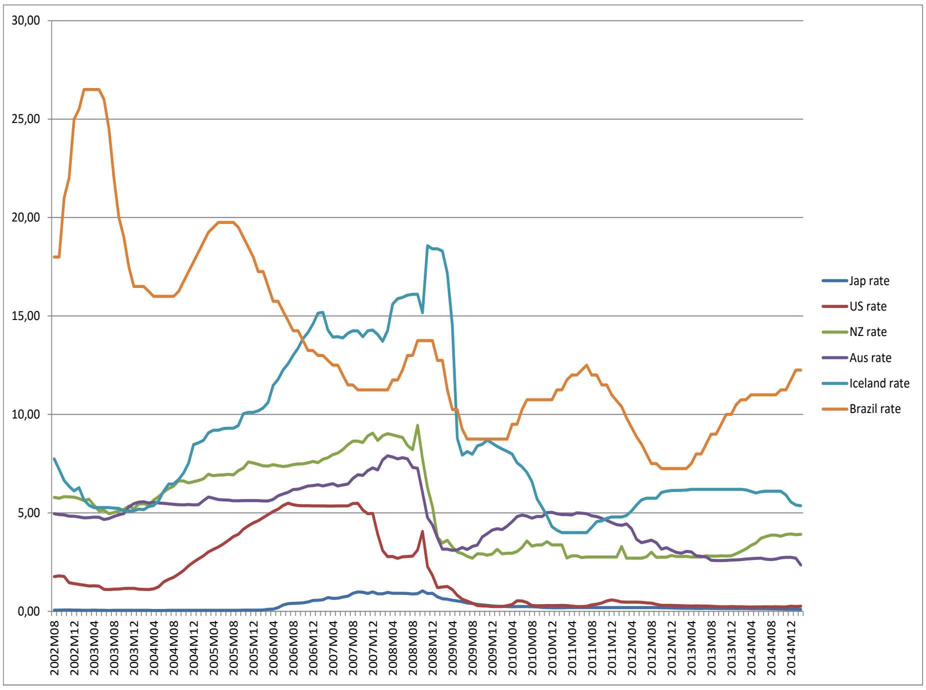
$$r_t = \alpha + \beta E_t \pi_{t+1} + \gamma x_t + \epsilon_t, \tag{0.2}$$

avec r_t, le taux d'intérêt de court terme, $E_t \pi_{t+1}$, le taux d'inflation anticipé et x_t l'output gap. L'équation 0.2 montre clairement qu'en réagissant à l'output gap et l'inflation anticipée, la banque centrale va modifier le taux d'intérêt de court terme qui est l'un des déterminants du rendement d'un "carry trade". De plus, les "carry trades" vont, eux mêmes, affecter l'output gap et l'inflation, ce qui va amener la banque centrale à réagir indirectement à ces investissements. Cette réaction de la banque centrale peut-être soit stabilisatrice soit déstabilisatrice pour l'économie. Certaines banques centrales fixent une cible de taux de change, conduisant les autorités monétaires à réagir directement à un des déterminants du rendement d'un "carry trade". Il apparaît maintenant évident que la façon dont les banques centrales établissent leur politique monétaire est un point crucial concernant les investissements sur devises. De toute évidence, les politiques monétaires du pays cible et du pays apporteur de fonds vont affecter le rendement des "carry trades". A ce sujet, il est important de mentionner le fait qu'à partir des années 2000, le contexte international est devenu favorable à ce type d'investissements.

Dans un premier temps, il apparaît judicieux de montrer comment des pays sources ont émergés dans les années 2000, puis comment certains pays cibles sont apparus à la même période. Un fait important est la politique d'assouplissement quantitatif qui a été mise en place au Japon à partir de Mars 2001. Le fait est que l'annonce d'une telle politique informe les investisseurs que les taux de court terme du Japon vont rester proches de zéro aussi longtemps que cette politique sera présente. En reprenant l'équation 0.1, nous observons clairement qu'une telle politique va rendre les "carry trades" plus attractifs. De plus, l'annonce d'une telle politique cible clairement quel pays sera utilisé comme pays source pour les investissements sur devises. Plus précisément, lorsqu'une banque centrale annonce qu'elle mettra en place une politique d'assouplissement quantitatif entre deux périodes A et B, les investisseurs potentiels seront conscients que le taux d'intérêt de court terme (r_t^* dans l'équation 0.1) restera proche de zéro sur toute la période allant de A à B. Par conséquent, les investisseurs vont saisir l'opportunité d'emprunter dans cette devise pour placer le montant emprunté dans une devise ayant un rendement plus élevé. Pendant de nombreuses années, le Japon a été le seul pays dans ce cas. La crise financière globale de 2008 a modifié le paysage dans le sens où elle a amené les Etats-Unis à mettre en place, à leur tour, une politique monétaire dite non conventionnelle. Ce qui fait des Etats-Unis un autre pays potentiellement source de "carry trades".

Concernant les pays cibles, il est important de mentionner les politiques de ciblage d'inflation, dans le sens où ces dernières ont pour effet d'accroître fortement le taux d'intérêt en période inflationniste. A ce propos, la Nouvelle-Zélande, dans les années 1990, est le premier pays à avoir expérimenté une telle politique monétaire. Suite à cette expérience Néo-Zélandaise, nombreux sont les pays à avoir, à leur tour, mis en place une politique de ciblage d'inflation. C'est par exemple le cas, entre autres, de l'Australie, du Brésil, de l'Islande, du Canada, de la République Tchèque. De par son effet positif sur le taux d'intérêt en période inflationniste, cette politique met en avant quels pays sont les cibles des "carry trades". D'après la figure 0.1, il y a clairement des opportunités d'arbitrages entre certains pays sur la période présentée. Dans un premier temps, la figure 0.1 reflète clairement le fait que le Japon (Yen) est un pays source sur toute la période. Nous pouvons aussi constater qu'avant la crise, les Etats-Unis pouvaient-être perçus comme un pays cible pour les "carry trades", alors qu'après la crise, le Dollar américain est devenu une devise source. En effet, avant la crise, un investissement typique était d'emprunter en Yen pour placer en Dollar américains. Un tel changement de statut pour la devise américaine est clairement lié à la politique d'assouplissement quantitatif. Pour finir, la figure 0.1 met en avant le fait que le Dollar Néo-Zélandais, le Dollar Australien, la Couronne Islandaise

Figure 0.1: Taux d'intérêts à trois mois

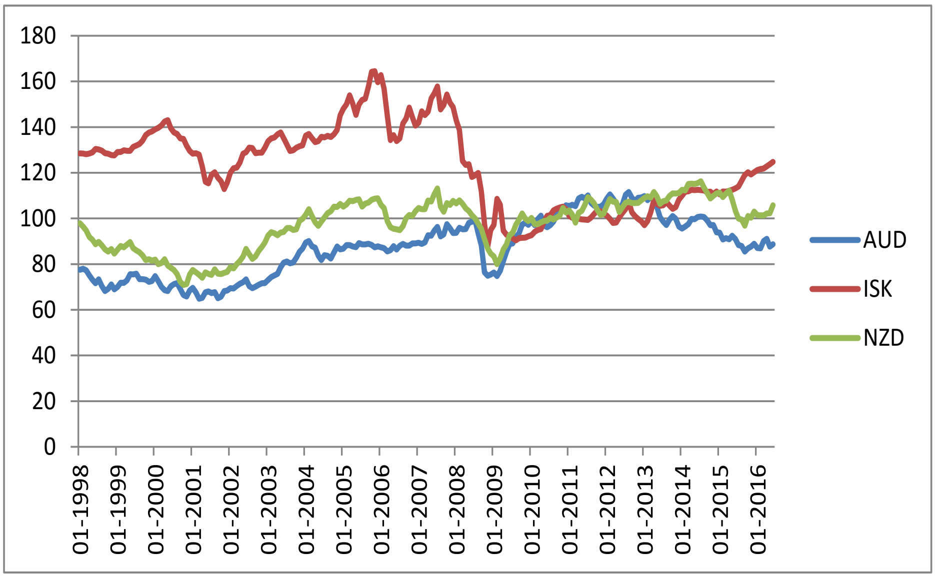


Notes: Les données utilisées proviennent de Datastream (données mensuelles).

ainsi que le Réal Brésilien ont enregistré des taux d'intérêt très élevés par rapport à ceux du Japon et des Etats-Unis. Ces pays en ciblage d'inflation apparaissent comme les pays cibles de "carry trades". Depuis les années 2000, les grandes économies exportent des liquidités vers les petites économies ouvertes qui ont une cible d'inflation.

L'équation 0.1 met clairement en avant le fait que la seconde source de rendement d'un "carry trade" est le taux de change. Cette partie du rendement d'un investissement sur devises est d'autant plus importante qu'elle représente le risque. Par exemple, si un investisseur investit en Dollar Néo-Zélandais et que cette devise se déprécie, ce dernier enregistrera une perte. Il est important d'établir un comparatif entre les figures 0.1 et 0.2. Concernant

Figure 0.2: Taux de change effectifs nominaux



Notes: Les données utilisées proviennent de la banque des réglement internationaux (données mensuelles). A noter qu'une augmentation de l'indice reflète une appréciation de la devise.

le Dollar Néo-Zélandais, le Dollar Australien et la Couronne Islandaise, nous pouvons constater, qu'avant la crise, lorsque le différentiel d'intérêt avec le Japon était élevé, ces devises ont eu tendance à s'apprécier. Néanmoins, nous pouvons constater qu'à certaines périodes, ces devises ont connu de fortes dépréciations, ce qui est une caractéristique bien connue du rendement des "carry trades" (monte par les escaliers et descend par l'ascenseur). Après la crise, cet effet est moins frappant sur la figure 0.2 mais nous pouvons toujours le deviner.

Une problématique très importante de cette thèse est d'analyser si les afflux de capitaux liés à ces investissements sur devises sont une source de déstabilisation ou de stabilisation pour le pays ciblé. Dans cette thèse, je soutiens que ce type d'investissement est déstabilisateur dans les petites économies ouvertes. Il est ensuite question de creuser cette question en étudiant quelle politique monétaire serait à même de stopper cet effet déstabilisateur.

L'effet déstabilisateur mentionné ci-dessus est lié au fait que ces investissements peuvent générer un cercle vicieux dans les petites économies qui ciblent l'inflation. En effet, dans ce type de pays, les afflux de capitaux sont expansionnistes, amenant ainsi une augmentation de l'inflation. De ce fait, la banque centrale va augmenter le taux d'intérêt de court terme qui va accroître le rendement des "carry trades" et amener des afflux de capitaux futurs. Ce mécanisme met clairement en avant le fait que dans les économies ayant une cible d'inflation, plus il y a de "carry trades", plus ils sont attractifs. Les chapitres deux et trois analysent en détail ce type d'investissement.

0.1.3 Contributions

Les contributions de cette thèse peuvent être divisées en deux parties. D'une part, le premier chapitre offre une nouvelle façon de penser la cointegration entre les taux de changes en proposant des fondements théoriques aux co-mouvements de long terme entre les taux de change. D'autre part, les deuxième et troisième chapitres étudient en profondeur les investissements sur devises connus sous le terme anglais de "carry trades". Le second chapitre s'intéresse à la façon dont les banques centrales des petites économies ouvertes doivent réagir afin de limiter l'effet déstabilisateur des "carry trades". Le troisième chapitre se concentre sur le cas Néo-Zélandais et étudie la façon dont les autorités monétaires Néo-Zélandaises répondent à ces investissements.

A partir d'un modèle théorique avec apprentissage adaptatif, le premier chapitre intitulé "On exchange rates comovements: New evidence from a Taylor rule fundamentals model with adaptive learning" introduit une façon de reproduire les co-mouvements de long terme entre les taux de change. D'un point de vue théorique, ce chapitre est très intéressant dans le sens où il offre une nouvelle manière de penser la cointégration entre les taux de change. D'un point de vue économique, les résultats de ce chapitre mettent en avant le fait que les mouvements communs de long terme entre les taux de change dépendent du degré d'intégration entre les économies ainsi que des politiques monétaires mises en places dans les différents pays. Plus précisément, dans ce modèle nous supposons que les petites économies ont une cible de taux de change effectif réel afin de ne pas dévier outre mesure de la parité des pouvoirs d'achat. Grâce à cette hypothèse, nous sommes capable d'étudier comment les taux de change réagissent lorsque les différentes banques centrales n'accordent pas la même importance à cette cible de taux de change effectif réel. Nos résultats mettent en avant le fait que lorsque deux banques centrales n'accordent pas les mêmes préférences à leur cible de taux de change, il n'y a plus de dynamiques de long terme communes entre leurs taux de change. Dans ce chapitre, nous considérons aussi les politiques monétaires dites non conventionnelles. Nos résultats révèlent que lorsque la grande économie s'engage dans une telle politique monétaire, les relations de cointégrations diminuent. Un tel résultat met en avant le fait que les politiques d'assouplissement quantitatif aux Etats-Unis vont amener les taux de change à diverger durant certaines périodes, mais les dynamiques communes de long terme entre les taux de change seront toujours présentes. Pour finir, nous validons nos résultats théoriques en s'appuyant sur une étude empirique.

Le deuxième chapitre intitulé "Adaptive learning, monetary policy and carry trades" étudie comment les banques centrales des petites économies ouvertes doivent réagir aux "carry trades". Le fait est que la façon dont elles vont répondre à ces investissements peut être déstabilisatrice. Comme mentionné précédemment, ces investissements peuvent générer un cercle vicieux. Ce chapitre est basé sur un modèle théorique dans lequel nous considérons différents types de politiques monétaires. Ensuite, nous simulons un choc d'inflation afin d'étudier quelle politique monétaire sera la plus performante concernant l'effet déstabilisateur de ces investissements. Dans un premier temps, nous considérons des politiques monétaires standards, à savoir une politique de ciblage d'inflation pur puis des politiques de ciblage d'inflation flexible (discrétionnaire ainsi qu'avec un engagement). Ensuite, nous introduisons un nouveau type de politique monétaire dans lequel la banque centrale a un objectif d'afflux de capitaux ainsi qu'un objectif d'inflation (une fois encore discrétionnaire et avec engagement). Graçe à notre hypothèse d'apprentissage adaptatif, nous étudions le cas dans lequel les agents ne connaissent pas les cibles de long terme de la banque centrale. Nos résultats mettent en avant trois points :

- Une politique de ciblage d'inflation pur déstabilise l'économie.
- Le cercle vicieux peut être réduit lorsque la banque centrale agit de façon discrétionnaire et a une cible d'inflation ainsi qu'une cible d'output. Il peut être totalement stoppé si la banque centrale agit de façon discrétionnaire et choisit une cible d'inflation ainsi qu'une cible d'afflux de capitaux.
- Lorsque les agents ne connaissent pas les cibles de long terme, l'effet déstabilisateur est amplifié.

Le troisième chapitre intitulé "carry trades in New-Zealand: Do monetary authorities take them into account?" est un travail empirique ayant pour vocation de montrer si la banque centrale Néo-Zélandaise (RBNZ) réagit de manière stabilisatrice ou déstabilisatrice aux "carry trades". Dans ce chapitre nous estimons quatre équations par la méthode des moments généralisés afin de montrer comment les investissements sur devises vont affecter l'économie. Nos résultats révèlent que la RBNZ a répondu de manière déstabilisatrice à ces investissements en provenance du Japon avant la crise. Cependant, après la crise, la banque centrale Néo-Zélandaise a pris en compte ces investissements en provenance du Japon en y répondant par une baisse du taux d'intérêt. Pour finir, après la crise, la banque centrale répond aux investissements en provenance des Etats-Unis de manière déstabilisatrice. Concernant ces investissements en provenance des Etats-Unis, nos résultats mettent en avant le fait que leur effet déstabilisateur est exacerbé lorsque les Etats-Unis utilisent une politique d'assouplissement quantitatif.

0.2 English version

0.2.1 The international context

In the 1990's, there was a consensus among practitioners and some academics concerning the liberalization of capital accounts. The basic idea was that liberalizing the capital account would generate growth. However, as presented in many studies, such a relationship is not so obvious (see e.g. Rodrick (1998) and Stiglitz (2004)). Moreover, such a liberalization could be destabilizing in developing countries. Many studies report that developing countries should have a financial sector enough developed before liberalizing their capital account. It is obvious that if the financial sector is not enough sound, capital flows generated by the capital account liberalization would be hugely destabilizing for the countries. Unfortunately, the story gives us many examples of crises clearly linked to such a capital account liberalization. Indeed, the Mexican crisis (1994), the Asian crisis (1997), the Russian crisis (1998) and the Argentina crisis (2001) are all example of developing countries which have liberalized their capital account too early.

A major feature concerning free movement of capital in such countries is that the growing stock of capital allows the country to borrow and invest more. First, the countries do not systematically evaluate well the risk of their borrowing. Second, the increasing borrowing is financed by foreign capitals. More precisely, the debt is denominated in foreign currency which exposes the country to important risks (see e.g. Mishkin (1999)). Argentina and Mexico were two particular countries in the sense that they were experiencing a currency board. Such a policy has led these two countries to be unable to adjust their exchange rates. These two countries have hugely suffered due to the currency depreciation brought by the crisis. However, even the other countries affected by the crisis have seen their currencies fallen sharply. Such an acknowledgment reveals how important it is to stabilize the exchange rates (see e.g. Demiroglu and Karagoz (2016)).

In such an international context, it has been crucial for economists to investigate how the exchange rate evolves. Indeed, understanding exchange rates' dynamics would help policy makers to stabilize the whole financial system. Unfortunately, for instance it does not exist models reproducing correctly the evolution of this variable. For instance academic works reveal that the model who better explains exchange rates' dynamics is a random walk. The theoretical determination of the exchange rate is one of the motivation of the first chapter of my thesis. Thus, I am going to review the recent findings concerning such an exchange rate modeling in order to shed light on the contribution of the first chapter of my thesis.

The presence of more and more countries in floating exchange rates has led economists to investigate exchange rates' determinants. There is a large literature on exchange rates' determinants. Among others, Bacchetta and Wincoop (2010), Engel and West (2003), and Molodtsova and Papell (2009) model this variables from macroeconomic fundamentals. The point is that in every exchange rates model there remain a part of this variable which remains unexplained.

Concerning the unexplained part of the exchange rate, the way agents form their expectations and make mistakes while forming these expectations seems to be a good candidate. It clearly appears that the investments' decisions on the foreign exchange market are linked to investors' expectations. Nobody would be surprised to ear that investors' positions clearly influence the exchange rate's behavior. By the way, there is also a large literature concerning the forward premium puzzle. The thing is that the combination of the covered and uncovered interest rate parities concludes that the forward rate is a perfect predictor of the future exchange rate. Such an assumption is presented by the following equation:

$$F_t = E_t s_{t+1},$$

with F_t the forward rate and $E_t s_{t+1}$ the expected exchange rate. The above mentioned forward premium puzzle comes from the fact that such an equation is not validated by empirical investigation. Thus, the forward rate is not a perfect predictor of the future exchange rate. From a monetary model with adaptive learning Chakraborty and Evans (2008) find that adaptive learning better explains the forward premium puzzle than rational expectations. In other words, that means that the way agents form there expectations could explain a part of the forward premium puzzle. That is a crucial finding in the sense that it suggests to model the exchange rate by accounting for the way agents form their expectations. Departing from this finding, in the first chapter, we investigate whether it is possible, through a theoretical model, to generate long run comovements between exchange rates. Such an issue is crucial concerning the understanding of exchange rate dynamics and would help policy makers to stabilize the financial system. Beside the unexplained part of the exchange rate there are also the economic fundamentals which explain a part of the evolution of this variable.

As presented by the uncovered interest rate parity (UIP), the most important variables to define the exchange rate are the domestic and foreign interest rates. The UIP is a crucial theroy in international finance, it is also known as the no arbitrage condition and is used in many exchange rates model. More precisely, the UIP states that changes in the exchange rate cancel the gain enhanced by a large interest differential. Theoretically, the UIP is defined as follow:

$$1 + r_t = \frac{E_t s_{t+1}}{s_t}(1 + r_t^*),$$

and clearly shows that the high yield currency tends to depreciate, canceling potential benefits from arbitrage. However, since the seminal paper of Fama (1984), we know that UIP is rejected with real data. Then, many authors have investigated such a deviation from UIP and have shown that high yield currencies tend to appreciate instead of depreciate. Notice that this is a main point concerning carry trades but I will detail this part later. For instance, let me focus on the first chapter in which we model exchange rate changes with Taylor rule fundamentals. In line with Molodtsova and Papell (2009), we set two Taylor rules, one for the domestic country and one for the foreign country. Then, assuming that UIP holds, we obtain an exchange rate equation. In our framework, the smallest economy does not want to deviate too much from the Purchasing Power Parity. With such a model, we have to reproduce the stylized fact which states that in the short run there are deviations from the UIP. Fortunately, the adaptive learning hypothesis allows to account for such an empirical fact. Indeed, given that in the short run, agents' perception of the economy is different than rational expectations (real evolution of the economy), deviation from the UIP in the short run are present in the model performed in the first chapter. As presented here, adaptive learning is a convenient hypothesis to model the exchange rate.

Such an hypothesis lies on the fact that agents are econometricians. More precisely, agents have a perception of the economy which could be wrong (agents are not fully rational, thus they do not know the true model of the economy). More precisely, from their beliefs concerning the economy and what they are able to observe they form their expectations according to an econometric model. Given that agents adapt their beliefs observing their past errors, they are able to know the true evolution of the economy in the long run. Notice that such an hypothesis is in line with what happens in international finance. Indeed, hedge funds and banks hire econometricians in order to construct model which will be an important part of the investment decision. Thus, while talking about international positions, adaptive learning seems to be a crucial assumption.

Recall that the UIP failure means that investors can do arbitrage between currencies which has led to the appearance of carry trades. The mechanism in simple: UIP states that exchange rate changes cancel the gain from a high interest differential. Thus, it is straightforward that the UIP failure offers investment opportunities in the sense that exchange rate changes do not cancel potential gains from a high interest differential.

0.2.2 Carry trades' emergence

The empirical failure of the UIP has led investors to bet against it. Such an operation is known as carry trades which aim at borrowing a low return currency and invest it in a high return one. These investments on currencies have been widely investigated since the seminal paper of Burnside et al. (2006a) which reveals that such investments present a higher Sharpe ratio than the US stock market. Interestingly, they also find that the returns from carry trades are not correlated with the one of the US stock market. Such investments have gained high attention in the sense that they affect the whole economy. Indeed, such investments rise the problem of carry trades reversal which could affect the whole economy. The risk is that investors' behavior could hugely depreciate the targeted currency. More precisely, carry trades enhance capital inflows which appreciate the exchange rate, leading investors to expect a higher return from carry trades enhancing further incoming carry trades. Nevertheless, the domestic currency is not expected to appreciate indefinitely, thus at a certain moment, investors expect a depreciation and sell the domestic currency. Investors' new positions lead to capital outflows and hugely depreciate the domestic currency. Such a risk is exacerbated in countries which are dependent on foreign capital[a].

Another important feature concerning carry trades is that they are closely related to the monetary policy. Indeed, the expected return from a carry trade can be formalized as follow (in log):

$$z_{t+1} = r_t - r_t^* + E_t s_{t+1} - s_t, \tag{0.3}$$

with r_t an r_t^* the domestic and foreign nominal interest rates respectively and $E_t s_{t+1}$ and s_t, the expected and current nominal exchange rates respectively. Importantly the domestic and foreign interest rates are set by their respective central banks (the short run interest rate is the tool used by central banks to stabilize the economy). Following Clarida et al. (1998), a basic reaction function can be defined as follows:

$$r_t = \alpha + \beta E_t \pi_{t+1} + \gamma x_t + \epsilon_t, \tag{0.4}$$

with r_t, the short run interest rate, $E_t \pi_{t+1}$, the expected inflation and x_t the output gap. Equation (0.4) clearly shows that reacting to inflation and the output gap, the central bank affects the short run interest rate which is one of the determinants of the carry trade returns. Notice that carry trades themselves can affect the output gap and then inflation, leading the central bank to indirectly react to carry trades whether in a destabilizing or in a stabilizing way. Moreover, some central banks could also have an exchange rate target, meaning that the central bank reacts directly to a component of carry trades' return. Accordingly, the way the central bank sets its monetary policy clearly affects carry trades' return. Moreover, both the monetary policies of the targeted country (the country receiving carry trades) and the source country affect the return of carry trades. Interestingly since 2000, the international context has become favorable to such investments.

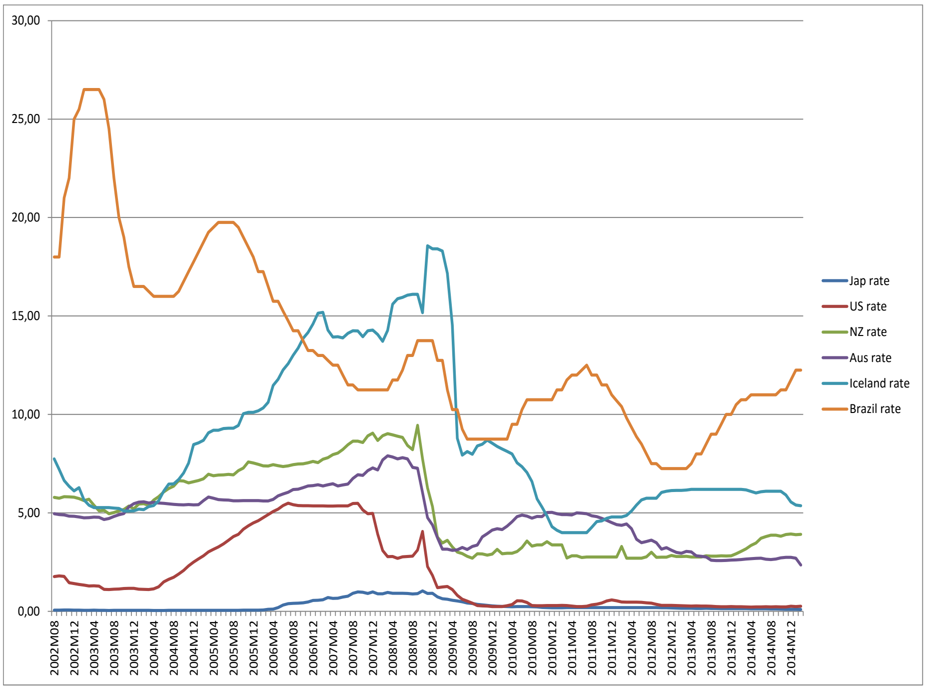
As a first step, it appears obvious to show how sourced countries have emerged in the 2000 and how targeted countries were also present in the

[a]This is clearly the case in New-Zealand (see e.g. chapter 3).

same period. On the one hand, Japan has been the first country to implement a quantitative easing policy in March 2001. Such a policy announces to market participants that the Japanese interest rate will remain close to zero all along the policy. Going back to equation (0.3), such a policy announcement clearly makes carry trades attractive, or at least, informs us concerning the source country of carry trades. More precisely, when a central bank announces that it will use an unconventional monetary policy from date A to date B, potential investors would know that the short run interest rate (r_t^* in equation (0.3)) would remain close to zero between dates A and B. Consequently, investors would take the opportunity to borrow this currency in order to invest it in a higher yield one. For a long time Japan has been the only sourced country for carry trades. However, since the Global Financial Crisis (GFC), other large economies have resorted to unconventional monetary policies. Indeed, after the GFC, the United-States began to implement a quantitative easing policy, which led the US to become a source country for carry trades from this date. More recently, the European central Bank also implemented a QE policy. Thus since 2001, with Japan and since the GFC with the United-States, two source countries for carry trades have emerged.

On the other hand, in the 1990's, New-Zealand was the first country to implement a strict inflation targeting policy. Many other countries have done the same (among others, e.g. Australia, Brazil, Iceland, Canada, Czech-Republic). Such a policy hugely increases the interest rate during inflationary periods, leading to high interest differentials with low return currencies. Accordingly, inflation targeting policies has led to the emergence of targeted currencies for carry trades. Figure (0.3) clearly reveals that there are arbitrage opportunities between some countries. First, Figure (0.3) reveals that the Japanese Yen could serve as a funding currency all along the period. However, before the GFC, the US were a targeted currency but became a source currency after the crisis. Indeed, before the GFC, the most used carry strategy was to borrow in Japanese Yen and invest in USD. Such a change for the US dollar is linked to the unconventional monetary policies done after the GFC. Finally, Figure (0.3) shows that New-Zealand, Australia, Iceland and Brazil have registered high interest rates compared to Japan and the US. Such countries targeting inflation clearly appear as targeted country for carry trades. Hence, since the 2000's, large economies export liquidities to

Figure 0.3: Three months interest rates

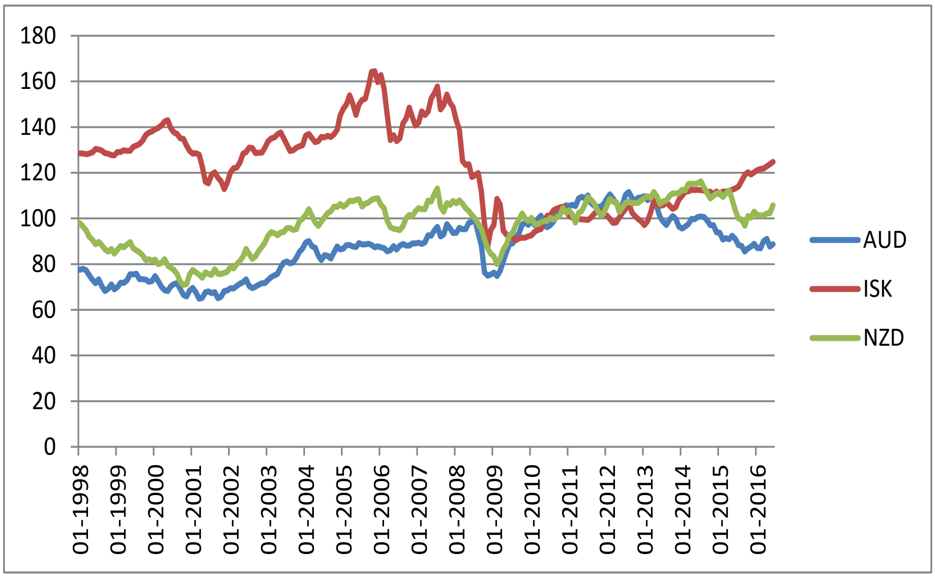


Notes: Data are taken from Datastream (monthly data).

small open economies which target inflation.

As presented in equation (0.3), the second source of return for carry trades are the exchange rate. Indeed, that is an important component of carry trades' return in the sense that it defines the risk. For an example if an investor invest in New-Zealand Dollar and that this currency depreciates, the investor would lose money. An important feature of carry trades is the fact that they enhance a risk reversal risk which is synonym to a sharp depreciation of the targeted currency. What is important here is the comparison of figures (0.3) and (0.4). Focusing on the AUD, NZD and ISK, we observe that before the crisis, when the interest differential with Japan was high, these currencies tend to appreciate. However, at some periods, there were sharp

Figure 0.4: Nominal effective exchange rates



Notes: Data are taken from the Bank of international settlement (monthly data). Notice that an increase in the index reflects an appreciation of the currency.

depreciations of these currencies. Such an observation is not surprising for countries receiving carry trades, and illustrate well the well known behavior of exchange rates in countries subjected to carry trades "going up by the stairs and going down with the elevator". After the crisis, the exchange rates presented in figure (0.4) seem more stable but the previous mentioned effect looks still present for the AUD and NZD.

A major issue of my thesis is to investigate whether capital inflows enhanced by carry trades destabilize or not the targeted small open economies. In this thesis, I argue that the small open economies are destabilized, thus I go further by investigating which monetary policy could be able to mitigate or suppress the destabilizing effect of carry trades.

By destabilizing effect, I mean that carry trades could enhance a vicious circle in small open economies targeting inflation. Indeed, in such countries, increasing carry trades lead to further capital inflows. Such capital inflows are expansionary, rising inflation. Then, the central bank raises the interest rate in order to reduce inflation. However, the increasing interest rate makes carry trades more attractive, leading to further expansionary capital inflows generating another intervention of the central bank. Thus, it clearly appears that in small open economies targeting inflation, the more there are carry trades, the more they are attractive. The second and third chapters analyze this carry trades issue.

0.2.3 Contributions

The contributions of my thesis can be divided in two parts. On the one hand, the first chapter offers a new way of thinking of cointegration between exchange rates by proposing theoretical determinants of long run comovement between exchange rates. On the other hand, the second and third chapters investigate the main issue of carry trades. The second chapter investigates how small open economies' central banks could mitigate the destabilizing effect of carry trades. The third chapter focuses on the case of New-Zealand by investigating how the Reserve Bank of New-Zealand (RBNZ) responds to such investments.

From a theoretical model with adaptive learning, the first chapter entitled "On exchange rates comovements: New evidence from a Taylor rule fundamentals model with adaptive learning" introduces a way to replicate long run comovements between exchange rates. Interestingly this chapter offers a new way of thinking concerning the theoretical determinants of cointegration between exchange rates. From an economic point of view, the simulations results allow to conclude that long run comovements between exchange rates are mainly based on the degree of integration of the economy and the monetary policies done in different countries. More precisely, in our model, we assume that the small open economies central banks target the real effective exchange rate not to deviate too much from the purchasing power parity (PPP). Such an assumption allows to investigate how different central banks preferences in terms of exchange rate targeting affect the common long run dynamics between exchange rates. Interestingly, we find that when two countries do not grant the same weight to the exchange rate, there are no more common long run dynamics between their exchange rates. We also investigate how unconventional monetary policies affect the long run comovement between exchange rates. Importantly, our results reveal that the number of cointegration relationships decrease but exchange rates still present long run comovements. Such a finding reveals that QE episodes in the United-States makes the exchange rates to diverge at some periods but do not cancel long run common dynamics between exchange rates. At last but not least, we perform an empirical estimation which allows to confirm our theoretical results with real data.

The second chapter entitled "Adaptive learning, monetary policy and carry trades" investigates how a small open economy central bank should respond to carry trades. Indeed, the way the central bank respond to such investments could destabilize the economy. The point is that carry trades could be self-fulfilling, leading to a vicious circle (the more there are carry trades, the more they are attractive). Thanks to a theoretical model, we consider different monetary policy frameworks. Then, by simulating an inflation shock we are able to conclude which of this framework better performs in terms of carry trades' vicious circle. First, we investigate standard monetary policies known as inflation targeting and flexible inflation targeting with both an inflation and an output gap target (both under discretion and commitment). Then we introduce a new framework in which the central bank has both an inflation and a capital inflows target (once again both under discretion and commitment). Thanks to our adaptive learning hypothesis, we are able to treat the case in which agents do not know the long run targets of the central bank. Our results shed light on three main points:

- The inflation targeting policy clearly destabilizes small open economies subject to carry trades.
- The standard flexible inflation-targeting policy under discretion (second best) is able to mitigate the carry trades' vicious circle while the flexible inflation-capital targeting policy under discretion (first best) is able to totally suppress it.

- When agents do not know the long run targets of the central bank, the destabilizing effect of carry trades is enlarged. Consequently, small open economies central banks in countries subject to carry trades have to be clear concerning their long run targets.

The third chapter entitled "Carry trades in New-Zealand: Do monetary authorities take them into account?" is a pure empirical work which investigates whether the RBNZ responds to carry trade in a stabilizing or a destabilizing way. In this chapter, we estimate four equations with the generalized method of moments in order to show how carry trades affect the New-Zealand's economy. Our results reveal that the Reserve Bank of New-Zealand responded in a destabilizing way to carry trades sourced in Japan before the GFC. Interestingly, we find that after the crisis the RBNZ reduced the interest rate after incoming carry trades from Japan. Such a result means that the RBNZ began to account for the self-fulfilling character of Japanese carry trades after the crisis. However, we also show that United-States sourced carry trades are still destabilizing after the GFC and that the RBNZ responded to such investments in a destabilizing way. Furthermore our results also reveal that US sourced carry trades are more destabilizing during quantitative easing episodes in the US.

Chapter 1 On exchange rate comovements: New evidence from a Taylor rule fundamentals model with adaptive learning[a]

1.1 Introduction

The aim of the paper is to propose a theoretical framework which combines Taylor rule fundamentals and adaptive learning to assess under which theoretical conditions cointegration between exchange rates can arise. Indeed, our motivation lies on the fact that in our knowledge there is no theoretical model which tries and is able to reproduce long run comovements between exchange rates. There are two important ingredients in our theoretical model which are the fact that small open economies central banks target a real effective exchange rate and that agents are not fully rational. First, assuming that central banks do not want to deviate too much from PPP allows us to consider different Taylor rules by considering different central banks' preferences in terms of exchange rates. Second, using adaptive learning allows us to reproduce important stylized facts concerning forward premia. Indeed, adaptive learning is able to reproduce the fact that forward premia are not $I(1)$ while rational expectations is not able to do so. The question of cointegration between exchange rates is highly relevant in the sense that the long run dynamics of exchange rates are really complex. Indeed, Baillie and Bollerslev (1994b) conclude for long run comovements between exchange rates by the mean of fractional cointegration. Such a finding reveals that the residuals are not $I(0)$ which means that the long run dynamics are complex. In this paper, we want to help understanding such complex long run common dynamics between exchange rates by the mean of a simple theoretical model.

There are few theoretical studies which focus on the determination of exchange rate co-movements, although the empirical literature has provided

[a]This chapter is an article co-written with Gilles de Truchis and Benjamin Keddad, (both Ph.D candidates at the begining of the paper).

evidence that currency pairs tend to move together both in the short and long run. For instance, Beckmann et al. (2012) find that the common factor of the exchange rates of 18 OECD countries is cointegrated with the common factors of economic fundamentals, thereby suggesting that common monetary policy and business cycles relative to the US are important determinants of USD exchange rates. Tamakoshi and Hamori (2014) and Li (2011) show that the currencies comove more closely during joint appreciations than joint depreciations against a world currency. Li (2011) explains this result by the existence of beggar-thy-neighbor policies between countries which have significant linkages of trade and capital flows. That is, the central bank of a given country will allow its currency to appreciate to avoid the inflationary pressure coming from the appreciation of a partner country's currency. In the same way, Engel (1996) proposes a simple monetary rule where a country adjusts its money supply depending on the exchange rate target of its central bank. Within this framework, the author shows that cointegration can emerge between cross-exchange rates due to central bank interventions. This reasoning is particularly relevant when considering fixed exchange rate regimes or target zone/crawling band exchange rate systems in which central banks intervene in order to keep the exchange rate within the bands. Under target zones, the exchange rates can fluctuate but remain linked together in the long run, generating cointegration relationships among the exchange rates. On this basis, cointegration theory has been used in many empirical studies for examining long-run exchange rate stability within the European Monetary System (see, e.g., Aroskar et al. (2004) ; Rangvid and Sørensen (2002) ; Woo (1999) ; Norrbin (1996)). More recently, Phengpis and Nguyen (2009) find that the Danish krone and the British pound are cointegrated with the euro which reflect the relative stronger degree of monetary policy coordination between the countries involved. Accordingly, Denmark, the UK and the EMU would constitute a *de facto* monetary bloc.

Although most of the aforementioned studies have stressed the role of macrofundamentals in generating exchange rate comovements, none of them rely on a formal theoretical framework. Since Meese and Rogoff (1983) and more recently, Kilian (1999), Cheung et al. (2005) and Engel et al. (2007), researchers have tried to provide evidence of the ability of macrofundamentals to explain exchange rate behavior *per se*. As stressed by Engel et al.

(2007), shocks on economic fundamentals may have a greater impact on exchange rates through expectations of monetary policy than through any other channel. Consequently, if we suppose that exchange rates are primarily driven by expectations, it is necessary to account for the endogeneity of monetary policy such as through interest rate rule. The rationale for this has its counterpart in the recent evolution of monetary policy and the results of many studies that demonstrated the superiority of Taylor-type monetary policy rules for stabilizing inflation (see, e.g, Taylor (1993)). Thereafter, the study of the connection between interest rates and exchange rates has resulted in a voluminous literature. For instance, Engel and West (2006) and Mark (2009) investigate the ability of Taylor rule fundamentals for explaining the behavior of the real exchange rates.

More directly related to our purpose, a recent literature has proposed the use of Taylor rules or interest rates to model exchange rate behavior. Under Taylor rules, inflation leads to an appreciation within an inflation targeting framework, because higher inflation induces expectations of tighter future monetary policy (see Molodtsova and Papell (2009) ; Engel et al. (2007) ; Clarida and Waldman (2007) ; Gourinchas and Tornell (2004))[b]. Molodtsova and Papell (2009) find stronger evidence of exchange rate short-term predictability with Taylor rule models than other conventional models for 11 out of 12 currencies against the US dollar over the post-Bretton Woods float. De Grauwe and Markiewicz (2013) study exchange rates determination and Taylor rule models with panel data forecasting. The authors stress that pooling information on countries with similar monetary policies and exchange rate framework allows significant improvement of the predictability of exchange rate.[c]

At the same time, a large strand of the literature has focused on the so-called adaptive learning hypothesis as it presents some ability to reproduce the main empirical stylized facts of exchange rates such as excess volatil-

[b]Molodtsova and Papell (2009) mentioned that this theoretical link potentially characterizes any country where the central bank uses the interest rate as the instrument in an inflation targeting policy rule. This conjecture departs from traditional flexible price models where an increase in inflation produces forecasted exchange rate depreciation.

[c]Among recent studies, see also Park and Park (2013) who consider a monetary model with time-varying cointegration coefficients and find time-varying long-run relationships between exchange rates and monetary fundamentals.

ity and persistent deviations of the exchange rate from macroeconomic fundamentals (Kim (2009), De Grauwe and Markiewicz (2013)). Introducing short-run deviations from rational expectations has also the main advantage of giving theoretical justification for explaining the short-horizon deviation of uncovered interest rate parity well-documented in the empirical literature (see, e.g., Lothian and Wu (2011) and Bekaert et al. (2007)). Finally, Chakraborty and Evans (2008) and Chevillon and Mavroeidis (2013) show that adaptive learning is able to mimic the long memory behavior of the forward premium documented (see Baillie and Bollerslev (1994b), Maynard and Phillips (2001) Maynard et al. (2013)).

In this paper, we aim to merge these avenues of research to investigate how long-run comovements can arise between exchange rates when adaptive learning operates in a three-country extension of the Taylor rule fundamentals model. Accordingly, our main contribution lies in methodological innovations for testing whether exchange rate cointegration can theoretically occurs under realistic assumptions. More specifically, we consider a theoretical framework where the central bank of the domestic country (i.e. the United States) targets the current inflation rate, the inflation gap, the output gap and the equilibrium real interest rate. Considering the disruptive effects of exchange rate misalignment on both external and internal balances, the central banks of the two foreign countries also target the purchasing Power Parity Level (PPP) of the exchange rate (see Clarida et al. (1998)).

On this basis, it becomes straightforward to derive two exchange rate equations from the interest rate differentials on the left-hand-side and fundamentals on the right-hand-side. Assuming further that the uncovered interest rate parity (UIP) holds in the long run and replacing the interest rate differential by the expected rate of depreciation, we can simulate the dynamic of each exchange rate (against the USD) and assess their comovements by means of fractional cointegration. There are several reasons for considering fractional cointegration when assessing long-run comovements. First, Baillie and Bollerslev (1994a) point out that cointegration between exchange rates cannot be properly estimated if the observables and the long run errors are considered as unit root and weakly dependent processes, respectively, thereby emphasizing that the fractional cointegration is more appropriate. Considering recent econometric developments in long memory and cointegration, Nielsen (2004) found mixed evidence of fractional cointegration whereas Hassler et al. (2006) and Nielsen and Shimotsu (2007) found strong evidence of cointegration among a subset of exchange rates.[d] Second, fractional cointegration allows taking into account a wider range of mean reverting processes toward the common long-run equilibrium compared to the classical $I(0)/I(1)$ framework. Depending on the degree of economic and monetary interdependence between countries, exchange rates can deviate persistently from each other, justifying the need to consider fractional cointegration tools.

Finally, the paper makes an original contribution in understanding why exchange rates comove, which is crucial for policymakers and market participants in many aspects. First, policymakers may find an interest to limit exchange rate fluctuations against selected foreign currencies in order to avoid the negative impact of currency misalignment. Second, understanding how exchange rates comove could provide meaningful information for a central bank aiming to achieve a desirable level of depreciation/appreciation of the domestic currency against those of its trade partners/competitors. Indeed, given the impact of exchange rates movements on real income and inflation, through the competitiveness of national exports and the price of imported goods, a careful assessment of factors which explains the comovement of exchange rates is crucial. Finally, the magnitude of exchange rate comovements plays an important role for international investors as it could affect the valuation of multi-currency options but also the hedging as well as the risk of currency/carry trade portfolios.

The main results of the paper are as follows: First, similar Taylor rules in integrated or partially integrated economies allow detection of common long-run dynamics in exchange rates.[e] Second, in the case of non integrated economies, even if the Taylor rules are similar, given that the economies do not face the same shocks or are not in the same business cycle, monetary authorities react in an opposite way. Third, the empirical application provided in last section suggests that a set of European spot exchange rates are

[d] All these studies use the dataset of Baillie and Bollerslev (1989). See also Kuhl (2010) who finds cointegration using the procedure of Johansen (1988).

[e] As explained below, we consider that Taylor rules are similar when monetary authorities of the two small open economies grant the same weight to the Euro and the US Dollar.

cointegrated, which implies implicit coordination of monetary policy within Europe.

Following this introduction, Section 1.2 introduces the model. Sections 1.3 and 1.4 present the simulation framework and the econometric techniques used to test for cointegration. Section 1.5 presents our empirical analysis and discuss the economic implications. Section 1.6 concludes the paper.

1.2 The model

We consider a three-country extension of the Taylor rule fundamentals model developed by Molodtsova and Papell (2009). We voluntary adopt a simple framework because we aim to show that long-run comovements are likely to arise between exchange rates without extra-complexity neither in the learning mechanism nor in the model. In our three country model, the exchange rate is defined as the currency per US dollar and monetary policies are described by Taylor rules. Thus, on one side we set the United-States Taylor rule. On the other, we set two small open economies Taylor rules by assuming that they do not want that their currency deviate too much from the PPP (see Clarida et al. (1998)). We suppose that the equilibrium exchange rates targeted by the central banks are given by a currency basket composed of the Euro and US Dollars (with potentially varying weights). We choose a currency basket rather than the bilateral real exchange rate because it is more realistic to assume that the central bank wants to maintain the equilibrium level of its currency vis à vis a weighted exchange rate composed of its major trading partner currency rather than the US dollar only. Accordingly, their respective real effective exchange rates (REER) appear in the Taylor rules. Thanks to this framework, given that changes in the exchange rate are directly linked to the interest differentials, we are able to model the two small open economies exchange rates vis-à-vis the US Dollar.

1.2.1 The Taylor rule fundamentals

1.2.1.1 The United States

It is well known that the Federal Reserve Bank has both objectives targeting inflation and growth. Thus the central bank will react to inflation and the output gap, leading to the following reaction function:

$$\bar{r}_{ut} = \pi_{ut} + \phi_u(\pi_{ut} - \bar{\pi}_{ut}) + \eta_u y_{ut} + i_u, \tag{1.1}$$

with $\bar{r}_{ut}$ the targeted short run nominal interest rate, $\bar{\pi}$ the target level of inflation, π_t the inflation at time t, y_t the output gap at time t and i the equilibrium real interest rate. Note that the subscript u denotes United States' variables. Following Molodtsova and Papell (2009), setting $\kappa_u = i_u - \phi_u \bar{\pi}_u$ and $\lambda_u = 1 + \phi_u$, the US reaction function is:

$$\bar{r}_{ut} = \kappa_u + \lambda_u \pi_{ut} + \eta_u y_{ut}. \tag{1.2}$$

As shown in Clarida et al. (1998), the interest rate adjusts gradually, such that:

$$r_{ut} = (1 - \delta)\bar{r}_{ut} + \delta r_{ut-1} + u_{ut}, \tag{1.3}$$

With δ the smoothing parameter and u_{ut} an exogenous shock to the interest rate[f]. Then inserting Equation (1.2) into (1.3) gives the following Taylor rule:

$$r_{ut} = (1 - \delta)(\kappa_u + \lambda_u \pi_{ut} + \eta_u y_{ut}) + \delta r_{ut-1} + u_{ut}. \tag{1.4}$$

The central bank uses the nominal interest rate r_{ut} to implement its monetary policy. An increase in inflation leads the central bank to raise the interest rate, slowing down the economic activity, reducing inflation further. The mechanism is the same for the output gap because this variable is inflationary. Notice that a decrease in the output gap is followed by a cut in the interest rate, boosting the economic activity.

[f] As stated by Clarida et al. 1998, such a shock could represent a random component to policy or imperfect forecasts of the central bank concerning reserves demand.

1.2.1.2 The small open economies

We consider that these economies want to maintain there PPP, which leads to the following Taylor rules:

$$r_{jt} = (1 - \delta_j)(\kappa_j + \lambda_j \pi_{jt} + \eta_j y_{jt} + \varphi_j q_{jt}) + \delta_j r_{jt-1} + u_{jt}, \tag{1.5}$$

with j a country specific index, $j = A$ or B for country A or B respectively. q_{jt} is the REER. In logarithm, $q_{jt} = \alpha_{ju}(s_{jt} + p_{ut} - p_{jt}) + \alpha_{je}(s_{jet} + p_{et} - p_{jt})$, where s_{jt} and s_{jet} are the nominal exchange rate of country j in US Dollar and Euro respectively. α_{ju} and α_{je} are the weights that the central bank grants to the US Dollar and Euro respectively[g], defined so that $\alpha_{ju} + \alpha_{je} = 1$. φ_j represents the weight granted by monetary authorities to the REER target. Using the nominal interest rate, the aim is to make PPP to hold. Thus, if the REER appreciates, the central bank cuts the interest rate causing the foreign currency to depreciate vis-à-vis the US Dollar. In this paper, we do not model fundamentals that drive REER. However, we can easily suppose that a similar equilibrium level of the exchange rates should reflect common trends in real fundamental macroeconomic variables (e.g. terms of trade, openness, government spending, productivity differentials, net foreign asset position) that drive REER and then, interest differentials and exchange rates. All these parameters allow us to investigate how different monetary policies' specifications will affect the link between two small economies' exchange rates.

1.2.2 The exchange rates

Exchange rate fluctuations depend on the interest differential, so assuming UIP we have the following,

$$\Delta E_t s_{t+1} = r_t - r_t^*, \tag{1.6}$$

[g]It is obvious that the small open economies considered here also react to the european monetary policy. Such a reaction is not directly modeled here, however the small open economies central banks react to the European monetary policy through the exchange rate. Indeed, given that the small open economies react to the exchange rate vis a vis the Euro, they also react to the European short run interest rate which determines the exchange rate.

With r_t and r_t^* the domestic and foreign interest rate respectively. Equation (2.1) states that the high yield currency tends to depreciate. Through adaptive learning, agents make mistakes while expecting the exchange rate, thus it allows us to introduce deviation from the UIP in the short run. Introducing adaptive learning in our model allows us to reproduce the fact that UIP does not hold in the short run. Indeed, as shown in section 2.4, adaptive learning introduces mistakes in agents expectations, leading to UIP deviation. Moreover, given that adaptive learning converges towards the Rational Expectation Equilibrium (REE) in the long run, it means that deviations from the UIP become littler across time. Thus adaptive learning is able to reproduce deviations from UIP in the short run and convergence to UIP in the long run, which is close to what expected in reality.

1.2.2.1 Conventional monetary policy in the United-States

In a first step, we model the exchange rates of the small open economies in terms of the US dollar. From Equations (1.4) and (1.5) , we have:

$$s_{jt} = \theta_j \hat{E}_t s_{jt+1} + v_{jt}, \tag{1.7}$$

$$\begin{aligned} v_{jt} = \theta_j \big(& (1-\delta_u)(\kappa_u + \lambda_u \pi_{ut} + \eta_u y_{ut}) + \delta_u r_{ut-1} + u_{ut} - (1-\delta_j)(\kappa_j - \lambda_j \pi_{jt} \\ & - \eta_j y_{jt} + \varphi_j \alpha_{je}(p_{et} - p_{jt}) - \varphi_j \alpha_{je} s_{jet} - \varphi_j \alpha_{ju}(p_{ut} - p_{jt})) - \delta_j r_{jt-1} - u_{jt} \big). \end{aligned} \tag{1.8}$$

where $\hat{E}$ reflects expectations of the exchange rate under learning (under learning agents estimate an econometric model to form their expectations) and $\theta_j = \frac{1}{1+\varphi_j \alpha_{ju}}$ reflects the importance of expectations on the current exchange rate (i.e. the weight of expected exchange rate on current exchange rate). Notice that this is a reduced form equation of the exchange rate. Indeed, we assume later that the fundamentals follow an $AR(1)$ process[h]. Regarding Equation (1.5), the parameter φ represents the weight the central bank grants to the REER. Given that fundamentals are observed at time t, the only expected part is the expected nominal exchange rate vis-à-vis the USD

[h]Such an assumption allows to construct the exchange rate by avoiding circularity and endogeneity problems. Indeed given that v_{jt} follows an $AR(1)$ process, the fact that the exchange rate is at the same time a determinant of the Taylor rule and determined by the interest rate is no more a problem.

which is included in the REER. Hence, the higher φ, the less the expected exchange rate affects the current exchange rate. This is a quite logical result in the sense that when the interest rate elasticity to the REER is high, it reflects an aggressive exchange rate monetary policy. Consequently, the more the central bank reacts strongly to the REER, the less expectations affect the current exchange rate. That is due to the fact that agents know the true value of the parameter φ, hence the higher the parameter is, the less the mistakes in agents expectations affect the current exchange rate. Notice that setting $\varphi = 0.5$ allows to obtain realistic values for θ and avoid to grant too much or not enough weight on agents' expectations. Moreover, the higher the parameter α_u, the more the current exchange rate vis à vis the USD affects expected changes in the expected exchange rate, thus the less expected exchange rate impacts the current exchange rate. v represents the fundamentals which are defined in Equation (1.8).

To understand precisely the evolution of the exchange rate, it is crucial to shed light on how the monetary policy in United States and in the two small open economies affects the exchange rate. As suggested by the UIP, an increase in the United States interest rate will depreciate the USD and an increase in the small open economy interest rate will appreciate the USD. Several empirical studies have shown that this is not the case in the short run, for example, capital inflows will lead to an USD appreciation after an increase in United States interest rate. The presence of adaptive learning in our model, through agents mistakes allow us to account for the above mentioned short run deviation.

Equation (1.8) points out the fundamentals' behavior which is crucial in our framework. Looking at Equations (1.7) and (1.8), we know that the current domestic exchange rate depends on the expected exchange rate, United States fundamentals, country specific fundamentals and the exchange rate vis à vis the Euro.

To gain some intuition, we can suppose the following economic reasoning from Equation (1.8). Consider an increase in inflation and/or output gap in the United States. The latter will increase its interest rate causing expected exchange rate depreciation of both foreign currencies. However, the US shock will also affect foreign exchange rates through the REER and the impact will be the same in both foreign countries under the following conditions: (1) the REER elasticities of foreign interest rates are the same, (2) the central banks target the same REER. Under these assumptions, the foreign central banks will react similarly to US shock and this should lead to greater exchange rate comovements (*ceteris paribus*). Conversely, the foreign interest rates may respond differently from the US shock if Taylor rules are not similar, lowering exchange rates' comovements. Another source of exchange rate comovements comes from country-specific fundamentals. Since foreign central banks also target the Euro for maintaining the PPP, the same reasoning applies in the case of a European shock. For example, when countries are subjected to common shocks (i.e. the covariance of country-specific fundamentals is high), we expect that exchange rate comovements will be greater. In the extreme case, this could be interpreted as a situation where the forcing variables driving monetary policies and exchange rates are sufficiently interrelated so that countries form an optimal currency area (OCA) (see e.g. Mundell (1961)).

1.2.2.2 Unconventional monetary policy in the United-States

After the global financial crisis, the United-States have resorted to quantitative easing (QE). Thus, it appears straightforward to consider the case in which the US implement such a policy. The recent literature on the zero lower bound reveals that such a policy does not affect similarly short-run and long run interest rates. Indeed Swanson and Williams (2014) show that the three and six month treasury yields are insensitive to macroeconomic news during zero lower bound. Interestingly, they find that the one and two year treasury yields are less insensitive during such episodes while the 5 and 10 year yields are quasi non insensitive. Such results clearly shows that the zero lower bound do not affect short run and long run interest rates in the same way. To reproduce such findings theoretically, Swanson and Williams (2014) use a New-Keynesian model. Given that we model the exchange rate of a country heating the zero lower bound, it seems obvious to introduce such a finding. However our model does not allow to model explicitly the output gap, inflation and the interest rate. Recall that we determine exchange rate changes from the interest differential, and the macroeconomic variables (fundamentals) which determine the interest differential are assumed to follow an AR(1) process. Thus, we are not able to introduce different interest rates in our model. However, it would be really interesting to use a DSGE model in order to set all the macroeconomic variables one by one and then construct the exchange rate. Given that such a modelization is not possible in our framework, we leave it for further researches.

Thus, to introduce QE in our model, we assume that in such periods, the US nominal interest rate hits the zero lower bound. Thus, we consider a state variable ϱ_t which can take values in $\mathbb{S} = \{0, 1\}$, with unconditional probabilities

$$\mathbb{P}(\varrho_t = i) = \frac{1 - p_{jj}}{2 - p_{ii} - p_{jj}}, \quad i = 0, 1, \quad j = 0, 1, \quad i \neq j$$

where $p_{ij} = \mathbb{P}(\varrho_{t+1} = j | \varrho_t = i)$ denotes the constant transition probability from regime i to regime j. When $\varrho_t = 0$ the United-States hit the ZLB, whereas $\varrho_t = 1$ indicates that conventional monetary policies operate. We assume that ϱ_t follows a first order Markov chain and impacts the fundamental equation v_{jt} as follows:

$$\begin{aligned} v_{jt} = \theta_j \big(\varrho_t ((1 - \delta_u)(\kappa_u + \lambda_u \pi_{ut} + \eta_u y_{ut}) + \delta_u r_{ut-1} + u_{ut}) - (1 - \delta_j)(\kappa_j - \lambda_j \pi_{jt} \\ - \eta_j y_{jt} + \varphi_j \alpha_{je}(p_{et} - p_{jt}) - \varphi_j \alpha_{je} s_{jet} - \varphi_j \alpha_{ju}(p_{ut} - p_{jt})) - \delta_j r_{jt-1} - u_{jt} \big) \end{aligned}$$

where all state-dependent variables are either equal to a non-null real number or equal to 0 depending whether ϱ_t equal 1 or 0. Indeed, the latter case implies that the United-States nominal interest rate is equal to zero and hence the exchange rate is defined by the following equation:

$$s_{jt} = \theta_j \hat{E}_t s_{jt+1} + v_{jt}(\varrho_t = 0) \tag{1.9}$$

In such a case, the US fundamentals do not affect anymore the small open economy exchange rate directly. Obviously the US economy still affects the exchange rate but only through its impact on the Euro. As stated previously, the fact that the US hit the ZLB will affect the US dollar, that is why it will impact the small open economy through the Euro/Dollar exchange rate. Such a specification allows to grant a probability for the US to be in one regime or another and to switch from one regime to another.

1.2.3 Patterns of shocks

Similar to Chakraborty and Evans (2008), we assume that our small open economy assumption allows to specify the following AR(1) exogenous stochastic processes for the fundamentals[i]:

$$v_{jt} = \mu_j + \psi_j v_{jt-1} + \varepsilon_{jt}, \tag{1.10}$$

where μ is a constant and $\psi_j < 1$ so that v_{jt} has short memory and ε_{jt} is a zero-mean *i.i.d.* bivariate sequence. Here, we suppose that ψ_j is close to one since empirical findings agreed upon the fact that macroeconomic variables contain either a unit root or a near-unit root. In our model, the dynamics of exchange rates are entirely defined by shocks on these fundamentals. In the sequel, we assume that these economic shocks, ε_{jt}, admits the following decomposition,

$$\begin{pmatrix} \varepsilon_{At} \\ \varepsilon_{Bt} \end{pmatrix} = \begin{pmatrix} \epsilon_{At} \\ \epsilon_{Bt} \end{pmatrix} + \begin{pmatrix} \alpha_{Ae}\epsilon_{et} \\ \alpha_{Be}\epsilon_{et} \end{pmatrix} + \begin{pmatrix} \alpha_{Au}\epsilon_{ut} \\ \alpha_{Bu}\epsilon_{ut} \end{pmatrix} \tag{1.11}$$

where ϵ_{et} and ϵ_{ut} reflect the shocks from European and US fundamentals respectively.[j]. Concerning the US shocks, we deliberately distinguish between the source of shocks that only affects the REER and then, the nominal exchange rates through PPP. Accordingly, the impact is endogenously determined by the level of the REER targeted by foreign central banks. As previously mentioned, depending on this equilibrium level, the impact will be more or less similar on both foreign interest rates. This is captured by the weights α_{je} and α_{ju}. The second source of the US shocks has the same impact on both foreign countries and represents the source of shocks that also affects the dynamic of exchange rates through other channels than REER in the Taylor rules. Since this shock similarly impacts both economies, it cannot generate divergences between the dynamic of exchange rates and consequently, it is not modeled in Equation (1.8). Finally, shocks on country-specific fundamentals are the last source of exchange rate fluctuations in the model. This

[i] Notice that with the two regimes the fundamental depends on ϱ_t and will be different whether the US are in QE or not.

[j] In the regime in which the US are at the ZLB, the US shocks do not affect the exchange rate in the same way. Indeed, in such a case, the US specific shock only affects the exchange rate through p_{ut}.

is captured by $(\epsilon_{At}, \epsilon_{Bt})'$ which represents a normally distributed bivariate sequence of shocks that affects in the same way both countries depending on their covariance modeled in the following matrix:

$$\Sigma_{\epsilon} = \begin{pmatrix} \sigma_A & \sigma_{AB} \\ \sigma_{AB} & \sigma_B \end{pmatrix}. \tag{1.12}$$

We support that Σ_{ϵ} is a convenient way to specify a general form of link between economies. For instance, if σ_{AB} is close to one, this might reveal the presence of symmetric shocks (or segmentation when $\sigma_{AB} \rightarrow 0$) between the two economies. This should induce central banks to react identically to inflation, leading to greater exchange rate comovements.

1.2.4 Introducing adaptive learning

We introduce adaptive learning in our model for two main reasons. On the one hand such an assumption allows to reproduce the stylized facts of the forward premia which is not the case when assuming rational expectations. On the other hand, it also allows us to introduce the fact that UIP does not hold in the short run. Notice that when v_{jt} is weakly dependent ($\psi_j < 1$), Chevillon and Mavroeidis (2013) show that adaptive learning mimics the persistent nature of forward premium only under constant gain least squares (CGLS). Accordingly, in our adaptive learning mechanism we focus on CGLS. Considering the studies of Branch and Evans (2006b) and Kim (2009) who document the good empirical performance of the CGLS, this choice is also relevant from an empirical point of view. At time t, agents perceived law of motion (PLM) is of the following form:

$$s_{jt} = a_{jt-1} + b_{jt-1} v_{jt}. \tag{1.13}$$

We assume that agents do not know the true value of the constant. Accordingly, they have to estimate it, thus we include a_j in the PLM. Notice that under rational expectations, the solution is the following:

$$s_t = \bar{a} + \bar{b} v_t, \tag{1.14}$$

With $\bar{a} = \mu(1-\theta)^{-1}$ and $\bar{b} = (1-\theta\psi)^{-1}\psi$. We assume that agents use constant gain least squares to estimate their econometric model which means that agents grant more weight to recent data than past data. Then, given that the process is run for sufficiently long, the distributions of a_t and b_t have means equal to $\bar{a}$ and $\bar{b}$ respectively and small variances around $\bar{a}$ and $\bar{b}$. Thus, the algorithm with constant gain leads itself to deviation from the REE in the sense that γ makes the variances of a and b non null under adaptive learning. In our simulations the difference between rational expectations and adaptive learning is due to this non null variances of the estimated parameters. Notice that the more the constant gain γ is high, the more the estimations of a and b diverge from $\bar{a}$ and $\bar{b}$[k].

Equation (1.13) shows that agents form their expectations from the observations of current fundamentals v_{jt}, meaning that the expected exchange rate takes into account domestic, European and United States fundamentals. According to Equation (1.13), at time t agents form their expectations of the exchange rate at time $t+1$[l] :

$$\hat{E}_t s_{jt+1} = a_j + b_j \psi_j v_{jt}. \tag{1.15}$$

Inserting Equation (1.15) into (1.7), we obtain the exchange rate expression under learning:

$$s_{jt} = \theta_j(a_j + \mu_j) + \left(\theta_j \psi_j b_j + 1\right) v_{jt}. \tag{1.16}$$

Agents have to estimate the parameters a and b to form their expectations. They do so through the following recursive least square algorithm:

$$\phi_{jt} = \phi_{jt-1} + \gamma_j R_{jt-1}^{-1} z_{jt-1}(s_{jt} - \phi'_{jt-1} z_{jt-1}), \tag{1.17}$$

$$R_{jt} = R_{jt-1} + \gamma_j (z_{jt-1} z'_{jt-1} - R_{jt-1}), \tag{1.18}$$

where $\phi_{jt} = (a_t \; b_t)'$, $z_{jt} = (1 \; v_t)'$ and γ_j is the gain from learning. The latter is constant over time due to the CGLS used in this framework. Chakraborty

[k] Accordingly, $\gamma = 0$ represents the rational expectations case in the sense that $a = \bar{a}$ and $b = \bar{b}$.

[l] When the model allows the US to be in QE, agents form their expectations according to the following equation: $\hat{E}_t s_{jt+1} = a_j + b_j \psi_j v_{jt}(\varrho_t)$, thus the learning process is similar as previously. The only innovation is in the fundamentals $v_{jt}(\varrho_t)$ which are different whether the US implement a conventional or an unconventional monetary policy.

and Evans (2008) show that R_{jt} can be interpreted as an estimate of the fundamentals' variance. Referring to Evans and Honkapohja (2001), we now investigate the E-stability. The mapping from the PLM to the actual law of motion (ALM) T is:

$$T\begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} \theta(\mu + a) \\ 1 + \theta b \psi \end{pmatrix}.$$

The E-stability is defined through the following differential equation:

$$\frac{d}{d\tau}\begin{pmatrix} a \\ b \end{pmatrix} = T\begin{pmatrix} a \\ b \end{pmatrix} - \begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} \theta\mu + (\theta - 1)a \\ 1 + (\theta\psi - 1)b \end{pmatrix},$$

where $\tau = \gamma t$. Given that $\theta < 1$ and $\psi < 1$, the REE is E-stable. Thus, whatever the initial values, $Eb_{jt} \to \bar{b}_j$ and $Ea_{jt} \to \bar{a}_j$ as $t \to \infty$. This adaptive learning convergence allows to reproduce the fact that there is a convergence towards UIP in the long run.

In the following we use this simple three-country framework to investigate whether long-run comovements are likely to arise between exchange rates. The same issue is questioned for the forward exchange rates.

1.3 Simulations and cointegration design

In this section, we simulate our theoretical model and investigate under which conditions exchange rates present common long run dynamics. Such simulations allow to better understand the exchange rates determinants in the long run.

1.3.1 Scenarios

As argued previously, our model is flexible in the sense that numerous realistic scenarios can be modeled. In the following, we perform a simulation study to investigate the exchange rate comovements between the two economies, named A and B respectively. In each scenario, it is assumed that at each period, both economies face three shocks. To summarize, the first and second shocks are, respectively, US and European shocks that are common to both economies and with an impact that depends on the weights

Figure 1.1: Scenario Symmetric

of US dollar and Euro in the REER targeted in each Taylor rule (α_{ju} and α_{je} respectively). The third shock corresponds to other shocks that affect country-specific fundamentals, more or less correlated depending on the degree of integration between the two economies. We assess the comovements of exchange rates under the following four scenarios:

Scenario 1- Symmetric: Both economies face symmetric shocks and are assumed to be strongly integrated. To represent those characteristics, we set the covariance parameter to $\sigma_{AB} = 0.9$. We refer to this scenario as "symmetric" scenario.

Scenario 2 - Semi-symmetric: Both economies are heterogeneously or partially integrated. In other words, the shock will be more or less common to both economies depending on its origin. For instance, a sectoral shock

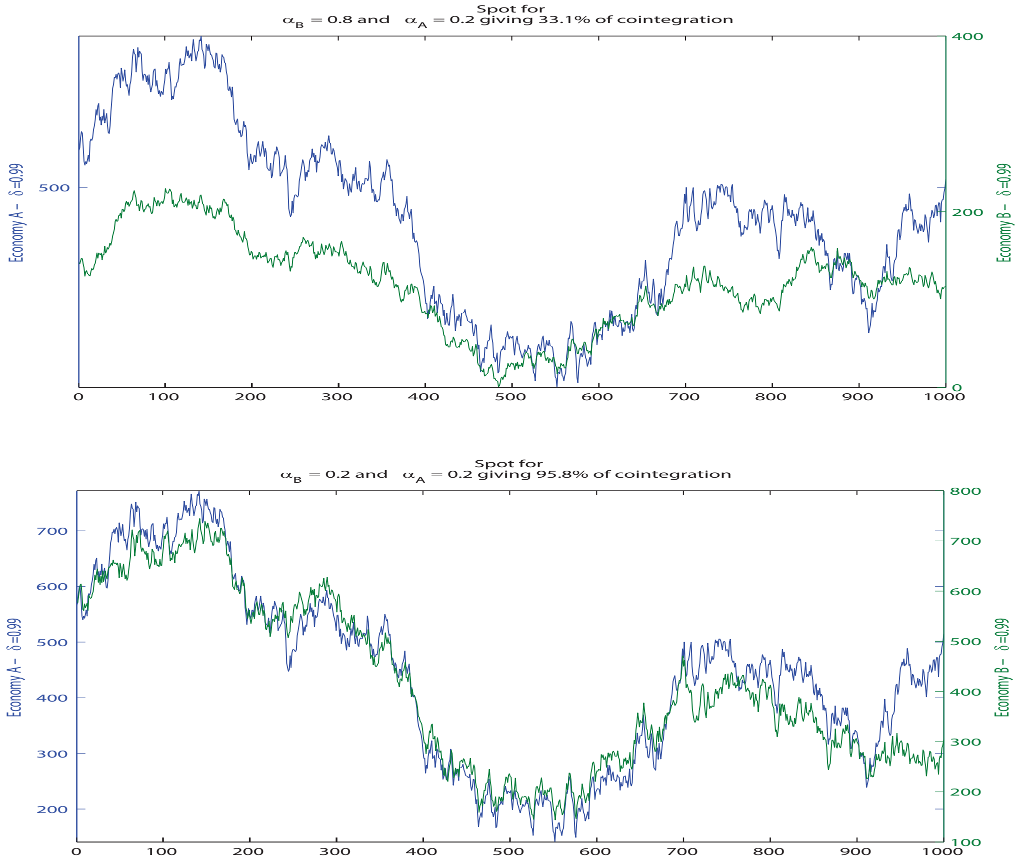


Figure 1.2: Scenarios Symmetric and semi-symmetric

is likely to impact both economies only if they are integrated with respect to this specific sector. Because shocks on specific sectors arise randomly, we consider a two regime Markov-chain driven process. In regime 1, shocks are symmetric and impact both economies ($\sigma_{AB} = 0.9$) and in regime 2, shocks are asymmetric and idiosyncratic ($\sigma_{AB} = 0.1$). Hence, we refer to this scenario as "semi-symmetric".

Scenario 3 - Non linear Symmetric: This scenario is an upgraded version of scenario 1. Here, we consider non-linear dynamics for the fundamentals of both economies, which is more realistic. Accordingly, business cycles evolve through a contractionary and an expansionary regime. Note that fundamentals are non-linear but synchronous because the Markov switching processes governing the dynamic of fundamentals are based on the same Markov chain. In regime 1, fundamentals follow a near-unit root process

Figure 1.3: Scenario Semi-symmetric

with negative drift whereas in regime 2, fundamentals follow a near-unit root process with positive drift. The transition matrix is the following:

$$TM = \begin{pmatrix} 0.95 & 0.05 \\ 0.1 & 0.9 \end{pmatrix}.$$

Such a matrix allows us to calculate the unconditional probability which informs us that the probability of being in an expansionary business cycle is of 67% while the probability of being in a contractionary business cycle is of 37%. Here, the covariance parameter is set to $\sigma_{AB} = 0.9$. We refer to this scenario as “non-linear symmetric” scenario.

Scenario 4 - Asynchronous: Such a scenario investigates the case of two non integrated economies ($\sigma_{AB} = 0.1$) and allow them not to be in the same

Figure 1.4: Scenario Non-linear symmetric

business cycle (i.e. the Markov chain differs between countries). In this scenario, we expect that monetary authorities of the two countries will not react the same way due to opposite business cycles. We name this scenario as “asynchronous”.

Scenario 5 - QE: Finally, this scenario is similar to the symmetric one, but here, we allow the United-States to be at the Zero Lower Bound (ZLB).

With respect to our Taylor rule fundamentals approach, we are particularly interested in the weight associated with each currency in the targeted REER. Accordingly, for each scenario, we consider three sub-cases where the weights of the dollar (euro) in the REER are either low (high) or high (low) and either equal or different. In the first sub-case, both economies have weights on US Dollar such as $\alpha_{ju} = 1 - \alpha_{je} = 0.2$ (countries A and

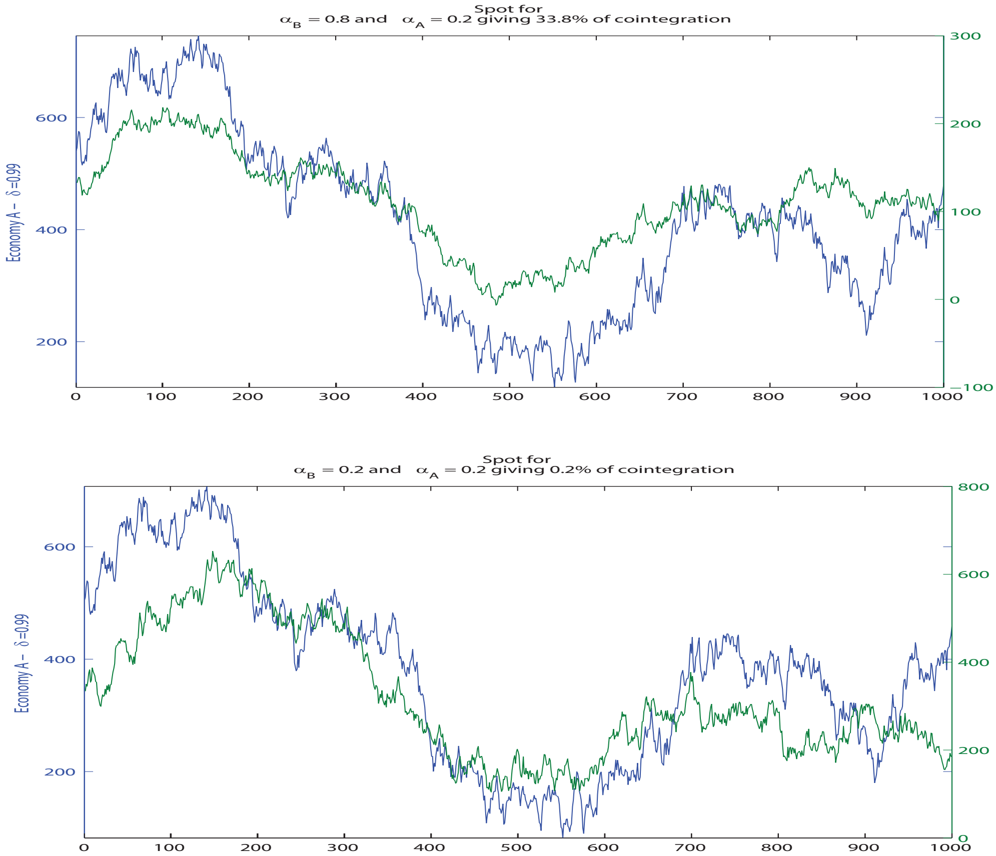


Figure 1.5: Scenarios Non-linear symmetric and asynchronous

B grant the same weight on Euro and US Dollar). Hence, the transmission channel for shocks is either fundamentals related to PPP or ϵ_A and ϵ_B if both economies are integrated. Presumably, we can have a combination of these channels. In the second sub-case, both economies have weights on US Dollar such as $\alpha_{ju} = 1 - \alpha_{je} = 0.8$. Here, the transmission channel for shocks is either dollar real exchange rate or country-specific shocks if both economies are integrated. As in the first sub-case, a combination of these channels is possible. In the last sub-case, we consider that countries A and B do not grant the same weight on the two currencies, with $\alpha_{Au} = 0.2$ and $\alpha_{Bu} = 0.8$. In such a case, the shocks do not impact the same way the two economies, leading to different central banks reaction.

For each scenario we perform $I = 1000$ replications of series with sample size $n = 3000$. Then we burn 2000 observations to eliminate initialization effect. Accordingly, in the sequel $n = 1000$. The gain parameter of the

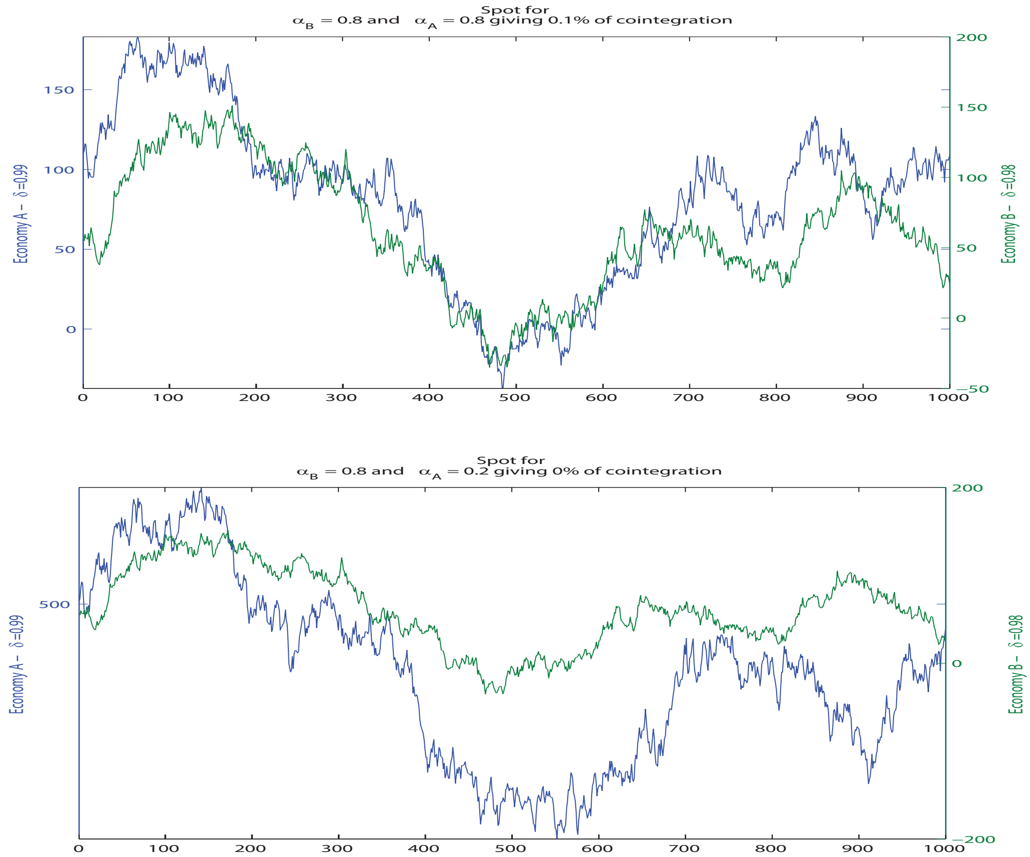


Figure 1.6: Scenario Asynchronous

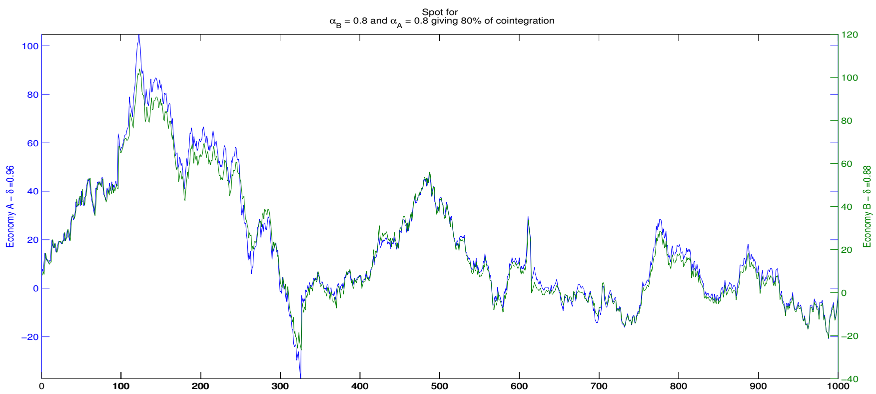


Figure 1.7: Episodes of QE in United-States

learning algorithm is set to 0.04 arbitrarily.[m] The Table 1.1 sums up the

[m]Unreported results show that our results remain unchanged when the gain is set to

values of all parameters used in the learning algorithm.[n]

1.3.2 Cointegration framework

We perform a cointegration analysis for each simulated series to investigate the presence of common long-run dynamics between exchange rates of both economies. This investigation constitutes the core of our contribution. We account for the possibility of fractional cointegration (FCI hereafter), i.e. long memory rather than unit root in observables and long memory rather than short memory in errors. Hence, FCI arises when long memory in errors is less than long memory in exchange rates.

To estimate the integration order of each series, we apply the semi-parametric estimator of Shimotsu (2010) that accommodates the presence of unknown mean, time trend and nonstationarity. Then, we compute $\bar{\delta} = I^{-1} \sum_{i=1}^{I} \delta_i$ with I the number of iterations. Finally, we analyze the cointegrating rank by using the procedure of Nielsen and Shimotsu (2007) that also operates semi-parametrically and accommodates nonstationarity. As we only consider bivariate relationships, the rank estimate $\hat{r}$ is either 0 in absence of cointegration or 1 in presence of cointegration. It is now easy to compute the percentage of cointegration relationship obtained over the I replications. The methodology of Nielsen and Shimotsu (2007) is detailed in Appendix 1.7.[o]

0.01.

[n] All computations are performed using MATLAB 2014a.

[o] Because all these procedures are semi-parametric, additional tuning parameters enters the simulation and are also detailed in Appendix 1.7.

Table 1.1 Simulation parameters

	Sub-cases A			Sub-cases B											
	$\alpha_{Au,1}$	$\alpha_{Au,2}$	$\alpha_{Au,3}$	$\alpha_{Bu,1}$	$\alpha_{Bu,2}$	$\alpha_{Bu,3}$	ψ_A	$\mu_{A,s_t=1}$	$\mu_{A,s_t=2}$	$\mu_{B,s_t=1}$	$\mu_{B,s_t=2}$	$\sigma_A = \sigma_B$	$\sigma_{AB,s_t=1}$	$\sigma_{AB,s_t=2}$	$\varphi_A = \varphi_B$
Sym.	0,2	0,8	0,2	0,2	0,8	0,8	0,999	0,1		0,1		1	0,9		0,5
Semi-sym.	0,2	0,8	0,2	0,2	0,8	0,8	0,999	0,1		0,1		1	0,1	0,9	0,5
Non-lin. sym.	0,2	0,8	0,2	0,2	0,8	0,8	0,999	-0,1	0,1	-0,1	0,1	1	0,9		0,5
Asynch.	0.2	0.8	0.2	0.2	0.8	0.8	0,999	-0,1	0,1	-0,1	0,1	1	0,1		0,5

Table 1.2 Cointegration between simulated spot exchange rates

		Dynamics											
Weights		Symmetric			Semi-symetric			Non-linear symmetric			Asynchronous		
α_{Au}	α_{Bu}	$\bar{\delta}_A$	$\bar{\delta}_B$	FCI	$\bar{\delta}_A$	$\bar{\delta}_B$	FCI	$\bar{\delta}_A$	$\bar{\delta}_B$	FCI	$\bar{\delta}_A$	$\bar{\delta}_B$	FCI
0,2	0,2	0,99	0,99	99,8%	0,99	0,99	95,8%	0,99	0,99	99,9%	0,99	0,98	0,2%
0,8	0,8	0,99	0,99	100,0%	0,99	0,99	96,8%	0,99	0,99	100,0%	0,99	0,98	0,1%
0,2	0,8	0,99	0,99	33,1%	0,99	0,99	10,1%	0,99	0,99	33,8%	0,99	0,98	0,0%

Table 1.3 Long memory in simulated forward premia

		Dynamics							
Weights		Symmetric		Semi-symmetric		Non-linear symmetric		Asynchronous	
α_{Au}	α_{Bu}	$\bar{\delta}_A$	$\bar{\delta}_B$	$\bar{\delta}_A$	$\bar{\delta}_B$	$\bar{\delta}_A$	$\bar{\delta}_B$	$\bar{\delta}_A$	$\bar{\delta}_B$
0,2	0,2	0,88	0,88	0,88	0,88	0,88	0,87	0,87	0,87
0,8	0,8	0,75	0,75	0,75	0,75	0,75	0,74	0,74	0,74
0,2	0,8	0,88	0,75	0,88	0,75	0,88	0,74	0,87	0,73

Note: Assuming CIP, we have $f_t = E_t s_{t+1}$, with f_t the forward rate and $E_t s_{t+1}$ the expected exchange rate. Thus, with such an assumption $E_t s_{t+1} - s_t$ represents the forward premium.

1.4 Discussion of the simulation results

Results are reported in Figures 1.1-1.6 and summarized in Table 1.2. First of all, simulations suggest that the parametric model retained for modeling the dynamics of exchange rates leads to satisfactory results. Long memory estimates of exchange rates show that the Taylor rule augmented with adaptive learning leads to exchange rate with unit root or at least near unit root behavior. This is mainly explained by the fact that fundamentals processes are near-unit root-processes with ψ close to one. Interestingly, Table 1.3 also documents the presence of long memory in simulated froward premia. Although we do not focus on the forward premium puzzle, this results supports that under adaptive learning, Taylor rule fundamentals model are able to reproduce this crucial empirical stylized fact.

In order to be clear in the presentation of the results, we will treat it through the four categories presented in Table 1.2. As Equation (1.5) shows, the Taylor rules of the two small open economies are similar, except for the weight granted to different currencies. In such a framework, the Taylor rules of the two small open economies are similar when their central banks grant the same weight to Euro and US Dollar ($\alpha_A = \alpha_B$). Thus, with such Taylor rules, when the two economies are integrated, their fundamentals evolve in the same sense, leading both central banks to have the same reaction.

Scenario 1 - Symmetric: In this framework, the two economies are highly integrated, in the sense that their fundamentals present a strong link because they are subjected to common shocks. The difference between countries could arise from the weights granted to US Dollar and Euro in the Taylor rules. In this case the two countries do not want to deviate from the PPP with a basket composed of Euro and US Dollar. Our results point out the fact that two integrated countries with a similar equilibrium level of REER present common long-run dynamics in their exchange rates. Indeed, we find 100% and 99.8% of cointegration relationships with $\alpha_{ju} = 0.8$ and 0.2, respectively, when the covariance of shocks is 0.9. In the special case where $\alpha_{Au} = \alpha_{Bu}$, reversing the weight on Euro and US Dollar does not impact the results because θ remains the same. The crucial point concerning the results is the difference in monetary policies' preferences. Obviously, a combination of these channels suggests an important interdependence between countries in terms of inflation rates, interest rates and then exchange rates. Within our theoretical framework, when country-specific fundamentals are affected by a macroeconomic shock such as an increase in the output gap, the central bank will react to contain inflation by rising its interest rate. If this shock affects both countries identically, each central bank will raise its interest rate in the same manner and exchange rates will comove in the long run. Accordingly, the presence of symmetric-shocks between countries reduces the need of an independent monetary policy in favor of a common monetary policy that can be tailored to each country. This finding is directly linked to the OCA literature that demonstrates that the cost of giving up monetary policy at the country level is negatively related to the degree of shocks synchronization because the use of the exchange rate to cope with these shocks would become unnecessary when they are symmetric. This is illustrated in this scenario by the fact that the dynamics of exchange rates are the same over the long run, suggesting that under these conditions countries form a *de facto* currency bloc where monetary policies are similar. This is corroborated by the estimation results when monetary authorities do not grant the same weight to US Dollar in their Taylor rule as the number of cointegration relationship between exchange rates reduces sharply (33%). These findings also reveal that when economies are affected by common shocks but with a different level of equilibrium REER, central banks respond to some extent similarly to inflation, leading to cointegration between exchange rates in only one-third of cases.

Scenario 2 - Semi-symmetric: In this case, there are two regimes where the countries fundamentals can be highly or weakly correlated according to the regime. As previously mentioned, this reflects the possibility of country-specific shock (regime 1) at some periods although countries remain highly linked in the second regime after the absorption of the country-specific shock. Hence, in this framework, when fundamentals are weakly linked, even if the two Taylor rules are similar, the central banks will not react in the same way (in regime 1) because shocks are not totally symmetric. As in the previous case, when the two Taylor rules are not similar in the two countries ($\alpha_A \neq \alpha_B$), the exchange rates do not present long-run common dynamics (only 10%), but the number of cointegration relationships is lower compared with the first scenario which is explained by the presence of asymmetric shocks. In the same way, when the Taylor rules are similar, the exchange rates still present common long-run dynamics but the number of cointegration relationships is slightly weaker, suggesting again that the presence of asymmetric shocks impacts the results. Overall, this result reflects the fact that even if at some periods the economies face asymmetric shocks, leading to different monetary policies, a common equilibrium level of the REER is enough to enhance cointegration between exchange rates. The explanation is as follows: country-specific shocks lead the central banks to react differently at some periods but monetary policies remain tied over the long run through the PPP. So, even if asymmetric shocks imply that inflation rates deviate from each other over the short run, they converge in the long run because central banks have the same objectives in terms of PPP.

Scenario 3 - Non-linear-symmetric: In such a scenario, we consider two integrated economies allowing for non-linear but symmetric dynamics in the fundamentals. That means that the two countries can be in expansion or recession but they are in the same regime. Again, the results show that when the value around which the REER should maintain is different between countries, there are few long-run commovements in exchange rates (only 33.8%). We still find cointegration because the two economies are in the same phase of the business cycle, thus the central bank reacts in the same way to inflation and output in each country. Since agents form their expectations in the same way in the two countries, when the two economies are highly linked, the central bank reaction is perceived similarly in the two economies. It could be different with a different learning process in the two economies. A different perception of the central bank reaction would affect the interest differential and the exchange rate. Given that agents learn and converge towards the REE, the different interest differentials would be transitive and would not affect the results so much.

Scenario 4 - Asynchronous: In this framework, we investigate the case of two economies weakly integrated, where shocks are only asymmetric. This scenario shows that when the two economies are weakly integrated, their exchange rates do not present common long-run dynamics regardless of how central banks react to REER misalignements. Here, monetary policies react differently at each period according to country-specific shocks suggesting that a common monetary policy is unsustainable over the long run. This finding confirms the previous ones and especially estimations results from scenario 1 where shocks are symmetric. For example, let us consider two countries in an opposite business cycle. Despite the fact that each central bank targets the same level of REER, on the one hand the central bank of the expansionary country will raise the interest rate, while on the other hand, monetary authorities in the declining economy will cut the interest rate. Given that the economies do not face the same shocks, monetary authorities react in an opposite way. Hence, the interest differential with United-States will lead to specific exchange rates dynamics. Referring to our results, we are able to conclude that an important degree of symmetric shocks is a crucial point for detecting common long-run dynamics in exchange rates.

Scenario 5 - QE: For the simulations allowing for US QE episodes, we set $p_{11} = 0.95$ and $p_{22} = 0.99$. Figure (1.7) reveals that allowing for QE episodes in the US still leads to long run comovements between exchange rates. Interestingly, compared to the symmetric scenario, the relations of cointegration decrease from 100% with a conventional monetary policy to 80% under QE. Our simulations results reveal that, overall, QE episodes affect exchange rates dynamics but does not make the exchange rates to diverge to much between countries in the long run.

A crucial point of our paper is the fact that agents are not fully rational. Learning from their past errors they integrate past observations in the formation of their expectations. It is well documented that agents' expectations impact the monetary policy e.g. Bullard and Mitra (2002), Evans and Honkapohja (2003) and Orphanides and Williams (2007). In our model, the exchange rate is constructed from the interest differential, including US, European and domestic fundamentals. Agents know the different Taylor rule specifications. Observing the shocks, they form their exchange rate expectations. Similar Taylor rules lead agents to have similar beliefs about exchange rate changes in two countries. However, specific shocks lead agents' beliefs to diverge according to the country, reducing the number of cointegration relationships.

These theoretical findings are directly linked to previous empirical results on the study of long-run exchange rate co-movements. Among them, Kuhl (2010) who stresses the importance of cointegration relationships for evaluating the stability of a monetary system. The author evaluates whether the introduction of the euro has generated common stochastic trend in the foreign exchange rate market. Before 1999, the Deutschmark mark and the French franc (against the USD) appear to be cointegrated, which is attributable to the convergence of inflation and interest rates on the way toward exchange rate unification. According to the author, adjustments toward the long-run equilibrium mainly reflects the impact of news arrivals linked to the adjustment process of fundamentals, which supposes the consistency with the no-arbitrage condition on the foreign exchange market. From our theoretical results, we can deduce that common shocks on fundamentals imply common belief about exchange rate changes in both countries, which states that cross-market arbitrage opportunities are ruled out because both exchange rates are considered as two similar assets.

Although they refer to the monetary model, Beckmann et al. (2012) provide supportive evidence that nominal exchange rate, money supply and income relative to the US are driven mainly by common stochastic components rather than country-specific ones. The pattern of their results is in line with our theoretical contribution in the sense that common shocks are important determinants of exchange rates against the dollar. The authors also emphasize the role of these common shocks in the country's decision to join a currency union. Indeed, monetary policy decision are more likely to be implicitly or explicitly coordinated in face of common shocks (stemming from the US for instance), which would translate into similar responses of the domestic exchange rates. In such cases, the use of the domestic exchange rate to deal with infrequent country-specific shocks is considerably reduced.

The role of global liquidity shocks over the recent period could also acts as an important factor of monetary conditions and then the evolution of exchange rates. Indeed, these shocks are likely to affect monetary aggregates in the same directions through different channels. For instance, the expansion of US monetary aggregates would appreciate European exchange rates and encourage the central banks of European countries (i.e. the European System of Central Banks) to react with expansionary monetary policy in order to maintain external competitiveness. Inversely, currencies could jointly appreciate within the same area when investors aggressively pursue higher yielding currencies (e.g. carry trade). With the surge in global liquidity and free capital flows, monetary policy cannot be fully independent even with flexible exchange rates, thus increasing exchange rates comovements especially across countries belonging the same economic area.

Finally, our results give some elements of answers to the question of carry trades and UIP deviations. Carry trade consists in a strategy which attempts to capture the difference between interest rates. Indeed, the carry traders borrow in low-interest (funding) currencies for investing in high-interest (investment) currencies. Obviously, this gain could either increase or decrease depending on exchange rate variations. As long as UIP holds, this carry gain is perfectly offset by the exchange rate depreciation of the investment currency. However, since the introduction of floating exchange rates in the early 1970s, high-interest currencies have tended to appreciate, rather than depreciate, as the UIP equation states. This well-known empirical evidence refers to the forward premium puzzle. Although carry trades form a profitable investment strategy, the uncertainty of exchange rate heavily weighs on carry trades profitability. Sudden changes in the macroeconomic environment (liquidity constraint, news on fundamentals, exposure to a common factors, change in risk tolerance ect.) can lead to substantial movement of spot exchange rate. For example, with concerns around a particular market starting to rise, capital flows can be reversed leading the funding currency to appreciate which in turn increase further unwinding of carry trades. What we can conclude is that funding as well as investment currencies (i.e. currencies with similar interest rates) are likely to co-move more extensively. Comovements among exchange rates may be symptomatic of these kind of mechanisms. Finally, assuming that adaptive learning induces UIP deviations and then arbitrage opportunities (see, Chakraborty and Evans (2008)), our theoretical results suggest that carry trades profitability exist.

1.5 What do the data say?

In this section we investigate whether our simulation results find some support in real data. Consistently with existing empirical studies and our simulation setting, we focus on six exchange rates. Some of them are European countries but are not in the eurozone. For all of them, there is clear evidence of high degree of interdependence in terms of economic structure, trade relationships and inflation dynamics. This interdependence is strengthened by the geographical proximity and the presence of mature financial markets. More precisely, we consider the most prevalent European currencies that are the euro, the British pound, the Danish krone, the Norwegian krone and the Swedish krona. Beside those European countries, we also consider the Canadian dollar aiming to illustrate the case of a moderately integrated developed country. Indeed, fundamentals of Canada are more responsive to the US central bank than the ECB given their strong economic relationships. We choose these countries because we can suppose that their monetary policy can be characterized by some variant of a Taylor-type rule. For instance, Molodtsova et al. (2011) find evidence of predictability for the US Dollar/euro exchange rates (from 1999 to 2007) under Taylor rules. Moreover, since 1990, Canada, The United Kingdom, Norway, Sweden have officially adopted inflation targeting rules. A special case is Denmark where the exchange rate regime corresponds to a fixed-exchange-rate policy aimed at keeping the krone stable against the euro.

Table 1.4 Long memory analysis of spot and forward series

	EU	UK	CAN	DAN	NOR	SWE	Std. Err.
$\hat{\delta}$				Spot			
$m = \lfloor n^{0,5} \rfloor$	0,948	1,038	1,048	0,949	1,065	1,020	0,064
$m = \lfloor n^{0,6} \rfloor$	1,018	1,029	0,934	1,025	1,004	1,021	0,042
$m = \lfloor n^{0,7} \rfloor$	1,012	0,995	0,960	1,017	0,971	0,991	0,028
$m = \lfloor n^{0,8} \rfloor$	1,016	0,999	1,009	1,007	0,964	0,974	0,019
LV-test							
$m = \lfloor n^{0,5} \rfloor$	1,892	-1,202	0,451	0,500	0,329	-0,053	
$m = \lfloor n^{0,6} \rfloor$	-1,902	-1,209	-0,594	-0,584	0,476	-0,055	
$m = \lfloor n^{0,7} \rfloor$	-1,902	1,231	-0,562	-0,576	-0,558	-0,023	
$m = \lfloor n^{0,8} \rfloor$	-1,902	1,228	0,501	-0,566	-0,578	-0,071	
$\hat{\delta}$				Forward			
$m = \lfloor n^{0,5} \rfloor$	0,947	1,037	1,050	0,948	1,065	1,020	0,064
$m = \lfloor n^{0,6} \rfloor$	1,025	1,031	0,935	1,024	1,004	1,018	0,042
$m = \lfloor n^{0,7} \rfloor$	1,016	1,009	0,960	1,016	0,965	0,988	0,028
$m = \lfloor n^{0,8} \rfloor$	1,007	1,015	1,009	1,009	0,972	0,971	0,019
LV-test							
$m = \lfloor n^{0,5} \rfloor$	0,517	0,039	0,474	0,476	0,478	0,021	
$m = \lfloor n^{0,6} \rfloor$	-0,589	0,035	-0,591	-0,548	0,582	0,025	
$m = \lfloor n^{0,7} \rfloor$	-0,582	0,020	-0,566	-0,542	-0,656	-0,096	
$m = \lfloor n^{0,8} \rfloor$	-0,575	0,024	0,516	-0,536	-0,644	-0,138	

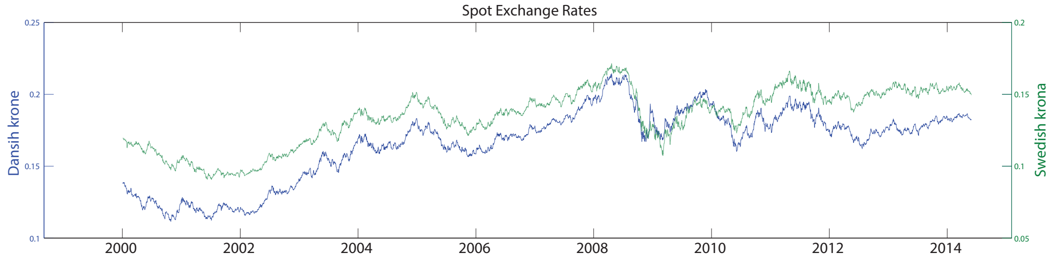
Note: this table reports the δ estimates from the semi-parametric procedure of Shimotsu (2010) and the fractional unit root test of Lobato and Velasco (2007). Different bandwidths are considered for the semi-parametric approach. They are also reported for the LV-test because we use the estimator of Shimotsu (2010) to compute the test. The asymptotic standard errors for $\hat{\delta}$ are reported in the last column. The LV-test is a left-sided test based on t-ratio statistics. At conventional 95% significance level, the critical value is 1.64. See Appendix 1.7 for more details.

All exchange rates are expressed in terms of the US dollar currency. Our data set runs from January 3, 2000 to May 30, 2014 for a total of $n = 3760$ observations. Data are extracted from Datastream. As illustration of the data, Figure 1.8 plots the exchange rates of the Danish krone and the Swedish krona.

Compared to the simulation section, our empirical strategy is the same. In a first stage, we estimate the integration orders of individual variable, using the estimator of Shimotsu (2010). In all cases, the unit root hypothesis against the fractional alternative is tested by means of the Lobato and Velasco (2007) procedure. In a second stage, we test for the homogeneity of integration orders and perform a cointegration rank analysis employing the procedure of Nielsen and Shimotsu (2007).

Table 1.4 shows integration orders of spot and forward series as well as the results of the LV fractional Wald test. Concerning the spot exchange rates,

Figure 1.8: Spot exchange rates for the Danish krone and the Swedish krona



integration orders are near to 1 regardless the bandwidth which suppose that the exchange rates possess unit-root. This is confirmed by the LV test since we cannot reject at conventional level of significance the null hypothesis of a unit-root (similar conclusions are drawn for forward exchange rates).

As a second step, we turn to the cointegration analysis. Table 1.5 reports the results. The procedure of Nielsen and Shimotsu (2007) is applied to test for equality of integration orders. The exchange rates are pairwise considered (i.e. EU/UK, EUR/CAN, DAN/NOR, DAN/SWE, NOR/SWE) but also together. In the latter case, $T_0 \xrightarrow{d} \chi^2_5$. At the conventional 95% significance level, the critical value of the χ^2_5 distribution is 11.01, thereby revealing that we accept $H_0 : \delta_{EU} = \delta_{UK} = ... = \delta_{SWE}$. The rank analysis is reported beside and clearly concludes in favor of several cointegration relationships. Considering e.g. $v(n) = m_G^{-0.25}$, the number of cointegration relationships varies from 4 to 2, depending on the bandwidth. In the former case, the critical value of the χ^2_1 distribution is 3.84 and the null hypothesis is rejected only once for the DAN/NOR duet. The rank analysis is very informative and reveals that strong evidence of cointegration exists between the euro and the British pound, the Danish krone and the Norwegian krone, the Danish krone and the Swedish krona and also the Norwegian krone and the Swedish krona. Conversely, the long run relationship between the euro and the Canadian dollar seems more fragile as it heavily depends on $v(n)$ and the bandwidth. When considering the whole exchange rate system, we find that European currencies are well-tied together.

We have also performed the cointegration analysis to investigate whether US QE episodes affect the long run dynamics of exchange rates. To do so we have re-performed the analysis before US QE episodes (from 2000 to 2009)

Table 1.5 Rank and homogeneity analysis of spot exchange rates

	$v(n) = m_G^{-0.45}$	$v(n) = m_G^{-0.35}$	$v(n) = m_G^{-0.25}$	$v(n) = m_G^{-0.15}$	$v(n) = m_G^{-0.05}$	T_0
			All exchange rates			
$m = \lfloor n^{0.5} \rfloor$	2	3	4	5	5	3.059
$m = \lfloor n^{0.6} \rfloor$	1	2	3	4	5	2.654
$m = \lfloor n^{0.7} \rfloor$	1	2	3	3	5	2.437
$m = \lfloor n^{0.8} \rfloor$	1	1	2	3	5	7.461
			EU / UK			
$m = \lfloor n^{0.5} \rfloor$	0	1	1	1	1	1.575
$m = \lfloor n^{0.6} \rfloor$	0	0	1	1	1	0.045
$m = \lfloor n^{0.7} \rfloor$	0	0	0	1	1	0.214
$m = \lfloor n^{0.8} \rfloor$	0	0	0	1	1	0.514
			EU / CAN			
$m = \lfloor n^{0.5} \rfloor$	0	0	1	1	1	1.434
$m = \lfloor n^{0.6} \rfloor$	0	0	0	0	1	1.958
$m = \lfloor n^{0.7} \rfloor$	0	0	0	0	1	1.709
$m = \lfloor n^{0.8} \rfloor$	0	0	0	0	1	0.083
			DAN / NOR			
$m = \lfloor n^{0.5} \rfloor$	1	1	1	1	1	2.917
$m = \lfloor n^{0.6} \rfloor$	0	1	1	1	1	0.223
$m = \lfloor n^{0.7} \rfloor$	0	0	1	1	1	2.211
$m = \lfloor n^{0.8} \rfloor$	0	0	1	1	1	4.405
			DAN / SWE			
$m = \lfloor n^{0.5} \rfloor$	1	1	1	1	1	1.295
$m = \lfloor n^{0.6} \rfloor$	0	1	1	1	1	0.010
$m = \lfloor n^{0.7} \rfloor$	0	1	1	1	1	0.806
$m = \lfloor n^{0.8} \rfloor$	0	0	1	1	1	2.817
			NOR / SWE			
$m = \lfloor n^{0.5} \rfloor$	1	1	1	1	1	0.505
$m = \lfloor n^{0.6} \rfloor$	0	1	1	1	1	0.160
$m = \lfloor n^{0.7} \rfloor$	0	0	1	1	1	0.475
$m = \lfloor n^{0.8} \rfloor$	0	0	1	1	1	0.260

Note: this table reports the cointegration rank estimates and the T_0 statistics from the semi-parametric procedure of Nielsen and Shimotsu (2007). Different bandwidths and tuning parameters are considered. $v(n) = m_G^{-0.45}$ is generally very stringent whereas $v(n) = m_G^{-0.05}$ is generally permissive. The T_0 statistic is reported in the last column. At conventional 95% significance level, the critical value is 11.01 when all time series are considered and 3.84 when pairwise series are considered. See Appendix 1.7 for more details.

and during and after US QE episodes (from 2009 to 2014). Table 1.6 reveals the expected result that before the implementation of QE in the US, there are long run comovements between the exchange rates of the countries studied here. Table 1.7 which investigates the period of QE in the US, reveals that there are still cointegration between exchange rates. However, we find contradictory results between the rank estimation and the test of integration order equality. More precisely, concerning all exchange rates, the estimation suggests more cointegration relationships while the test rejects equality in three cases. Under QE our results are more fragile and less ro-

Table 1.6 Rank and homogeneity analysis of spot exchange rates before the US QE

	$v(n) = m_G^{-0.45}$	$v(n) = m_G^{-0.35}$	$v(n) = m_G^{-0.25}$	$v(n) = m_G^{-0.15}$	$v(n) = m_G^{-0.05}$	T_0
			All exchange rates			
$m = \lfloor n^{0.5} \rfloor$	2	3	4	5	5	3.667
$m = \lfloor n^{0.6} \rfloor$	2	2	3	4	5	2.126
$m = \lfloor n^{0.7} \rfloor$	1	2	3	4	5	1.796
$m = \lfloor n^{0.8} \rfloor$	1	1	2	3	5	3.421
			EU / UK			
$m = \lfloor n^{0.5} \rfloor$	0	1	1	1	1	2.9
$m = \lfloor n^{0.6} \rfloor$	0	0	1	1	1	0.109
$m = \lfloor n^{0.7} \rfloor$	0	0	0	1	1	0.132
$m = \lfloor n^{0.8} \rfloor$	0	0	0	1	1	0.562
			EU / CAN			
$m = \lfloor n^{0.5} \rfloor$	0	0	0	1	1	1.264
$m = \lfloor n^{0.6} \rfloor$	0	0	0	0	1	0.755
$m = \lfloor n^{0.7} \rfloor$	0	0	0	0	1	0.502
$m = \lfloor n^{0.8} \rfloor$	0	0	0	0	1	0.223
			DAN / NOR			
$m = \lfloor n^{0.5} \rfloor$	0	1	1	1	1	2.348
$m = \lfloor n^{0.6} \rfloor$	0	0	1	1	1	$1.3 * 10^{(-5)}$
$m = \lfloor n^{0.7} \rfloor$	0	0	1	1	1	0.925
$m = \lfloor n^{0.8} \rfloor$	0	0	1	1	1	0.968
			DAN / SWE			
$m = \lfloor n^{0.5} \rfloor$	1	1	1	1	1	1.626
$m = \lfloor n^{0.6} \rfloor$	1	1	1	1	1	0.251
$m = \lfloor n^{0.7} \rfloor$	0	1	1	1	1	0.026
$m = \lfloor n^{0.8} \rfloor$	0	0	1	1	1	0.014
			NOR / SWE			
$m = \lfloor n^{0.5} \rfloor$	1	1	1	1	1	0.361
$m = \lfloor n^{0.6} \rfloor$	0	1	1	1	1	0.223
$m = \lfloor n^{0.7} \rfloor$	0	1	1	1	1	1.366
$m = \lfloor n^{0.8} \rfloor$	0	0	1	1	1	0.769

Note: this table reports the cointegration rank estimates and the T_0 statistics from the semi-parametric procedure of Nielsen and Shimotsu 2007. Different bandwidths and tuning parameters are considered. $\nu(n) = m_G^{-0.45}$ is generally very stringent whereas $\nu(n) = m_G^{-0.05}$ is generally permissive. The T_0 statistic is reported in the last column. At conventional 95% significance level, the critical value is 11.01 when all time series are considered and 3.84 when pairwise series are considered.

bust, thus the results have to be interpreted with precaution. To conclude, both our theoretical and empirical investigations reveal that QE have reduced the comovements between exchange rates, but there are still long run comovements between them.

Overall, our results suggest that European spot exchange rates are cointegrated, which has several implications. When confronting our theoretical results with real data, we first see that our simulations scenarios can be related with the panel of countries studied in our empirical framework. The

Table 1.7 Rank and homogeneity analysis of spot exchange rates during and after the US QE

	$v(n) = m_G^{-0.45}$	$v(n) = m_G^{-0.35}$	$v(n) = m_G^{-0.25}$	$v(n) = m_G^{-0.15}$	$v(n) = m_G^{-0.05}$	T_0
			All exchange rates			
$m = \lfloor n^{0.5} \rfloor$	3	3	3	5	5	2.92
$m = \lfloor n^{0.6} \rfloor$	3	3	3	4	5	8.684
$m = \lfloor n^{0.7} \rfloor$	1	2	3	4	5	6.281
$m = \lfloor n^{0.8} \rfloor$	1	2	3	3	5	7.494
			EU / UK			
$m = \lfloor n^{0.5} \rfloor$	0	1	1	1	1	0.410
$m = \lfloor n^{0.6} \rfloor$	0	0	1	1	1	0.028
$m = \lfloor n^{0.7} \rfloor$	0	0	0	1	1	0.143
$m = \lfloor n^{0.8} \rfloor$	0	0	0	1	1	0.252
			EU / CAN			
$m = \lfloor n^{0.5} \rfloor$	0	0	0	1	1	0.049
$m = \lfloor n^{0.6} \rfloor$	0	0	0	0	1	3.268
$m = \lfloor n^{0.7} \rfloor$	0	0	0	0	1	0.823
$m = \lfloor n^{0.8} \rfloor$	0	0	0	0	1	0.062
			DAN / NOR			
$m = \lfloor n^{0.5} \rfloor$	1	1	1	1	1	0.9024
$m = \lfloor n^{0.6} \rfloor$	0	1	1	1	1	4.645
$m = \lfloor n^{0.7} \rfloor$	0	0	1	1	1	2.428
$m = \lfloor n^{0.8} \rfloor$	0	0	1	1	1	4.442
			DAN / SWE			
$m = \lfloor n^{0.5} \rfloor$	1	1	1	1	1	1.854
$m = \lfloor n^{0.6} \rfloor$	1	1	1	1	1	4.93
$m = \lfloor n^{0.7} \rfloor$	0	1	1	1	1	4.52
$m = \lfloor n^{0.8} \rfloor$	0	0	1	1	1	3.04
			NOR / SWE			
$m = \lfloor n^{0.5} \rfloor$	1	1	1	1	1	0.214
$m = \lfloor n^{0.6} \rfloor$	1	1	1	1	1	0.001
$m = \lfloor n^{0.7} \rfloor$	0	1	1	1	1	0.365
$m = \lfloor n^{0.8} \rfloor$	0	0	1	1	1	0.178

Note: this table reports the cointegration rank estimates and the T_0 statistics from the semi-parametric procedure of Nielsen and Shimotsu 2007. Different bandwidths and tuning parameters are considered. $\nu(n) = m_G^{-0.45}$ is generally very stringent whereas $\nu(n) = m_G^{-0.05}$ is generally permissive. The T_0 statistic is reported in the last column. At conventional 95% significance level, the critical value is 11.01 when all time series are considered and 3.84 when pairwise series are considered.

European countries exchange rates can belong to the three first scenarios while the pair Canada/European countries exchange rates can be related to our asynchronous scenario.

From our empirical methodology, we are able to conclude that our model performs well at reproducing the cointegration relationships between exchange rates, especially between European currencies. For these countries the long-run comovements between exchange rates could be explained by the combination of similar monetary policies and strong economic links. Indeed, although the exact inflation target varies from country to country, their monetary policies are based on explicit quantitative targets for the expected course of inflation in the medium term (e.g. 2-3 years). Considering that these countries are highly linked through trade and financial areas, inflation dynamics have been very close within this group over the last years. This could be explained by the existence of a stationary process which drives interest rate differentials as suggested by our theoretical results. The latter explanation can easily reflect why the common European exchange rates have comoved over the last years. In this view, Phengpis and Nguyen (2009) suggest that long-run relationships between European exchange rates reflects strong monetary interdependence or implicit coordination of monetary policy. From the perspective of adaptive learning, this indicates that agents have homogeneous anticipations on the Taylor rule fundamentals of European countries. As mentioned previously, it is crucial to consider adaptive learning while studying exchange rates. On the one hand, as Chakraborty and Evans (2008) suggest, adaptive learning is better at explaining the forward premium puzzle than rational expectations. On the other hand, considering non-fully rational agents allows to introduce the well documented deviation of UIP in the short run. Finally, our empirical results could be explained by the fact that agents consider European exchange rates as common or substitutable assets when they are forming their expectations. Similar beliefs on the conduct of monetary policy within the region lead agents to anticipate a simultaneous increase of interest rates from the central banks which translates into greater exchange rate comovements. These results have important implications from the perspective of financial integration within Europe. Indeed, The elimination of the exchange rate risk has been the source of increasing cross-border capital flows within the Eurozone during the 2000s. Accordingly, the long-run comovements of exchange rates can further stimulate financial integration between countries that have already adopted the euro and other European countries.

1.6 Conclusion

From a Taylor rule fundamentals model with adaptive learning, we simulate different scenarios and investigate whether exchange rates of two small open economies present common long-run dynamics. Thanks to our theoretical framework, we conclude that two small open economies exchange rates co-move under some conditions. In the case of two countries economically linked, our results suggest that similar Taylor rules leads to long-run comovements between exchange rates. However, considering two economies strongly linked with non-similar Taylor rules, the long-run comovements between exchange rates disappear. This particular result suggests that two countries economically linked should coordinate their monetary policies, or at least set similar Taylor rules in order to avoid specific exchange rates dynamics. Finally, investigating two countries with distinct business cycle leads to different central bank's behavior, affecting the interest differential, generating specific exchange rates dynamics. Interestingly, investigating the case of quantitative easing episodes in the US reveals that such a policy reduces the relation of cointegration between exchange rates but exchange rates still present common long run dynamics. In a second step, we confront our theoretical model with empirical data.

Our empirical study allows us to conclude that our theoretical model does reproduce exchange rate long-run dynamics quite well. The countries chosen in our empirical procedure can be linked with the scenarios studied in our simulations. Hence, we are able to conclude under which conditions two exchange rates are prone to generate long-run comovements between exchange rates. This conclusion is relevant for foreign exchange investors and international finance management. For instance, long-run common dynamics in exchange rates can predict how to construct safer currency portfolio. The most important dimension of our results concerns the link between exchange rates cointegration and economic stabilization. Indeed, common long-run dynamics validate, to some extent, a long-run no arbitrage condition.

An interesting avenue of research would consist in exploring the presence of commonalities in forward premia. This approach would be relevant to investigate more directly the persistency of the deviations to the UIP and might be informative regarding the possibility of carry trade arbitrages between the two currencies. As forward premia generally have heterogeneous integration orders, an appropriate approach would consist in applying the recently developed unbalanced cointegration concept (see e.g. Hualde 2014). From a theoretical point of view, it would be really interesting to investigate a model integrating capital inflows in order to investigate the channels through which carry trades impact the long-run relationships between forward premia.

1.7 Appendix: Estimation procedures

This appendix briefly details the two-step exact local Whittle (2S-ELW) estimator of Shimotsu (2010) and the procedure developed by Nielsen and Shimotsu (2007) to estimate the rank r and test for the homogeneity of integration orders. It also details the fractional unit root test of Lobato and Velasco (2007). Consider x_t, a random process with possible unknown mean, μ and integrated of order δ. In a first step, Shimotsu (2010) proposes to estimate the unknown mean by a weighted average of the sample mean based on x_1. Then, the 2S-ELW of Shimotsu (2010) is defined as $\hat{\delta} = \arg\min_{\delta} R(\delta)$ where

$$\begin{aligned} R(\delta) &= \log \hat{G}(\delta) - 2\delta \frac{1}{m} \sum_{j=1}^{m} \log \lambda_j, \\ \hat{G}(\delta) &= \frac{1}{m} \sum_{j=1}^{m} I_{(x-\hat{\mu})(\delta)}(\lambda_j). \end{aligned} \tag{1.19}$$

with $m = \lfloor n^k \rfloor$ the bandwidth filter where $k = \{0.5, 0.6, 0.7, 0.8\}$ and $I_{(x-\hat{\mu})(\delta)}(\lambda_j)$ the periodogram of $(x_t - \hat{\mu})(\delta)$ evaluated at frequency $\lambda_j = (2\pi j)n^{-1}$. Using a taper in the first step to deal with the possible presence of polynomial trend, Shimotsu (2010) shows that $\delta \in (-0.5, 1.75)$ has an $N(0, 1/4)$ asymptotic distribution.

Now consider y_t and x_t, two variables integrated of same order δ_*. The equality of integration orders is a fundamental requirement of the cointegration theory. Accordingly, Nielsen and Shimotsu (2007) suggest an homogeneity test appropriated for both, long memory stationary and non-stationary variables. Consider p time series, $x_{1t}, x_{2t}, \ldots, x_{pt}$ integrated of orders $\delta_1, \delta_2, \ldots, \delta_p$ respectively. Under the null hypothesis $H_0 : \delta_1 = \delta_2 = \ldots = \delta_p$, the test statistic $\hat{T}_0$ detailed in Nielsen and Shimotsu (2007) either converges in probability to 0 or converge in distribution to χ^2_{p-1} depending on the cointegration rank of the p time series.

Concerning the rank analysis, Nielsen and Shimotsu (2007) propose to estimate the cointegration rank of y_t and x_t by solving the following optimization problem,

$$\hat{r} = \arg\min_{u=0,1} L(u), \quad L(u) = v(n)(2-u) - \sum_{j=1}^{2-u} \tau_j, \tag{1.20}$$

with τ_j the j-th eigenvalue of the correlation matrix

$$\hat{P}(\delta_*) = \hat{D}(\delta_*)^{-1/2}\hat{G}(\delta_*)\hat{D}(\delta_*)^{-1/2}$$

where $\hat{D}(\delta_*) = \text{diag}\left(\hat{G}_{11}(\delta_*), \hat{G}_{22}(\delta_*)\right)$, $\hat{G}(\delta_*)$ is a matrix obtain from a multivariate version of (1.19) and $v(n)$ a tuning parameter defined as $v(n) = m_G^{-0.25}$ where m_G is a specific bandwidth used to obtain $\hat{G}(\delta_*)$ and set to $m_G = \lfloor n^{0.45} \rfloor$. The choice of $v(n)$ is of importance because the procedure is more conservative when $v(n)$ is small. Accordingly, we also performed our simulations for $v(n) = m_G^{-0.45}$, $v(n) = m_G^{-0.35}$, $v(n) = m_G^{-0.15}$ and $v(n) = m_G^{-0.05}$. In all cases, the number of long-run relationships between the spot exchange rates and the forward exchange rates are not significantly affected.

Concerning the fractional unit root test of Lobato and Velasco (2007), consider x_t, a random process integrated of order $\delta \in (-0.5, 1.75)$. Recall that x_t is stationary for $\delta \in (-0.5, 0.5)$, mean reverting non-stationary for $\delta \in [0.5, 1)$ and has a unit root for $\delta = 1$. The test of Lobato and Velasco (2007) consists in restating $(1-L)^{\delta}x_t = \varepsilon_t$ as

$$(1-L)x_t = \varphi z_{t-1}(\delta) + \varepsilon_t, \quad z_{t-1}(\delta) = \frac{(1-L)^{\delta-1} - 1}{1-\delta}(1-L)x_t, \tag{1.21}$$

to test with a left-sided t-ratio statistic whether δ is not significantly different from 1 under the null hypothesis. Accordingly, under the null, $\phi = 0$ and $\delta = 1$ whereas under the alternative, $\phi < 0$ and $\delta \neq 1$. We employ the results obtained from Shimotsu (2010) to compute the test.

Chapter 2 Adaptive Learning, Monetary Policy and Carry Trades[a]

2.1 Introduction

Since the beginning of the 2000's unconventional monetary policies have emerged. In 2001, the Bank of Japan was the first central bank to undertake a quantitative easing (QE) program. After the 2008 crisis, the Federal Reserve Bank also resorted to such a policy. The European Central Bank is belatedly engaged in QE. Such a policy aims at injecting huge quantities of liquidity in order to boost growth in large economies. This policy aims at raising bank domestic credit but carry trades transfer such liquidity abroad. The point is that capital moves from large economies to small open economies such as New-Zealand, Australia and Brazil. Moreover, these economies' central banks target inflation, which means that their interest rates are high relative to the zero lower bounds reached by developed countries engaged in QE, leading to carry trades.

Carry trades are investments which involve borrowing a low-return currency in order to invest in a high-return one. Jonsson (2009) describes well the fact that in small open economies, increasing interest rates (particularly when the interest rate is above the one in other countries) during expansionary periods will attract capitals which will appreciate the exchange rate and lead to a false wealth effect. In other words, inflation targeting policies in small open economies can destabilize a country subject to carry trades through the following mechanism: when inflation increases, the central bank raises the interest rate which increases carry trades' returns. Given that capital inflows are expansionary, they enhance inflation, leading the central bank to raise again the interest rate. Thus, the more there are carry trades, the more they are attractive (we will call it the carry trades' vicious circle). The only tool to stabilize the financial sector in these small open economies are macroprudential policies but given that there aim is not to act on the foreign exchange market, they are not able to act on the carry trades' vicious circle. In the case of New-Zealand, as presented in *New Zealand* (2014),

[a]This chapter is an article co-written with Eric Girardin and Patrick Pintus.

macroprudential policy only stabilizes the housing market. Consequently, the destabilizing effects have to be managed by the central bank. The aim of this paper is to investigate how the central bank of a small open economy can reduce or suppress the carry trades' vicious circle. Hence, we focus on the short run interest rate as the tool used by the central bank to stabilize the economy. Obviously, other policies could act on the above mentioned vicious circle as e.g. capital control, taxes on the foreign exchange market, exchange rate targeting among others but we leave such investigations for further research.

Carry trades' strategies are widely investigated in macroeconomics and involve investments which seem less risky than usual financial operations. Burnside et al. (2006b) have shown that the Sharpe ratio associated to carry trades is higher than the Sharpe ratio of the US stock market, reflecting a better risk performance. Through this operation, investors, whose aim is to earn the interest differential, have to take into account exchange rate changes which directly impact the return of carry trades, see e.g Burnside et al. (2011b). Changes in the exchange rate can either increase the gain, cancel it or even generate a loss. For example, an appreciation of the currency of the targeted country will raise the return of carry trades above the interest differential. Investors also have to care about the reversal of carry trades. Indeed as reported in Jonsson (2009) and Plantin and Shin (2016), after cumulative inflows generated by carry trades, investors sell the target country currency, leading to large outflows, reducing carry trades' returns. Such outflows also destabilize the host country in the sense that the expansionary effect of carry trades instantaneously disappears. This kind of investment is profitable only if uncovered interest parity (UIP) does not hold. Fama (1984) has shown that UIP does not hold in the short run.

One of the findings of Plantin and Shin (2016) is that carry trades can be destabilizing when investors' strategies are complementary, pointing out the importance of investors' behavior. Carry trades' returns are directly linked to monetary policies which determine the interest differential. Many authors as Bullard and Mitra (2002), **EH02**; Evans and Honkapohja (2006) and Evans and Honkapohja (2003) as well as Orphanides and Williams (2005) and Orphanides and Williams (2006) have shown, through adaptive learning, that agents beliefs are crucial concerning the monetary policy's effect on the economy. It is clear that agents' behavior plays a central role in the destabilizing character of carry trades. Hence it appears essential to consider non fully rational agents (thanks to adaptive learning) while studying the effect of monetary policies on carry trades.

In this paper, we merge the literatures about monetary policy, carry trades and adaptive learning in order to investigate which monetary policy can reduce or suppress the vicious circle generated by carry trades in small open economies. Notice that we assume that the foreign country (a large economy) is at the zero lower bound by setting its interest exogenously and equals to zero. We begin with a strict inflation targeting policy (benchmark) which is, as mentioned before, favorable to the carry trades vicious circle. Thereafter, we study the case of a flexible inflation-output targeting policy in order to investigate whether adding an output objective in the central bank's loss function can reduce or suppress the carry trades' vicious circle. Taking into account the recent work of the IMF e.g. Ostry (2012), *Guidance Note for the Liberalization and Management of Capital Flows* (2015), we consider monetary policies which manage capital inflows. The latter policies, by decreasing the interest rate after an increase in capital inflows, should suppress the carry trades' vicious circle. We introduce this central bank's behavior by considering monetary authorities which have both an inflation and a capital inflows target. More precisely, with such a policy, the central bank will minimize the spreads between inflation and capital inflows and their targets. Hence, thanks to our adaptive learning approach, we are able to investigate how the economy evolves when agents do not know the long run values of the targeted variables. In such a case, agents know which framework the central bank uses to implement its monetary policy but ignore the long run targets of the central bank.

Our results imply that two monetary policy designs better perform. On the one hand, when the central bank chooses a standard policy, as strict- or flexible inflation-output targeting, the carry trades' vicious circle is minimized by a discretionary flexible inflation-output targeting policy announcing the long run target of the output (this is the "second best" framework). On the other hand, the "first best" policy is flexible inflation-capital targeting under discretion announcing the long run capital inflows target.

The rest of the paper is laid out as follows. Section 2.2 presents the model.

In section 2.3, we introduce a secret behavior of the central bank. Section 2.4 is devoted to the calibration of the model. Section 2.5 and 2.6 present the results with a transparent and a secret monetary policy respectively. Section 2.7 investigates statistically how carry trades affect different inflation targeting countries. Section 2.8 concludes.

2.2 The model

2.2.1 The exchange rate

Carry trades come from the action of borrowing an amount of a low-yield currency and investing it in a high-yield currency. Uncovered Interest Parity (UIP) states that the low/high return currency tends to appreciate/depreciate: $(1 + r_t) = (1 + r_t^*)\frac{E_t s_{t+1}}{s_t}$, with r_t and r_t^* the domestic and foreign interest rate respectively and s_t and $E_t s_{t+1}$ the current and expected exchange rates. Carry trades come from the failure of the UIP condition in the short run (investors bet against UIP). An increase in the host country interest rate increases the return of a carry trade which enhances capital inflows and appreciates the currency. Since Fama (1984), many authors have investigated whether UIP holds empirically by estimating the following equation $\Delta s_{t+K} = \alpha + \beta(r_t - r_t^*) + \epsilon_{t+k}$, where $\beta = 1$ if UIP holds. In the short run β is always negative which reflects the fact that an increase in the domestic interest rate appreciates the domestic currency. That is why we write a different equation from UIP which states that the high-return currency tends to appreciate: $(1 + r_t^*) = (1 + r_t)\frac{E_t s_{t+1}}{s_t}$ in the short run. When the economy reaches its long run equilibrium, UIP holds and carry trades stop. Denoting F_t the forward rate and $E_t s_{t+1}$, the expected exchange rate, combining covered interest parity (CIP: $(1 + r_t) = (1 + r_t^*)\frac{F_t}{s_t}$) and UIP, we have:

$$F_t = E_t s_{t+1}. \tag{2.1}$$

We now relax the CIP condition. Inserting the parameter δ (similarly to Chakraborty and Evans (2008)) in Equation (2.1), allows us to introduce exchange rate biasedness, i.e. the fact that the forward rate is not a perfect predictor of the future exchange rate (Fama (1984)). Equation (2.1) becomes:

$$F_t = \delta E_t s_{t+1} + \omega_t, \tag{2.2}$$

ω_t is an AR(1) shock which affects the exchange rate. Hence, we have: $\omega_t = \eta_3 \omega_{t-1} + \tilde{\omega_t}$. With $\tilde{\omega_t}$ an i.i.d random variable with zero mean and variance σ^2_ω. We rewrite our parity condition in log which gives:

$$s_t = F_t + r_t - r^*_t, \tag{2.3}$$

Given that the foreign country is assumed to be engaged in quantitative easing, the foreign interest rate is set to its zero lower bound[b] ($r^*_t = 0$), then from Equations (2.2) and (2.3), we obtain the following exchange rate equation:

$$s_t = \delta E_t s_{t+1} + r_t + \omega_t. \tag{2.4}$$

Equation (2.4) shows that an expected exchange rate appreciation will appreciate the current exchange rate. That is due to the fact that if agents expect an appreciation, they will buy the domestic currency, which will appreciate it at time t. By increasing the return of a carry trade, an increase in the interest rate appreciates the domestic currency.

2.2.2 Capital inflows

We introduce a friction in the financial markets by assuming that investors are not able to rebalance their portfolio at each period. Then, similarly to Plantin and Shin (2016) changes in capital inflows depend on the rate at which investors can rebalance their portfolio (λ). Notice that here $\lambda \in]0;1[$ is a constant, meaning that at each period there is a constant fraction of investors who are able to rebalance their portfolio. Expected changes in capital inflows also depend on the amount invested by investors who have had the opportunity to rebalance their portfolio (c_t) and the amount invested in

[b]For simplicity, we include quantitative easing by assuming that the foreign interest rate is equal to zero. This assumption reflects well the zero lower bound reached by the foreign interest rate but do not account for the liquidity's injection. A model which includes the liquidity injection enhanced by QE would allow to analyze the impact of the increasing liquidity in the foreign country during QE. Our aim here is to focus on the inflation targeting country, thus our assumption is not too strong concerning the impact of carry trades on the domestic economy.

domestic currency at time t, denoted n_t, which can be interpreted as current capital inflows.

$$E_t n_{t+1} - n_t = \lambda(c_t - n_t) + z_t, \tag{2.5}$$

z_t is a shock which affects capital inflows. The assumption of a constant λ refers to the fact that investors are not able to rebalance their positions at each period. This assumption is realistic in the sense that carry trades can be done through forward contracts which fix a future date at which the investor will have to close its position (in the meantime, the investor would not be able to close it). Note that z_t is an AR(1) of the form: $z_t = \eta_4 z_{t-1} + \tilde{z}_t$, with $\tilde{z}_t$ an i.i.d random variable with zero mean and variance σ_z^2. Obviously, the amount invested by carry traders who have rebalanced their portfolio is linked to the return of a carry trade (that is why we set c_t as an endogenous variable) which depends positively on the host country's expected interest rate and the expected change in the exchange rate ($R_t = E_t r_{t+1} + E_t s_{t+1} - s_t$). Thus we have:

$$c_t = \tau E_t r_{t+1} + \mu(E_t s_{t+1} - s_t).$$

The parameters τ and μ introduce the fact that investors do not always grant the same importance to the changes in the exchange rate and the interest rate when they take their investment decision. More precisely, μ and τ are the elasticities of the amount invested by traders who have had the opportunity to rebalance their portfolio with respect to expected changes in the exchange and interest rates respectively. Hence, the expression of capital inflows is:

$$n_t = \sigma E_t n_{t+1} - \lambda\sigma\left\{\tau E_t r_{t+1} + \mu(E_t s_{t+1} - s_t)\right\} + z_t, \tag{2.6}$$

with $\sigma = \frac{1}{1-\lambda}$. Looking at Equation (2.6), we observe an opposite effect of the current and expected interest rates on capital inflows. On the one hand, we observe a negative effect of $\lambda\sigma(\tau E_t r_{t+1} + \mu E_t s_{t+1})$ which is linked to carry trades reversal. More precisely, the more investors take long positions on the domestic currency (the more $(\tau E_t r_{t+1} + \mu E_t s_{t+1})$is high), the less capital inflows will increase because investors expect future short positions on the domestic currency. On the other hand, a higher current interest rate appreciates the domestic currency which generates further capital inflows. λ reflects how important is the mass of investors on capital inflows. The more there are investors (λ is high), the more the impact of each variable on capital inflows is high. That means that through their decisions, when they are numerous, investors influence the macroeconomic variables by increasing capital inflows.

2.2.3 The monetary policies

We investigate several kind of monetary policies. We begin with the well-known strict inflation targeting policy which we use as a benchmark. From this benchmark we consider two different extensions of the monetary policy. On the one hand, monetary authorities can act in a standard way, adding an output gap target. On the other, they can have a capital inflows target. Depending on the monetary authorities' objectives the central bank will minimize either the first or the second loss function below:

$$min\frac{1}{2}E_t\left[\sum_{i=0}^{\infty}\beta^i[(\pi_{t+i}-\bar{\pi})^2+\alpha_y(y_{t+i}-\bar{y})^2]\right], \tag{2.7}$$

$$min\frac{1}{2}E_t\left[\sum_{i=0}^{\infty}\beta^i[(\pi_{t+i}-\bar{\pi})^2+\alpha_n(n_{t+i}-\bar{n})^2]\right]. \tag{2.8}$$

The central bank minimizes Equation (2.7) when it implements a flexible inflation-output targeting policy. Clarida et al. (2000) have modeled this kind of policy under discretion and commitment. Notice that $\alpha_y = 0$ reflects a strict inflation targeting policy. In Equation (2.8), the central bank implements a flexible inflation-capital targeting policy. $E_t\pi_{t+1}$ denotes expected inflation at time t for $t+1$, E_tn_{t+1} expected capital inflows at time t for $t+1$, $\bar{\pi}$ and $\bar{n}$ are the targeted levels of inflation and capital inflows respectively. As suggested in the literature, the loss function implicitly takes 0 as the targeted inflation[c] ($\bar{\pi} = 0$). We use the same assumption concerning capital inflows' target ($\bar{n} = 0$). In Equation (2.7) E_ty_{t+1} is the expected output gap at time t for $t+1$ and $\bar{y}$ the targeted level of the output gap. The output gap is constructed as follow, $y_t = x_t - o_t$ with x_t the current output and o_t potential output, both in log. Given that the loss function takes the potential

[c]Inflation is expressed as a percent deviation from trend.

output as the target, $\bar{y} = 0$. Notice that α_y is the weight that the central bank grants to the output gap and α_n the one devoted to capital inflows. The constraints for the minimization program are the output gap and inflation, which are expressed as follows:

$$y_t = E_t y_{t+1} + \upsilon E_t n_{t+1} - \varphi(r_t - E_t \pi_{t+1}) + g_t, \tag{2.9}$$

$$\pi_t = \kappa y_t - \phi s_t + \beta E_t \pi_{t+1} + u_t. \tag{2.10}$$

In Equation (2.9) expected capital inflows ($E_t n_{t+1}$) enhance growth. Such an assumption is line with Jonsson (2009) in the sense that capital inflows are expansionary by allowing to borrow cheap and lend more expensively. Such a relation is present when the expected exchange rate appreciates. Notice that g_t and u_t represent shocks which increase the output gap and inflation respectively, they both follow an AR(1) process. In Equation (2.10) an appreciation of the domestic currency reduces inflation. We are now able to minimize Equations (2.7) and (2.8) and investigate six different monetary policies.

In a first step, we investigate our benchmark which is a strict inflation targeting policy. Then, we consider that the central bank adds an output gap objective in its loss function analyzing a flexible inflation-output targeting policy both under discretion and commitment. Thereafter, we investigate whether adding a capital inflows target instead of an output gap one is more efficient regarding carry trades. Once again, we consider this framework both under discretion and commitment. To end up, we consider the exotic case of a strict capital inflows targeting policy. Obviously, this is not a realistic scenario and we expect this policy to be highly inflationary in presence of carry trades.

2.2.3.1 Strict inflation targeting

Similarly to Svensson (1997b), the first-order condition is the following $E_t \pi_{t+i} = \bar{\pi}$. Inserting it into (2.10) and rearranging, we get the following reaction function:

$$r_t = \gamma_y E_t y_{t+1} + \gamma_\pi E_t \pi_{t+1} + \gamma_s E_t s_{t+1} + \gamma_n E_t n_{t+1} + \gamma_g g_t + \gamma_u u_t + \gamma_\omega \omega_t, \tag{2.11}$$

with,

$$\gamma_\pi = \psi(\beta + \kappa\varphi - 1); \qquad \gamma_u = \psi;$$
$$\gamma_n = \varphi\kappa\upsilon; \qquad \gamma_y = \gamma_g = \psi\kappa;$$
$$\gamma_s = \psi\phi\delta; \qquad \gamma_\omega = -\psi\phi;$$
$$\psi = \frac{1}{\phi + \kappa\varphi}.$$

Given that both the output gap and capital inflows are inflationary, after an increase in those two variables, the central bank raises the interest rate. Obviously, when expected inflation increases the central bank raises the interest rate in order to maintain inflation at the desired level. An expected domestic currency appreciation has two different impacts. On the one hand, it decreases inflation, leading the central bank to decrease the interest rate. On the other, it increases the expected return of carry trades, augmenting expected capital inflows, which are inflationary, bringing the central bank to raise the interest rate.

2.2.3.2 Flexible inflation-output targeting under discretion

The first order conditions, $y_t = -\frac{\kappa}{\alpha_y}\pi_t$ and $\pi_t = -\frac{\alpha_y}{\kappa}y_t$, are used to obtain the following reaction function:

$$r_t = \gamma_\pi E_t\pi_{t+1} + \gamma_y E_t y_{t+1} + \gamma_s E_t s_{t+1} + \gamma_n E_t n_{t+1} + \gamma_g g_t + \gamma_u u_t + \gamma_\omega \omega_t, \tag{2.12}$$

with,

$$\gamma_\pi = (1-\zeta)\left(1 + \frac{\kappa\beta}{\varphi(\alpha+\kappa^2)}\right); \qquad \gamma_u = \frac{\kappa}{\varphi(\alpha+\kappa^2)}(1-\zeta);$$
$$\gamma_n = \frac{\upsilon}{\varphi}(1-\zeta); \qquad \gamma_y = \gamma_g = \frac{1}{\varphi}(1-\zeta);$$
$$\gamma_s = -\zeta\delta; \qquad \gamma_\omega = -\zeta;$$
$$\zeta = \frac{\phi\kappa}{\varphi(\alpha+\kappa^2) + \phi\kappa}.$$

In this framework, the central bank reacts in two ways following a higher expected inflation. On the one side, as usual, the central bank increases the interest rate in order to keep inflation around the targeted level. On the other, a higher inflation depreciates the domestic currency which reduces capital inflows, decreasing the output gap and bringing the central bank to cut the interest rate. An appreciation of the domestic currency diminishes inflation and the interest rate. The central bank reacts in two opposite ways after an increase in the output gap and capital inflows. On the one hand, since inflation rises, the central bank raises the interest rate. On the other hand, the domestic currency appreciates, reducing inflation, and the central bank decreases the interest rate. Notice that the final impact of an increase in both the expected output gap and capital inflows on the interest rate is positive.

2.2.3.3 Flexible inflation-output targeting under commitment

In this framework the central bank announces its aim in terms of output gap. Thus if the monetary authorities want to be credible, they have to honor their past promises. That is why, we include the lagged output gap (y_{t-1}). In this monetary policy setting, the first order conditions are $y_t = -\frac{\kappa}{\alpha}\pi_t + y_{t-1}$ and $\pi_t = -\frac{\alpha}{\kappa}(y_t - y_{t-1})$; thus the reaction function becomes:

$$r_t = \gamma_\pi E_t \pi_{t+1} + \gamma_y E_t y_{t+1} + \gamma_s E_t s_{t+1} + \gamma_n E_t n_{t+1} + \gamma_{ylag} y_{t-1} \\ + \gamma_g g_t + \gamma_u u_t + \gamma_\omega \omega_t. \quad (2.13)$$

All the parameters in Equation (2.13) are the same as in Equation (2.12) except $\gamma_{ylag} = (\zeta\iota - 1)\frac{\iota\alpha}{\varphi(\alpha+\kappa^2)}$. Notice that, here, the central bank reacts both to the lagged and expected output gap. An increase in the lagged output gap announces a higher future interest rate, leading to a lower expected output gap. Under such circumstances, the central bank cuts the interest rate after an increase in the past output gap in order to honor its past promises.

2.2.3.4 Flexible inflation-capital targeting under discretion

We now investigate the case of a central bank which reacts both to capital inflows and inflation. That means that the monetary authorities want to reduce the vicious circle generated by carry trades and target inflation. In this case the central bank has to minimize Equation (2.8) under the constraints

(2.9) and (2.10). The first order conditions resulting from this minimization program are $n_t = \frac{\alpha}{\sigma}\pi_t$ and $\pi_t = \frac{\sigma}{\alpha}n_t$. Thereafter, we have to rewrite Equation (2.6) in order to introduce the variable n_t in Equation (2.10):

$$s_t = \frac{1}{\lambda\sigma}n_t - \frac{1}{\lambda}E_t n_{t+1} + \tau E_t r_{t+1} + \mu E_t s_{t+1} - \frac{1}{\lambda\sigma}z_t. \tag{2.14}$$

From the first order conditions, Equations (2.10) and (2.4), we get the following reaction function:

$$\begin{aligned} r_t = {} & \gamma_y E_t y_{t+1} + \gamma_\pi E_t \pi_{t+1} + \gamma_s E_t s_{t+1} + \gamma_n E_t n_{t+1} \\ & + \gamma_r E_t r_{t+1} + \gamma_g g_t + \gamma_u u_t - \gamma_\omega \omega_t - \chi z_t, \end{aligned} \tag{2.15}$$

with

$$\begin{aligned} \gamma_y &= \frac{\chi\alpha\kappa}{\sigma}; & \gamma_\pi &= \chi\left(\frac{\alpha\kappa\varphi + \beta\alpha}{\sigma}\right); \\ \gamma_s &= \chi\left(\lambda\sigma\mu - \frac{\alpha\phi\delta}{\sigma}\right); & \gamma_n &= \chi\left(\frac{\alpha\kappa\upsilon}{\sigma} - \sigma\right); \\ \gamma_r &= \chi\sigma\tau; & \gamma_g &= \frac{\chi\alpha\kappa}{\sigma}; \\ \gamma_u &= \frac{\chi\alpha}{\sigma}; & \gamma_\omega &= \chi\left(\frac{\phi\alpha}{\sigma} + \lambda\sigma\mu\right), \end{aligned}$$

and $\chi = \frac{\sigma}{\lambda\sigma^2\mu + \alpha\kappa\varphi + \alpha\phi}$. In Equation (2.15) both γ_y and γ_π are positive, which means that after an increase in both the output gap and inflation, the central bank raises the interest rate, in order to reduce inflation. The central bank reacts in two opposite ways after an increase in capital inflows and an appreciation of the domestic currency. Given that capital inflows are expansionary, they increase inflation, that is why monetary authorities raise the interest rate. On the other side, an increase in capital inflows makes carry trades more attractive, which brings the central bank to reduce the interest rate in order to minimize capital inflows' volatility (notice that the whole impact is negative). On the one hand, the central bank increases the interest rate after an expected appreciation of the domestic currency because the latter reduces capital inflows. On the other, given that an appreciation of the domestic currency reduces inflation, the central bank lowers the interest rate not to deviate from its inflation target.

2.2.3.5 Flexible inflation-capital targeting under commitment

In this framework the central bank announces its aim in terms of capital inflows' volatility. Thus if the monetary authorities want to be credible, they have to honor their past promises. That is why, we include lagged capital inflows (n_{t-1}). Using the same methodology as in the previous section, we obtain the following first order conditions:

$$\begin{aligned} n_t &= \frac{\alpha}{\sigma}\pi_t + n_{t-1}, \\ \pi_t &= \frac{\sigma}{\alpha}(n_t - n_{t-1}). \end{aligned} \tag{2.16}$$

Using the first order conditions (2.16) and Equation (2.6), we get the optimal capital inflows:

$$\begin{aligned} n_t = \frac{\alpha\kappa}{\sigma}E_t y_{t+1} + \left(\frac{\alpha\kappa\varphi + \beta\alpha}{\sigma}\right)E_t\pi_{t+1} - \frac{\phi\delta\alpha}{\sigma}E_t s_{t+1} + \frac{\alpha\kappa\upsilon}{\sigma}E_t n_{t+1} - \\ \frac{\alpha\kappa\varphi + \phi\alpha}{\sigma}r_t + n_{t-1} + \frac{\kappa\alpha}{\sigma}g_t + \frac{\alpha}{\sigma}u_t - \frac{\phi\alpha}{\sigma}\omega_t. \end{aligned} \tag{2.17}$$

From Equations (2.6) and (2.17), we obtain the central bank's reaction function under commitment:

$$\begin{aligned} r_t = \gamma_y E_t y_{t+1} + \gamma_\pi E_t \pi_{t+1} + \gamma_s E_t s_{t+1} + \gamma_n E_t n_{t+1} + \\ \gamma_r E_t r_{t+1} + \chi n_{t-1} + \gamma_g g_t + \gamma_u u_t - \gamma_\omega \omega_t - \gamma_z z_t. \end{aligned} \tag{2.18}$$

The parameters in Equation (2.18) are the same as in Equation (2.15). The only innovation is the presence of lagged capital inflows. That means that the central bank reacts to all variables in the same way as under discretion, except that it increases the interest rate after a rise in past capital inflows. An increase in past capital inflows announces a lower future interest rate, decreasing expected capital inflows leading to a higher interest rate at time t.

2.2.3.6 Strict capital inflows targeting

Here we investigate the case of a central bank which only wants to minimize capital inflows' volatility in order to limit the vicious circle enhanced by carry trades. Our methodology is similar to the one developed in Svensson (1997b) but instead of controlling inflation, the central bank targets capital inflows. In this case, the loss function is of the following form $L = \frac{1}{2}E_t\left[\sum_{i=0}^{\infty}\beta^i(n_{t+i}-\bar{n})^2\right]$, and the first order condition is $E_t n_{t+i} = \bar{n}$. Using the FOC and Equations (2.4) and (2.6), we obtain the following reaction function:

$$r_t = \gamma_s E_t s_{t+1} + \gamma_n E_t n_{t+1} + \gamma_r E_t r_{t+1} - \omega_t - \gamma_z z_t, \tag{2.19}$$

with

$$\gamma_s = (1-\delta); \qquad \gamma_n = \frac{1-\sigma}{\lambda\sigma\mu};$$
$$\gamma_r = \frac{\tau}{\mu}; \qquad \gamma_z = \frac{1}{\lambda\sigma\mu}.$$

The first thing to note is that $\sigma > 1$; thus after an increase in capital inflows, the central bank decreases the interest rate. By reducing the interest rate, the central bank lowers carry trades' returns, allowing to maintain capital inflows around the target. As mentioned previously, this is not a realistic scenario and we expect it to be highly inflationary[d].

2.3 Introducing a changing behavior of the central bank

Here we consider the case in which agents think that the central bank changes its behavior. We can think of the arrival of a new governor which leads agents to think that the long run objectives of the central bank will change. In such a case agents will ignore the long run targets of the central bank. More precisely agents will have to estimate the long run values of the output gap and capital inflows as the case may be.

[d]We voluntary do not present the impulse response functions for this scenario. The results reveal that this monetary policy is inflationary after a 5% capital inflows shock (as expected) and the IRF are available upon request.

2.3.1 The formation of expectations under discretion

Concerning those monetary policies, we are in the case of purely forward looking models. The economy is formalized through the systems presented in Appendix 2.8.2, 2.8.3, 2.8.5 and 2.8.6. We rewrite these systems in the following way:

$$A_t = B + M\hat{E}_t A_{t+1} + \Phi\Omega_t. \quad (2.20)$$

$\hat{E}_t$ means that expectations are non rational, A_t is a (5×1) vector containing the endogenous variables of the model ($A_t = (y_t, \pi_t, s_t, x_t, r_t)'$), M and Φ are (5×5) matrices of parameters and

$$\Omega_t = F\Omega_{t-1} + \epsilon_t. \quad (2.21)$$

With Ω_t a (5×1) vector of shocks which is defined as an AR(1) process. It clearly follows that Ω_{t-1} and ϵ_t are (5×1) vectors. F is a (5×5) matrix where $F = I\eta$ with I the identity matrix and $\eta \in]0;1[$. Then η represents the parameters in the diagonal of matrix F with all these parameters equal to 0.9. We could choose different values for these parameters but we assume that they are equal for simplicity. B is a (5×1) vector of constants, with $B = (I - M)\bar{A} - \Phi\bar{\Omega}$. The vector of constants B is only present in the system when agents do not know the long run values of the targeted variables. Otherwise, $B = 0$ and agents do not have to estimate the vector of constants.
Agents will forecast $\hat{E}_t A_{t+1}$ using discounted least squares from the following econometric model: $A_t = a_{t-1} + b_{t-1}\Omega_t + \epsilon_t$, with a a (5×1) vector and b a (5×5) matrix. When agents know the targeted values, $a = 0$. Agents' perceived law of motion (PLM) is of the following form:

$$A_t = a + b\Omega_t. \quad (2.22)$$

At the beginning of period t, agents have estimated b_{t-1} using discounted least squares. Then the shocks Ω_t are realized and agents form their expectations from the PLM (2.22). Thereafter, A_t is generated according to system (2.20). In t+1, agents update their forecast with their past estimations of a and b, leading them to forecast according to:

$$\hat{E}_t A_{t+1} = a + Fb\Omega_t \quad (2.23)$$

Subsequently, agents estimate a and b according to the following algorithm:

$$\phi_t = \phi_{t-1} + \gamma R_{t-1}^{-1} z_{t-1}(A_t - \phi'_{t-1} z_{t-1}), \tag{2.24}$$
$$R_t = R_{t-1} + \gamma(z_t z'_t - R_{t-1}), \tag{2.25}$$

with γ a small positive constant representing the gain. R_t is an estimate of the second moment of Ω_t. $\phi_t = (a, b)'$ and $z_t = (1, \Omega_t)'$. Using Equations (2.23) and (2.20), we get the implied "Actual Law of Motion" (ALM):

$$A_t = (Mb_{t-1}F + \Phi)\Omega_t. \tag{2.26}$$

The mapping from the PLM to the ALM is:

$$T(a, b) = (B + Ma,\ MFb + \Phi), \tag{2.27}$$

Thus, the E-stability is determined by the following differential equation:

$$\frac{da}{d\tau} = B + (M - I)a,$$
$$\frac{db}{d\tau} = \Phi + (MF - I)b.$$

Referring to Evans and Honkapohja (2001), $(\bar{a},\ \bar{b})$[e] is a globally stable equilibrium point if all the eigenvalues of M and MF are inside the unit circle. This is the case in the model, thus, whatever the initial values, $E(a_t,\ b_t) \rightarrow (\bar{a},\ \bar{b})$ as $t \rightarrow \infty$.

2.3.2 The formation of expectations under commitment

When the monetary policy is committed, there is a lagged vector in the system. Thus, in this framework, agents will observe one additional vector which will change the way they will forecast. Hence, the system becomes:

$$A_t = B + M\hat{E}_t A_{t+1} + NA_{t-1} + \Phi\Omega_t, \tag{2.28}$$

[e]Notice that here the rational expectation equilibrium is defined as follows: $\bar{a} = (I - M)^{-1}B$ and $\bar{b} = (I - MF)\Phi$.

with N a (5×5) matrix and A_{t-1}, a (5×1) vector. Under commitment the vector of constants is of the following form, $B = (I - M - N)\bar{A} - \Phi\bar{\Omega}$ and agents' PLM becomes:

$$A_t = a + b\Omega_t + dA_{t-1}. \tag{2.29}$$

Using discounted least squares, agents will estimate the (5×5) matrices b and d and the (5×1) vector a. As previously, in $t+1$, they update their forecast, but here with their past estimations of a, b and d. From Equation (2.29), we have:

$$\hat{E}_t A_{t+1} = (I + d)a + d^2 A_{t-1} + (bF + db)\Omega_t. \tag{2.30}$$

Inserting Equation (2.30) in Equation (2.28), we obtain the following ALM:

$$A_t = B + M(I + d)a + (Md^2 + N)A_{t-1} + (MbF + Mdb + \Phi)\Omega_t. \tag{2.31}$$

Agents will estimate the matrices b and d and the vector a. Defining the parameters' matrix $\phi = (a, b, d)'$ and the state variable vector $z_t = (1, A_{t-1}, \Omega_t)'$, the estimation is based on the following recursive least squares algorithm:

$$\phi_t = \phi_{t-1} + \gamma R_{t-1}^{-1} z_{t-1}(A_t - \phi_{t-1}' z_{t-1}), \tag{2.32}$$
$$R_t = R_{t-1} + \gamma(z_t z_t' - R_{t-1}), \tag{2.33}$$

From Equations (2.29) and (2.30), the REE is defined as the fixed point of:

$$\begin{aligned} a &= T(a) = (I - M - Md)^{-1}B, \\ b &= T(b) = (I - Mdb - MF)^{-1}\Phi, \\ d &= T(d) = (I - Md)^{-1}N. \end{aligned}$$

The mapping from the PLM to the ALM is:

$$T(a, b, d) = \left\{(I - M - Md)^{-1}B, (I - Mdb - MF)^{-1}\Phi, (I - Md)^{-1}N\right\}.$$

In line with chapter 10 of Evans and Honkapohja (2001), E-stability depends on $DT_d(\bar{d})$ and $DT_d(\bar{b}, \bar{d})$. Proposition 10.1 of Evans and Honkapohja

(2001) states that the solution is E-stable if all the eigenvalues of $DT_b(\bar{b})$ an $DT_d(\bar{b}, \bar{d})$ have real parts less than one. Here, we have:

$$DT_d(\bar{d}) = \{(I - M\bar{d})^{-1}N\}' \otimes \{(I - M\bar{d})^{-1}M\}, \tag{2.34}$$

$$DT_d(\bar{b}, \bar{d}) = F' \otimes \{(I - M\bar{d})^{-1}M\}. \tag{2.35}$$

Given that, in our framework, all the eigenvalues of (2.34) and (2.35) lie inside the unit circle, whatever the initial values, we have $Eb_t \to \bar{b}$ as $t \to \infty$ and $Ed_t \to \bar{d}$ as $t \to \infty$.

2.4 Calibrations

We are now able to study the dynamics of the system under learning. However, it is necessary to set the values of all parameters. We consider three

Table 2.1 Parameters' value

Parameters	CGG	W	MN
κ	0.075	0.024	0.3
β	0.99	0.99	0.99
φ	4	$(0.157)^{-1}$	0.164

different calibrations for the rules (2.11), (2.12), (2.13), (2.19), (2.15) and (2.18) which are taken from Clarida et al. (2000) (CGG), Woodford (1999) (W) and McCallum and Nelson (1998) (MN). Notice that we obtain quasi similar results with these three different specifications, the results reported in this paper are based on the CGG calibration. In Table 2, we set $\alpha_y = 0.4$ which is a standard value in the literature. We also set $\alpha_n = 0.4$ in order to have an harmonized framework. Concerning the parameters τ and μ, we assume that $\mu > \tau$ because the expected exchange rate is the only source of risk in carry trades. Thus investors grant more importance to exchange rate changes than interest rate changes because they are risk averse. Estimating the output gap and the reaction function of New Zealand from 1995 to 2008 with GMM, we find that capital inflows have a significant impact on the output gap (0.03). Thus, we set $v = 0.03$. The value of λ means that at each period, 50% of the investors can rebalance their portfolio. In line with

Table 2.2 Other parameters' value

Parameters	Values
α_y	0.4
α_n	0.4
τ	0.1
μ	0.5
v	0.03
λ	0.5
ϕ	0.1
δ	0.6
η	0.9

Recall that $F = I\eta$ with I a (5×5) identity matrix and $\Omega_t = F\Omega_{t-1} + \epsilon_t$ is a vector of exogenous shocks.

most of the learning literature e.g. Branch and Evans (2006a), Chakraborty and Evans (2008) and Orphanides and Williams (2005), we set $\gamma = 0.04$. We study here the case of a "constant gain" least squares algorithm. We set $\delta = 0.6$ in line with Chakraborty and Evans (2008).
This calibrated model will be used to investigate the impact of a 5% inflation shock on the economy with each monetary policy framework. We simulate such a shock because in a small open economy targeting inflation, the carry trades vicious circle appears after an increase in inflation. Considering the monetary policies targeting capital inflows, we also consider a 5% capital inflows shock, which reflects an increase in carry trades[f]. Notice that we choose T=150 which reflects a little less than 13 years using monthly data.

2.5 Which monetary policy performs the best?

In this section we investigate how the central bank can either reduce or suppress the vicious circle generated by carry trades. Agents know the true model of the economy, we will investigate later how mistakes in agents' beliefs will influence the economy after a shock.

[f]We do not present the IRF because it does not reveal more evidence than before. However, the results are available upon request and a subsection is devoted to the economic explanation of such a shock.

2.5.1 Strict and flexible inflation-output targeting

In this framework, we investigate the cases of a central bank engaged either in inflation targeting or flexible inflation-output targeting both under discretion or commitment.

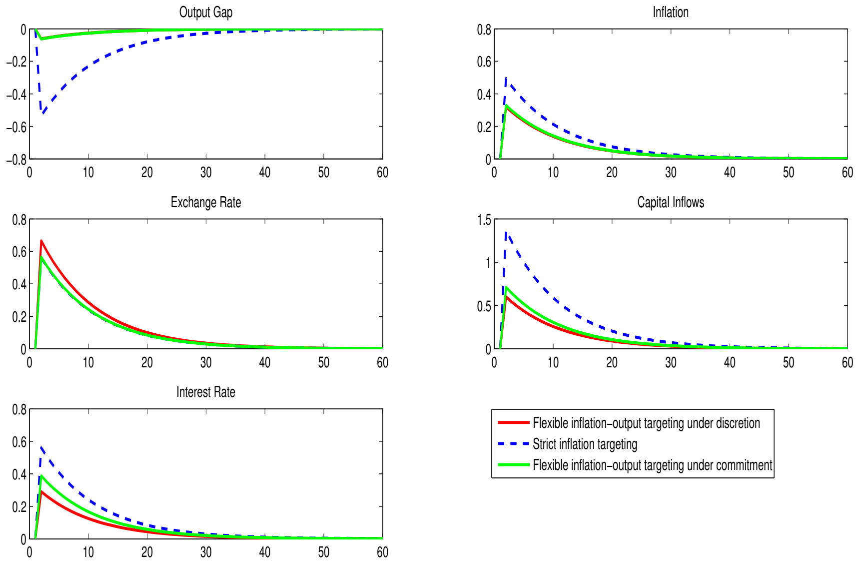


Figure 2.1: Response to a 5% inflation shock

Figure (2.1) shows how the economy reacts after an inflation shock under three different monetary policies. Our results confirm the vicious circle enhanced by carry trades in a strict inflation-targeting country. An increase in inflation leads the central bank to raise the interest rate which increases the return of carry trades. Given that carry trades are expansionary, the increase in capital inflows brought by the higher interest rate will increase inflation and the mechanism just mentioned will re-appear. Keeping in mind that the central bank wants to mitigate the latter vicious circle, the intuition is that reacting to both inflation and the output gap could diminish it.
Hence, we investigate the case of a central bank implementing a flexible inflation-output targeting policy and whether discretion is more efficient than commitment. In all cases the vicious circle generated by carry trades is downplayed when the central bank includes an output gap objective in its loss function. Figure (2.1) reveals that the vicious circle is minimized when

the monetary policy is discretionary. Indeed, the interest rate increases less after an increase in inflation, which raises carry trades' returns to a lesser extent. The most important vicious circle appears under commitment, due to the fact that the lagged output gap was higher than the current one. Given that the central bank takes into account this variable under commitment, it means that inflation will be impacted positively by this lagged variable. Thus inflation increases more than under discretion, leading the central bank to raise the interest rate to a larger extent, which makes carry trades more attractive.

We have seen that in the case of strict and flexible inflation-output targeting, a central bank which wants to downplay the vicious circle generated by carry trades has to react both to inflation and the output gap under discretion. However, even if this framework allows the central bank to mitigate the vicious circle, the latter is still present. This has motivated us to investigate the case of a central bank which directly reacts to capital inflows by decreasing the interest rate.

2.5.2 Flexible inflation-capital targeting

Here, the central bank wants to suppress the carry trades' vicious circle reacting to capital inflows. Thus, we consider a central bank which targets both inflation and capital inflows.

Figure (2.2) shows that with a flexible inflation-capital targeting policy, the carry trades vicious circle is suppressed both under discretion and commitment. After the shock, inflation increases, leading agents to expect an increase in the interest rate and capital inflows. At this point, the central bank cuts the interest rate in order to reduce carry trades returns and respect its capital inflows target. Through this mechanism monetary authorities are able to suppress the carry trades' vicious circle. Notice that under commitment, through the expected increase in capital inflows, capital inflows deviate from the central bank commitment, leading to cut the interest rate to a larger extent.

We can discriminate one of the two policies studied in this section. Given that the inflation objective is crucial for central banks, we consider here that the flexible inflation-capital targeting policy under discretion performs bet-

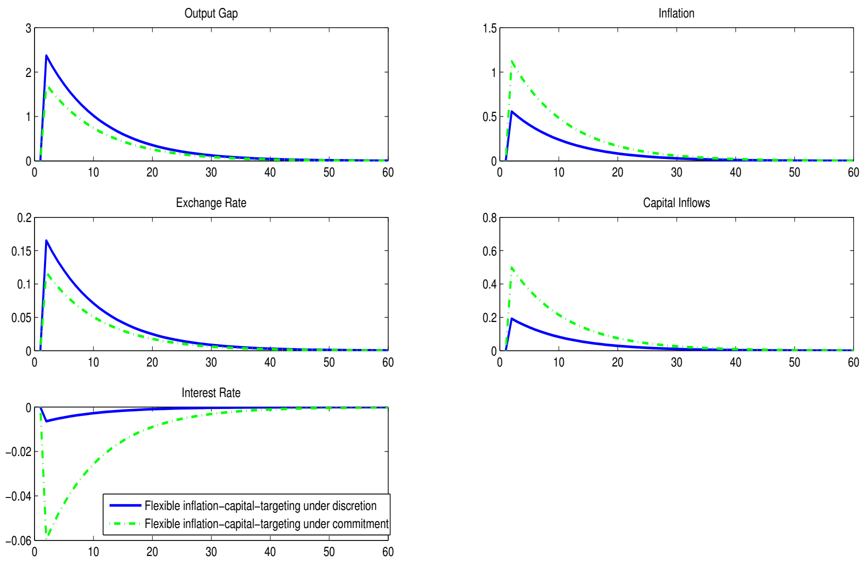


Figure 2.2: Response to a 5% inflation shock

ter than the one under commitment. Indeed, thanks to this policy, monetary authorities are able to suppress the carry trades' vicious circle without enlarging inflation too much.

Thanks to Figures (2.1), and (2.2), we have identified the most efficient monetary policies either in a standard strict and flexible inflation-output targeting framework or reacting both to inflation and capital inflows. The best way to design monetary policy is a flexible inflation-capital targeting policy under discretion (first-best). However if the central bank wants to keep a standard flexible inflation-output targeting framework it should target both inflation and the output gap under discretion (let us call it "the second best"). In the following section we go further in the comparison of the monetary policies by plotting all the policies on the same graphic.

2.5.3 Further insights on monetary policies

Figure (2.3) allows to compare all the policies on the same graphic. Such an analysis helps to better understand how the shock impacts the economy according to the monetary policy framework. In order to see clearly the differences between monetary policies, we simulate an inflation shock on ten periods. Figure (2.3) clearly reveals a trade-off between inflation and capital

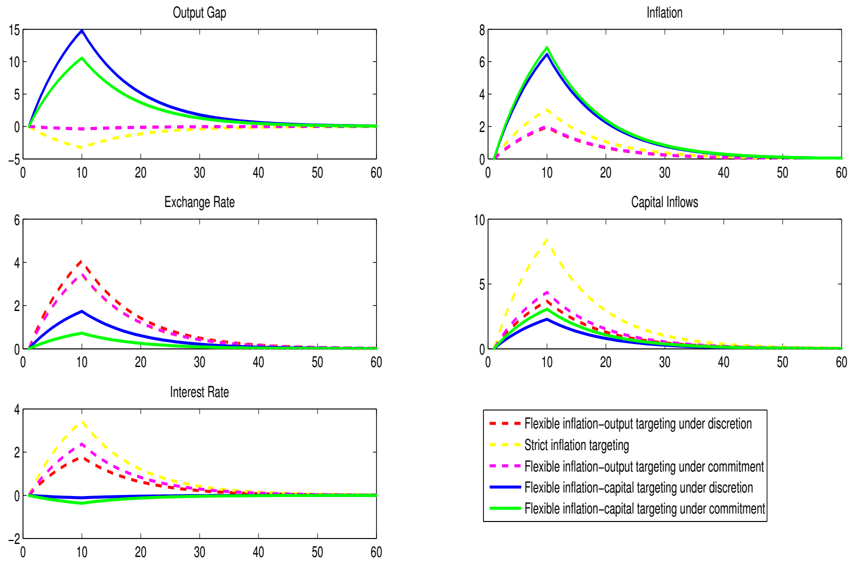


Figure 2.3: Response to a 5% inflation shock

inflows. A flexible inflation-output targeting policy leads to carry trades and further capital inflows. However, targeting inflation and capital inflows suppresses the carry trades vicious circle but is everytime more inflationary than a flexible inflation-output targeting policy. The aim of this paper is to find a monetary policy able to suppress the carry trades' vicious circle, thus we still consider the flexible inflation-capital targeting policy under discretion as the first-best. For the moment, we have shown which monetary policy is the most efficient regarding carry trades' vicious circle brought by an increase in inflation. We now consider an increase in capital inflows in the case of central banks targeting inflation.

2.5.4 Increasing carry trades

Concerning flexible inflation-capital targeting policies, we also investigate what happens after a 5% capital inflows shock, revealing a direct increase in carry trades. This investigation clearly reveals that the discretionary flexible inflation-capital policy also suppresses the carry trades vicious circle after

such a shock[g]. After an increase in carry trades, with the first-best policy, the central bank is still able to avoid the carry trades' vicious circle.
As mentioned previously, we also consider the exotic case of a strict capital inflows targeting policy. This kind of policy could exist in a small open economy hit by a financial crisis. Such a policy suppresses the carry trades' vicious circle but is hugely inflationary.
We now consider an economy in which agents do not know the level of the variables that the central bank targets. Introducing such a misspecification allows to investigate how agents beliefs affect the efficiency of the monetary policies.

2.5.5 Changing behavior of central banks

In this section we assume that agents think that the central bank has changed its long run targets. More precisely, it means that agents will forecast the values contained in the vector $(\bar{y}, \bar{\pi}, \bar{s}, \bar{n}, \bar{r})'$. Several central banks clearly announce their inflation targets, but in some cases the target is between a range of values or not clearly announced. Moreover, concerning a flexible inflation-output targeting policy, it is not straightforward to announce the output target. It is also possible that agents do not know the long run targets of the central bank when a new governor arrives or when agents do not trust monetary authorities. Hence, we will investigate how the economy reacts when agents do not know the output target. Thereafter, with a flexible inflation-capital targeting policy, both under discretion (first-best) and commitment, we investigate whether the central bank should announce its long run capital inflows target or not. The following table shows the true values of the long run targets and agents' beliefs.

Table 2.3 Targeted values

Flexible inflation targeting under discretion		Capital inflows targeting
$\bar{\pi}_{RE} = 0$	$\bar{y}_{RE} = 0$	$\bar{n}_{RE} = 0$
$\bar{\pi}_L = 0.05$	$\bar{y}_L = 0.05$	$\bar{n}_L = 0.01$

[g] The IRF are not presented here but available upon request.

Table (2.3) introduces misspecifications in agents beliefs. Under flexible inflation-output targeting agents think that the output gap target is positive instead of being equal to zero. In this case agents think that monetary authorities target a long run positive output gap reflecting a long run objective in growth. Thus, with such a belief agents also think that the central bank has a higher inflation target. Indeed, thinking that the central bank has a higher objective in growth, agents obviously expect the central bank to react less strongly to inflation in order to let growth increase. Concerning a flexible inflation-capital targeting policy, agents think that the authorities have the same objective in the long run by targeting a positive long run level of capital inflows[h].

2.5.5.1 The “second-best" framework

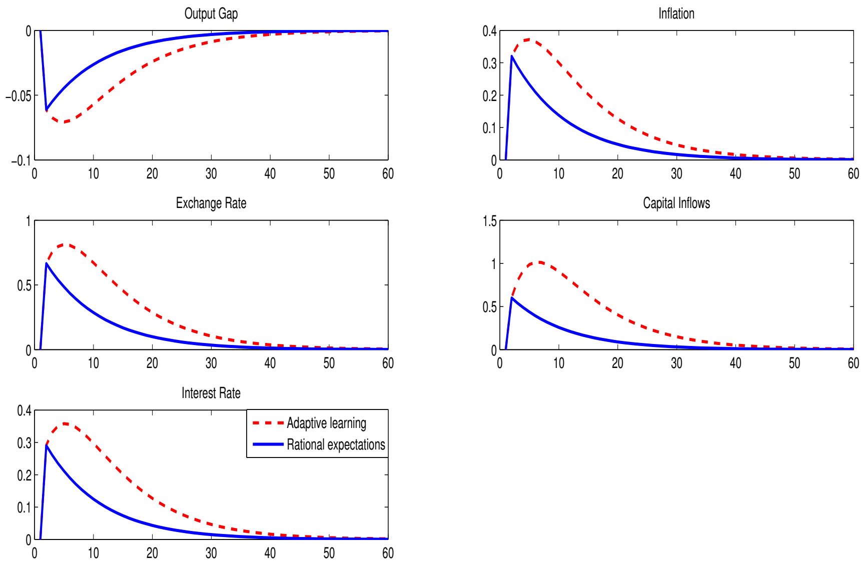


Figure 2.4: Response to a 5% supply shock
Agents have wrong beliefs about inflation and the output gap

Figure (2.4) shows that when agents do not know the long run targets of the central bank it destabilizes the economy in the sense that the vicious circle generated by carry trades is worsened compared to the RE framework. Such

[h]Such a policy could be considered by agents in small open economies which suffer from a lack of domestic saving.

an overestimation of the inflation shock can be explained in two steps. Given that agents think that both the inflation and output gap targets are higher, they believe that the central bank will react less strongly to inflation which lead them to overestimate the impact of the inflation shock on inflation itself. Hence, inflation increases more after the shock. Then, agents observe that inflation raised less than what they expected, leading them to overestimate the answer of the central bank to the shock in order to converge to the true model of the economy. Thus, with such a framework, the destabilizing effect of carry trades is worsened and more persistent.
Monetary authorities have to announce their long run output gap target in order to mitigate carry trades' destabilizing effect. We have seen that flexible inflation-capital targeting policies are prone to suppress carry trades vicious circle, we now investigate those policies with misspecifications.

2.5.6 The "first-best" framework

We consider a flexible inflation-capital targeting policy under discretion with agents overestimating the long run capital inflows target.

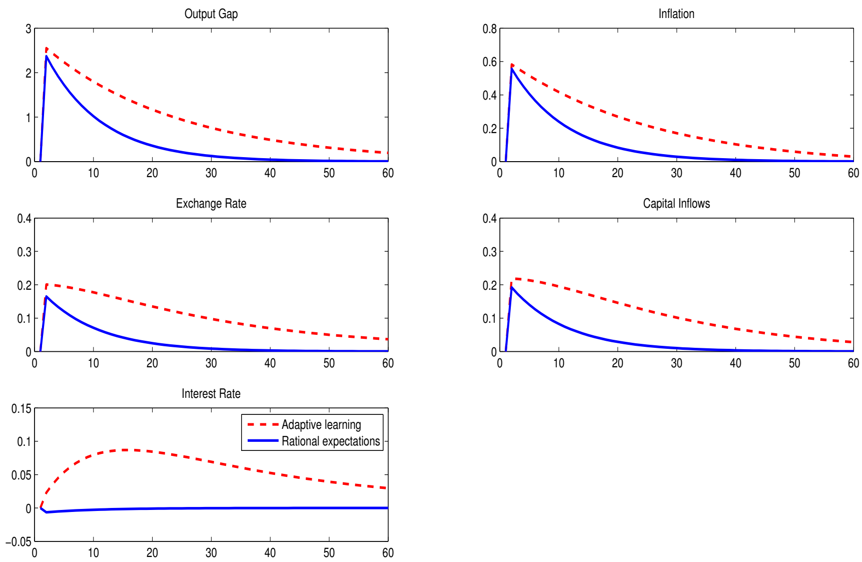


Figure 2.5: The "first best": secret monetary policy
Response to a 5% inflation shock

Given that agents think that the capital inflows target is positive, they expect an increase in the interest rate. As shown in Figure (2.5) the way agents behave seriously impacts the economy and the effect of the monetary policy. The increase in the interest rate enlarges carry trades returns leading to capital inflows. With such agents' beliefs, the carry trades' vicious circle usually present with standard monetary policies also appears with a central bank having objectives in terms of capital inflows. Thus, in such a framework, agents' beliefs cancel the positive effect of the monetary policy.
Given that the flexible inflation-capital targeting policy under commitment also suppresses the carry trades' vicious circle, we investigate how misspecifications in agents' beliefs affect the economy in such a framework.

2.5.7 Flexible inflation-capital targeting under commitment

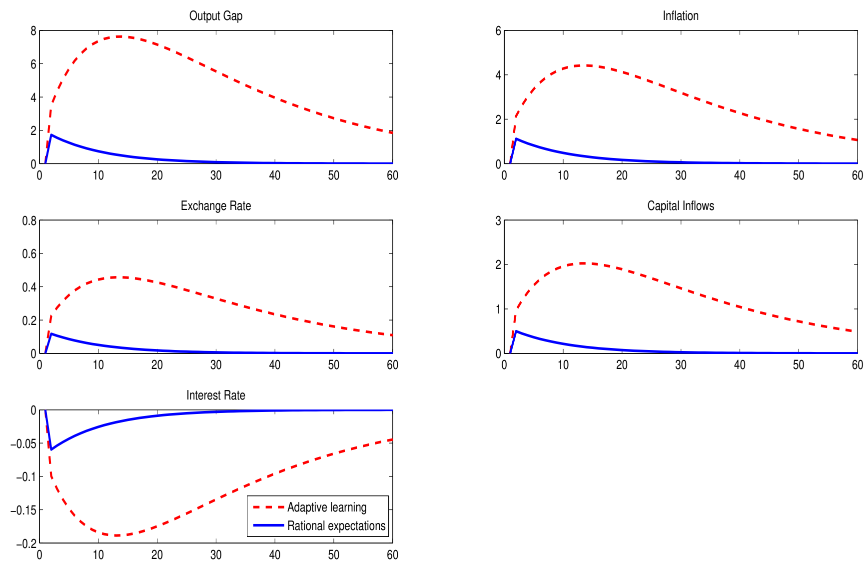


Figure 2.6: Flexible inflation-capital targeting under commitment: secret monetary policy
Response to a 5% inflation shock

In this framework agents do not know the long run capital inflows target which lead them to overestimate the impact of the shock on each variable. As presented in Figure (2.6), the central bank cuts strongly the interest rate in order to suppress carry trades vicious circle. Given that agents learn from

their past errors, each variable converges to its REE. In such a framework, carry trades vicious circle is also suppressed but the policy becomes highly inflationary which is not desirable. From Figure (2.6), we can tell that monetary authorities should be transparent concerning their long run target in order to avoid an higher impact of the shock on each economic variable.
This section shows how it is important to keep in mind that agents are not fully rational. The fact that they are econometricians makes the economy to evolve differently, even more when they do not know the steady states.

2.5.8 Further insights in monetary policies with adaptive learning

We have already seen that when agents have wrong beliefs concerning the long run targets of the central bank, the carry trades vicious circle is every time increased. We now take a look at the differences between the different monetary policies under adaptive learning.

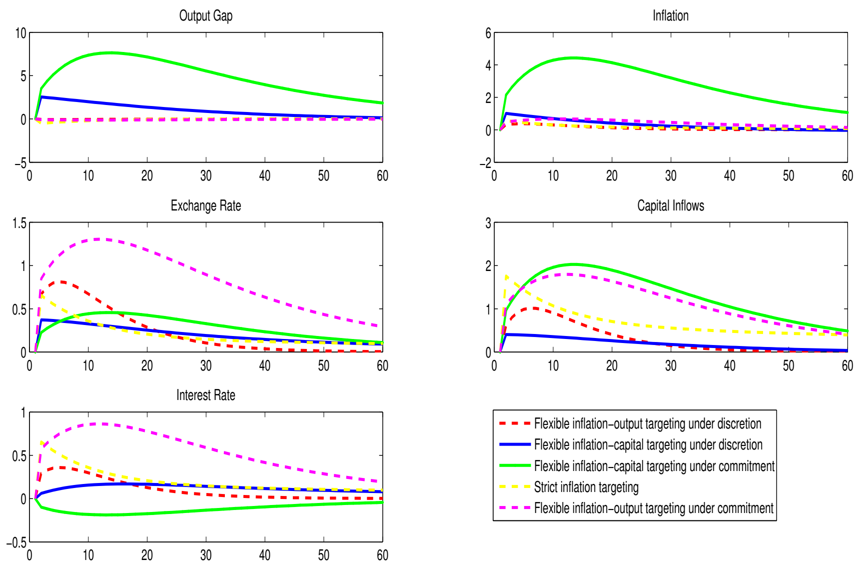


Figure 2.7: Response to a 5% supply shock
Policies with wrong beliefs

Figure 2.7 shows that when agents have wrong beliefs about the long run targets of the central bank, there is still an arbitrage between inflation and capital inflows between the second and first best monetary policies. However in such a case, what we can conclude is that the central bank has to make agents aware of the long run targets not to destabilize more the economy. Concerning the flexible inflation-capital targeting policy under commitment with agents' wrong beliefs, the results reveal that with this policy the interest rate decreases after the shock which is a good point concerning carry trades destabilizing effect. However such a policy is hugely inflationary which is clearly not wanted by monetary authorities. The strict inflation targeting policy and the flexible inflation-output targeting policy under commitment still enhance the carry trades' vicious circle. Notice that the destabilizing effect is even bigger when agents do not know the long run targets of the central bank.

2.6 A Statistical analysis

In the theoretical part, we have shown that a strict inflation targeting policy was the more destabilizing policy in countries subject to carry trades. In this section we investigate whether real data conclude the same. Such an investigation is done through a simple statistical analysis. We consider seven inflation targeting countries (targeted currencies), Australia, Canada, Czech-Republic, Iceland, New-Zealand, Poland and Sweden and two source countries, Japan and the United-States. For the Nominal exchange rates, we use monthly data from datastream. We also use the 3-month interbank interest rates from the Fred (Federal Reserve Economic data) database. Then, in line with Brunnermeier et al. 2009, we construct the return from investing in the foreign currency by borrowing in the domestic currency as follows:

$$z_{t+1} = (i_t^* - i_t) - \Delta s_{t+1}, \tag{2.36}$$

with $s_t = log\ (nominal\ exchange\ rate)$ and Δs_{t+1} the depreciation of the foreign currency. i_t and i_t^* denote the log of the domestic and foreign interest rates respectively. Notice that the foreign interest rate i_t^* is the inflation targeting country in which the investment is done. Accordingly, we investigate the case of an investment in each currency. Concerning the domestic interest rate, we use alternatively the US interest rate and the Japanese interest rate in order to consider the two countries as the source of the investment.

Table 2.4 Summary Statistics

	AUD	CAD	CZK	JPY	ISK	NZD	PLN	SEK
Δs_t	-0.002	-0.001	-0.002	0.0001	0.003	-0.003	-0.001	-0.001
z_{USt}	0.018	0.008	0.008	-0.017	0.019	0.019	0.017	0.005
$i^*_{t-1} - i_{USt-1}$	0.016	0.007	0.006	-0.017	0.022	0.016	0.016	0.004
Skewness CT_{US}	-1.414	-1.154	-0.287	-0.143	-1.836	-0.657	-1.071	-0.191
z_{jpt}	0.035	0.025	0.025	–	0.036	0.036	0.035	0.022
$i^*_{t-1} - i_{jpt-1}$	0.033	0.024	0.023	–	0.039	0.033	0.034	0.022
Skewness CT_{jp}	-1.535	-0.663	-0.364	–	-1.711	-0.849	-1.198	-0.268

Notes: We use monthly data from January 2001 to March 2015. Δs_t represents the monthly change in the foreign exchange rate (Units of foreign currency per US Dollars).

Table 2.4 reports a positive correlation between the average interest differential and the average return of a carry trade which sheds light on the violation of the UIP for the period studied. The four first lines of table 2.4 focus on US-sourced carry trades. Importantly, the return of the JPY is negative in the sense that this currency is also a sourced currency. Moreover, the interest differential between Japan and the US is negative which clearly sheds light on the importance of the interest differential for carry trades. The three last lines of table 2.4 present statistics for Japan-sourced carry trades. Given that changes in the exchange rate JPY/USD are close to zero (0.0001), we use the exchange rate between inflation targeting countries and the USD to construct portfolios with JPY as the funded currency[i].

First, table 2.4 sheds light on the fact that currencies with the higher yield are the same with the two sourced currencies, revealing again how important is the interest differential concerning carry trades. This analysis also reveals that in the two cases, ISK is the currency which presents the higher yield and also the most negative skewness[j]. For example, an investor taking a position in ISK financed in USD would earn the average interest differential (0.022), minus the negative excess return of the ISK relative to USD (0.03) and would

[i] It means that when the foreign currency appreciates relative to the USD it also appreciates relative to the JPY. Thus, constructing the return from Japan-sourced carry trades with the exchange rate relative to the USD is a good way to approximate the return of Japan-sourced carry trades.

[j] The NZD and AUD have also a high yield compared to the other currencies as reported in table (2.4), we will analyze such currencies later on.

be subject to the negative skewness of -1.836. Notice that ISK is a special currency in our sample in the sense that this is the only one which presents a negative excess FX return. Such a characteristic is linked to the financial crisis in this country and clearly reveals that carry trades reversal did happen in Iceland.

A relevant feature pointed out by table 2.4 is the similar return offered by investing in NZD and AUD with the two sourced currencies (quite equals for an investment sourced in USD). More importantly, the results reveal that investing in NZD offer the same return as investing in AUD; but while investing in NZD, the negative skewness is far smaller. Such a finding reveals that the two currencies offer a similar return with a different risk. Such an acknowledgment sheds light on the attractiveness of the NZD as a targeted currency for carry trades.

Overall, our statistical results reveal that carry trades indeed destabilize inflation targeting countries. Such a conclusion lies on the fact that we find negative skewness for all the inflation targeting countries studied in this section. Thus our panel of countries present carry trades reversal risks.

2.7 Conclusion

We study the impact of carry trades on the targeted economy. Recall that carry trades destabilize an inflation targeting economy in the sense that capital inflows lead the central bank to raise the interest rate, which increases carry trades' returns and generates further capital inflows. In this paper, we show this to be the case and investigate other monetary policies which could mitigate or suppress this vicious circle.

Through a forward-looking model, we investigate strict inflation targeting and flexible inflation-output targeting under discretion and commitment. We find that flexible inflation-output targeting under discretion is able to mitigate the carry trades' vicious circle. Given that the destabilizing impact of those investments persists, we investigate the case of a central bank which wants to stabilize the economy by targeting both inflation and capital inflows. Our results imply that the best framework to stabilize an economy subject to carry trades is a flexible inflation-capital targeting policy under discretion. Considering non fully rational agents, we then investigate the case of a secret monetary policy in which agents do not know the long run targets. Figures (2.4), (2.5) and (2.6) show that when agents do not know the long run targets of the central bank, whatever the policy implemented, the economy is destabilized.

The main result obtained is that for an economy subject to carry trades, there are two solutions for the central bank. On the one hand if monetary authorities want to keep a standard framework as strict inflation targeting or flexible inflation-output targeting, they should use a discretionary flexible inflation-output targeting policy, choosing the "second-best" framework. On the other, a flexible inflation-capital targeting policy under discretion totally suppresses the vicious circle, that is the "first-best" monetary policy according to our study.

Large scale monetary expansion (through QE) in large countries leads them to export capital to small open economies which target inflation. To avoid the destabilizing effect of these capital inflows, the small open economies' central banks should seriously take this problem into account while setting their monetary policy. Our recommendation is a flexible inflation-capital targeting policy under discretion announcing the long run capital inflows target.

In this paper we deliberately focus on capital inflows management to suppress the carry trades' vicious circle. Nevertheless the vicious circle could be suppressed by other policies. Thus, further research could investigate how macroprudential policies, exchange rate targeting or taxes could mitigate or suppress the vicious circle presented in our paper.

2.8 Appendix

2.8.1 The model in level

In such a framework, the model is not in deviation, thus the model is of the form: $A_t - \bar{A} = M(E_t A_{t+1} - \bar{A}) + \Phi(\Omega_t - \bar{\Omega})$, leading to $A_t = B + ME_t A_{t+1} + \Phi\Omega_t$ with $B = (I - M)\bar{A} - \Phi\bar{\Omega}$. In order to calculate the steady states, we have to consider separately Equations (2.4), (2.6), (2.9), (2.10) and the reaction function corresponding to the studied case. Thus, according to the monetary policy we consider Equations (2.11), (2.12), (2.13), (2.19), (2.15) and (2.18). For example, under a flexible inflation-targeting policy, we rewrite Equations (2.4), (2.6), (2.9), (2.10) and (2.12) in level, which allows to obtain:

$$0 = \gamma_g \bar{g} + \gamma_u \bar{u} + \gamma_\omega \bar{\omega}, \tag{2.37}$$

$$\bar{r} = (\frac{1}{\varphi} - \gamma_g)\bar{g} - \gamma_u \bar{u} - \gamma_\omega \bar{\omega}, \tag{2.38}$$

$$\bar{r} = -\gamma_g \bar{g} - \gamma_u \bar{u} - (1 + \gamma_\omega)\bar{\omega}, \tag{2.39}$$

$$\frac{\bar{r}}{a} - \kappa \bar{y} + \phi \bar{s} = -(\kappa\varphi\gamma_g - \kappa + \phi\gamma_g)\bar{g} - (\kappa\varphi\gamma_u + \phi\gamma_u)\bar{u} - (\kappa\varphi\gamma_\omega + \phi\gamma_\omega + \phi)\bar{\omega}, \tag{2.40}$$

$$\bar{r} + \bar{s} = -\gamma_g \bar{g} - \gamma_u \bar{u} - (1 + \gamma_\omega)\bar{\omega} - \frac{1}{\lambda\sigma\mu}\bar{z}, \tag{2.41}$$

with $a = \frac{1}{\kappa\varphi + \phi}$. From Equations (2.38) and (2.39), $\bar{\omega} = -\frac{1}{\varphi}\bar{g}$. Given that UIP holds in the long run $\bar{\omega} = 0$, leading to $\bar{g} = 0$, and using Equations (2.37) to $\bar{u} = 0$. Thus, retaking Equations (2.38) and (2.39), we get that $\bar{r} = 0$. From the model, we know that in the case of flexible inflation targeting, $\bar{y} = \bar{\pi} = 0$. In addition, with Equations (2.40) and (2.41), we can conclude that $\bar{s} = \bar{z} = 0$. Thus we have,

$$\begin{pmatrix} \bar{y} \\ \bar{\pi} \\ \bar{s} \\ \bar{n} \\ \bar{r} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

We use the same methodology for each monetary policy. The constant terms are zero in all cases because UIP holds in the long run.

2.8.2 Strict inflation targeting

We have

$$A_t = B + ME_t A_{t+1} + \Phi\Omega_t,$$

With M the (5×5) following matrix:

$$\begin{pmatrix} 1-\varphi\psi\kappa & \varphi(1-\psi\varphi(\beta+\kappa\varphi-1)) & -\varphi\psi\delta\phi & \upsilon-\varphi\psi\kappa\upsilon & 0 \\ \kappa(1-\varphi\psi\kappa-\phi\varphi) & \beta+\kappa\varphi(1-\psi(\beta+\kappa\varphi-1) & -\phi\delta(\kappa\varphi\psi+1+\psi\phi\delta) & \kappa\upsilon(1-\varphi\psi\kappa-\phi\psi) & 0 \\ \psi\kappa & \psi(\beta+\kappa\varphi-1) & \delta(1+\psi\phi\delta) & \phi\kappa\upsilon & 0 \\ \lambda\sigma\mu\psi\kappa & \lambda\sigma\mu\psi(\beta+\kappa\varphi-1) & \lambda\sigma\mu(\delta+\delta\psi\phi-1) & \sigma(1+\lambda\mu\kappa\upsilon) & -\lambda\sigma\tau \\ \psi\kappa & \psi(\beta+\kappa\varphi-1) & \psi\phi\delta & \psi\kappa\upsilon & 0 \end{pmatrix},$$

Φ the following (5×5) matrix:

$$\begin{pmatrix} 1-\varphi\psi\kappa & -\varphi\psi & \varphi\psi\phi & 0 & 0 \\ \kappa(1-\kappa\varphi\psi)-\phi\psi & 1 & \phi(\kappa\varphi\psi-1+\psi\phi) & 0 & 0 \\ \kappa\psi & \psi & 1-\psi\phi & 0 & 0 \\ \kappa\lambda\sigma\mu\psi & \lambda\sigma\mu\psi & \lambda\sigma\mu(1-\psi\phi) & 1 & 0 \\ \kappa\psi & \psi & -\psi\phi & 0 & 0 \end{pmatrix},$$

and $B = (I - M)\bar{A} - \Phi\bar{\Omega}$.

2.8.3 Flexible inflation targeting under discretion

We have

$$A_t = B + ME_t A_{t+1} + \Phi \Omega_t,$$

With M the (5×5) following matrix:

$$\begin{pmatrix} \zeta\iota & -\frac{\beta\kappa}{\varphi(\alpha+\kappa^2)}(1-\zeta\iota) & \varphi\zeta\delta\iota & \upsilon\zeta\iota & 0 \\ \kappa\zeta\iota - \frac{\phi\iota}{\varphi} & \beta - (1-\zeta\iota)\frac{\beta\kappa^2}{\alpha+\kappa^2} - \phi\iota\left(1+\frac{\beta\kappa}{\alpha+\kappa^2}\right) & \iota\delta(\kappa\varphi\zeta - \phi) & \upsilon\iota\left(\kappa\zeta - \frac{\phi}{\varphi}\right) & 0 \\ \frac{\iota}{\varphi} & \iota\left(1+\frac{\beta\kappa}{\varphi(\alpha+\kappa^2)}\right) & \iota\delta & \frac{\iota\upsilon}{\varphi} & 0 \\ \frac{\lambda\sigma\mu\iota}{\varphi} & \lambda\sigma\mu\iota\left(1+\frac{\beta\kappa}{\varphi(\alpha+\kappa^2)}\right) & \lambda\sigma\mu(\delta\iota - 1) & \sigma\left(1+\frac{\lambda\mu\iota\upsilon}{\varphi}\right) & -\lambda\sigma\mu\tau \\ \frac{1}{\varphi}(1-\iota\zeta) & 1+\frac{\kappa\beta}{\varphi(\alpha+\kappa^2)}(1-\iota\zeta) & -\iota\zeta\delta & \frac{\upsilon}{\varphi}(1-\iota\zeta) & 0 \end{pmatrix},$$

Φ the following (5×5) matrix:

$$\begin{pmatrix} \iota\zeta & (\iota\zeta - 1)\frac{\kappa}{\alpha+\kappa^2} & \varphi\iota\zeta & 0 & 0 \\ \kappa\zeta\iota - \frac{\phi\iota}{\varphi} & 1 - \kappa(1-\zeta\iota) - \frac{\phi\iota\kappa}{\varphi(\alpha+\kappa^2)} & \iota(\kappa\varphi\zeta - \phi) & 0 & 0 \\ \frac{\iota}{\varphi} & \frac{\iota\kappa}{\varphi(\alpha+\kappa^2)} & \iota & 0 & 0 \\ \frac{\iota\lambda\sigma\mu}{\varphi} & \frac{\iota\lambda\sigma\mu\kappa}{\varphi(\alpha+\kappa^2)} & \lambda\sigma\mu\iota & 1 & 0 \\ \frac{1}{\varphi}(1-\iota\zeta) & \frac{\kappa}{\varphi(\alpha+\kappa^2)}(1-\iota\zeta) & -\iota\zeta & 0 & 0 \end{pmatrix},$$

and $B = (I - M)\bar{A} - \Phi\bar{\Omega}$.

2.8.4 Flexible inflation targeting under commitment

We just add one lagged vector and one matrix of parameters to the optimal monetary policy under discretion.

$$\begin{pmatrix} \frac{(\zeta\iota-1)\kappa}{\alpha+\kappa^2} & 0 & 0 & 0 & 0 \\ \frac{\phi\iota\alpha}{\varphi(\alpha+\kappa^2)} - \frac{\kappa^2(1-\zeta\iota)}{\alpha+\kappa^2} & 0 & 0 & 0 & 0 \\ -\frac{\iota\alpha}{\varphi(\alpha+\kappa^2)} & 0 & 0 & 0 & 0 \\ -\frac{\zeta\lambda\sigma\mu\alpha}{\varphi(\alpha+\kappa^2)} & 0 & 0 & 0 & 0 \\ (\iota\zeta-1)\frac{\iota\alpha}{\varphi(\alpha+\kappa^2)} & 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ \pi_{t-1} \\ s_{t-1} \\ n_{t-1} \\ r_{t-1} \end{pmatrix}$$

Notice than under commitment, $B = (I - M - N)\bar{A} - \Phi\bar{\Omega}$.

2.8.5 Strict capital inflows targeting

Once again, the system is the following: $A_t = B + ME_tA_{t+1} + \Phi\Omega_t$, with M the (5×5) following matrix:

$$\begin{pmatrix} 1 & \varphi & \varphi(\delta-1) & -\frac{\varphi(\alpha-\sigma)}{\lambda\sigma\mu} & -\frac{\varphi\tau}{\mu} \\ \kappa & \kappa\varphi+\beta & \kappa\varphi(1-\delta)+\phi & -\frac{\phi-(\alpha-\sigma)(1+\kappa\varphi)}{\lambda\sigma\mu} & -\frac{\kappa\varphi\tau+\phi\tau}{\mu} \\ 0 & 0 & 1 & \frac{\alpha-\sigma}{\lambda\sigma\mu} & \frac{\tau}{\mu} \\ 0 & 0 & 0 & \frac{\alpha-\sigma}{\lambda\sigma\mu}+\sigma & \frac{\tau}{\mu} \\ 0 & 0 & 1-\delta & \frac{\alpha-\sigma}{\lambda\sigma\mu} & \frac{\tau}{\mu} \end{pmatrix},$$

and Φ:

$$\begin{pmatrix} 1 & 0 & \varphi & \frac{\varphi}{\lambda\sigma\mu} & 0 \\ \kappa & 1 & \kappa\varphi & \frac{\kappa\varphi+\phi}{\lambda\sigma\mu} & 0 \\ 0 & 0 & 1 & -\frac{1}{\lambda\sigma\mu} & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & -1 & -\frac{1}{\lambda\sigma\mu} & 0 \end{pmatrix}.$$

Notice that with such a policy, $B = (I - M)\bar{A} - \Phi\bar{\Omega}$.

2.8.6 Flexible capital inflows targeting under discretion

Recall:

$$A_t = B + ME_t A_{t+1} + \Phi\Omega_t$$

Notice that $B = (I - M)\bar{A} - \Phi\bar{\Omega}$.
M is the (5×5) matrix:

$$\begin{pmatrix}
1 - \frac{\varphi\chi\alpha\kappa}{\sigma} & \varphi\left(1 - \chi\left(\frac{\alpha\kappa\varphi+\alpha\beta}{\sigma}\right)\right) & -\varphi\chi\left(\lambda\sigma\mu - \frac{\alpha\phi\delta}{\sigma}\right) & \upsilon - \varphi\chi\left(\frac{\alpha\kappa\upsilon}{\sigma} - \sigma\right) & -\varphi\chi\sigma\tau \\
\kappa - \frac{\chi\alpha\kappa}{\sigma}(\kappa\varphi + \phi) & \beta + \kappa\left(\varphi - \varphi\chi\left(\frac{\alpha\kappa\varphi+\alpha\beta}{\sigma}\right)\right) - \phi\chi\left(\frac{\alpha\kappa\varphi+\alpha\beta}{\sigma}\right) & \left(\frac{\alpha\phi\delta}{\sigma} - \lambda\sigma\mu\right)(\kappa\varphi\chi + \phi\chi) - \phi\delta & \kappa\upsilon + \left(\sigma - \frac{\alpha\kappa\upsilon}{\sigma}\right)(\kappa\varphi\chi + \phi\chi) & -\kappa\varphi\chi\sigma\tau - \phi\chi\sigma\tau \\
\frac{\chi\alpha\kappa}{\sigma} & \chi\left(\frac{\alpha\kappa\varphi+\alpha\beta}{\sigma}\right) & \delta + \chi\left(\lambda\sigma\mu - \frac{\alpha\phi\delta}{\sigma}\right) & \chi\left(\frac{\alpha\kappa\upsilon}{\sigma} - \sigma\right) & \chi\sigma\tau \\
\lambda\alpha\chi\kappa & \lambda\chi(\alpha\kappa\varphi + \alpha\beta) & \lambda\sigma\delta + \lambda\sigma\chi\left(\lambda\sigma\mu - \frac{\alpha\phi\delta}{\sigma}\right) - \lambda\sigma\mu & \sigma + \lambda\sigma\chi\left(\frac{\alpha\kappa\upsilon}{\sigma} - \sigma\right) & \lambda\sigma^2\chi\tau - \lambda\sigma\tau \\
\frac{\chi\alpha\kappa}{\sigma} & \chi\left(\frac{\alpha\kappa\varphi+\alpha\beta}{\sigma}\right) & \chi\left(\lambda\sigma\mu - \frac{\alpha\phi\delta}{\sigma}\right) & \chi\left(\frac{\alpha\kappa\upsilon}{\sigma} - \upsilon\right) & \lambda\sigma\tau
\end{pmatrix}$$

And Φ the (5×5) matrix:

$$\begin{pmatrix}
1 - \frac{\varphi\chi\alpha\kappa}{\sigma} & -\frac{\varphi\chi\alpha}{\sigma} & \varphi\chi\left(\frac{\phi\alpha}{\sigma} + \lambda\sigma\mu\right) & \varphi\chi & 0 \\
\kappa\left(1 - \frac{\kappa\varphi\chi\alpha+\phi\alpha\chi\kappa}{\sigma}\right) & 1 - \frac{\kappa\varphi\chi\alpha+\phi\chi\alpha}{\sigma} & (\phi\chi + \kappa\varphi\chi)\left(\frac{\phi\alpha}{\sigma} + \lambda\sigma\mu\right) & 0 & 0 \\
\frac{\chi\alpha\kappa}{\sigma} & \frac{\chi\alpha}{\sigma} & 1 - \chi\left(\frac{\phi\alpha}{\sigma} + \lambda\sigma\mu\right) & -\chi & 0 \\
\lambda\chi\alpha\kappa & \lambda\chi\alpha & \lambda\sigma\left(1 - \chi(\frac{\phi\alpha}{\sigma} + \lambda\sigma\mu)\right) & 1 - \lambda\sigma\chi & 0 \\
\frac{\chi\alpha\kappa}{\sigma} & \frac{\chi\alpha}{\sigma} & -\chi\left(\frac{\phi\alpha}{\sigma} + \lambda\sigma\mu\right) & -\chi & 0
\end{pmatrix}$$

2.8.7 Flexible capital inflows targeting under commitment

Recall:

$$A_t = B + ME_tA_{t+1} + NA_{t-1} + \Phi\Omega_t$$

Notice that $B = (I - M - N)\bar{A} - \Phi\bar{\Omega}$.
M is the 5×5 matrix:

$$\begin{pmatrix} 1-\frac{\varphi\chi\alpha\kappa}{\sigma} & \varphi\left(1-\chi\left(\frac{\alpha\kappa\varphi+\alpha\beta}{\sigma}\right)\right) & -\varphi\chi\left(\lambda\sigma\mu-\frac{\alpha\phi\delta}{\sigma}\right) & \upsilon-\varphi\chi\left(\frac{\alpha\kappa\upsilon}{\sigma}-\sigma\right) & -\varphi\chi\sigma\tau \\ \kappa-\frac{\chi\alpha\kappa}{\sigma}(\kappa\varphi+\phi) & \beta+\kappa\left(\varphi-\varphi\chi\left(\frac{\alpha\kappa\varphi+\alpha\beta}{\sigma}\right)\right)-\phi\chi\left(\frac{\alpha\kappa\varphi+\alpha\beta}{\sigma}\right) & \left(\frac{\alpha\phi\delta}{\sigma}-\lambda\sigma\mu\right)(\kappa\varphi\chi+\phi\chi)-\phi\delta & \kappa\upsilon+\left(\sigma-\frac{\alpha\kappa\upsilon}{\sigma}\right)(\kappa\varphi\chi+\phi\chi) & -\kappa\varphi\chi\sigma\tau-\phi\chi\sigma\tau \\ \frac{\chi\alpha\kappa}{\sigma} & \chi\left(\frac{\alpha\kappa\varphi+\alpha\beta}{\sigma}\right) & \delta+\chi\left(\lambda\sigma\mu-\frac{\alpha\phi\delta}{\sigma}\right) & \chi\left(\frac{\alpha\kappa\upsilon}{\sigma}-\sigma\right) & \chi\sigma\tau \\ \lambda\alpha\chi\kappa & \lambda\chi(\alpha\kappa\varphi+\alpha\beta) & \lambda\sigma\delta+\lambda\sigma\chi\left(\lambda\sigma\mu-\frac{\alpha\phi\delta}{\sigma}\right)-\lambda\sigma\mu & \sigma+\lambda\sigma\chi\left(\frac{\alpha\kappa\upsilon}{\sigma}-\sigma\right) & \lambda\sigma^2\chi\tau-\lambda\sigma\tau \\ \frac{\chi\alpha\kappa}{\sigma} & \chi\left(\frac{\alpha\kappa\varphi+\alpha\beta}{\sigma}\right) & \chi\left(\lambda\sigma\mu-\frac{\alpha\phi\delta}{\sigma}\right) & \chi\left(\frac{\alpha\kappa\upsilon}{\sigma}-\upsilon\right) & \lambda\sigma\tau \end{pmatrix}$$

Φ the 5×5 matrix:

$$\begin{pmatrix} 1-\frac{\varphi\chi\alpha\kappa}{\sigma} & -\frac{\varphi\chi\alpha}{\sigma} & \varphi\chi\left(\frac{\phi\alpha}{\sigma}+\lambda\sigma\mu\right) & \varphi\chi & 0 \\ \kappa\left(1-\frac{\kappa\varphi\chi\alpha+\phi\alpha\chi\kappa}{\sigma}\right) & 1-\frac{\kappa\varphi\chi\alpha+\phi\chi\alpha}{\sigma} & (\phi\chi+\kappa\varphi\chi)\left(\frac{\phi\alpha}{\sigma}+\lambda\sigma\mu\right) & 0 & 0 \\ \frac{\chi\alpha\kappa}{\sigma} & \frac{\chi\alpha}{\sigma} & 1-\chi\left(\frac{\phi\alpha}{\sigma}+\lambda\sigma\mu\right) & -\chi & 0 \\ \lambda\chi\alpha\kappa & \lambda\chi\alpha & \lambda\sigma\left(1-\chi(\frac{\phi\alpha}{\sigma}+\lambda\sigma\mu)\right) & 1-\lambda\sigma\chi & 0 \\ \frac{\chi\alpha\kappa}{\sigma} & \frac{\chi\alpha}{\sigma} & -\chi\left(\frac{\phi\alpha}{\sigma}+\lambda\sigma\mu\right) & -\chi & 0 \end{pmatrix}$$

And N the 5×5 matrix:

$$\begin{pmatrix} 0 & 0 & 0 & -\varphi\chi & 0 \\ 0 & 0 & 0 & -\kappa\varphi\chi-\phi\chi & 0 \\ 0 & 0 & 0 & \chi & 0 \\ 0 & 0 & 0 & \lambda\sigma\mu\chi & 0 \\ 0 & 0 & 0 & \chi & 0 \end{pmatrix}$$

Chapter 3 Carry trades in New-Zealand: Do monetary authorities take them into account?[a]

3.1 Introduction

Carry trades have become a major issue in international finance; these investments, playing against uncovered interest parity, aim at borrowing a low return currency in order to invest in a high return one. Through such an operation, investors expect to earn the interest differential adjusted for exchange rate changes. New-Zealand is a small open economy targeting inflation, which exposes the country to such investments. Indeed, incoming carry trades increase the output gap in New-Zealand which raise inflation, leading the RBNZ to raise the interest rate. Such a raise in interest rates makes carry trades more attractive, leading to further capital inflows. Thus, such investments could destabilize the economy and enhance a vicious circle induced by monetary authorities' actions.

The aim of this paper is to investigate through which channels carry trades affect New-Zealand's economy. First, we empirically examine the (de)stabilizing effects of carry trades in two steps. On the one hand, we estimate New-Zealand's output gap equation from 2002 to 2015, revealing expansionary incoming carry trades. On the other, the central bank's reaction function estimation allows us to analyze whether the RBNZ's response to carry trades make such investments more or less attractive. Then the estimations of exchange rate returns and bank-credit give further insights on the way in which carry trades affect this small open economy.

A growing interest in carry trades was generated by the seminal paper of Burnside et al. (2006a) who show that carry trades' payoff are not correlated with the US stock market's returns. Moreover, they document that carry trades present a larger Sharpe ratio than investments in US stock markets. After this important acknowledgment, many authors have worked on the determinants of carry trades' return and optimal currencies' portfolio

[a]This chapter is an article co-written with Eric Girardin.

(see among others, e.g., Burnside et al. (2011a) and Dupuy (2015) and Kim (2015)). Another strand of the literature on carry trades has shown that such investments could be destabilizing for small open economies. Indeed, central banks tools are short run interest rates, thus when they implement their monetary policies, it is straightforward that such policies affect the interest differential between countries. Then increasing or decreasing the interest differential will raise or reduce carry trades returns.

Chung and Jordà (2009) point out the fact that between 2000 and 2009 New-Zealand had a sizable interest rate differential with Japan accompanied by an appreciation of the NZ Dollar. They even reveal that in their panel data, New-Zealand has the highest interest differential (both with Japan and the US), suggesting higher carry trades' returns in New-Zealand than in other countries. In the same vain, Winters (2008) shows that an increase in the interest differential between Japan and other countries leads to a depreciation of the yen. Interestingly, the author points out that this relationship was strong in New-Zealand and more persistent than for other host countries.

Following a large strand of the literature, we estimate both the reaction function and the output gap equation with the Generalized method of Moments (GMM) as in Clarida et al. (1998). One of the motivations of this paper is that we suggest that the RBNZ does not only react to inflation and the output gap but also to expected changes in the exchange rate, carry trades and foreign variables. Ball (1999) reported that New-Zealand responded to exchange rate changes. Moreover, some papers, such as Richardson and Williams (2015) or Kendall and Ng (2013), reinforce our beliefs concerning the RBNZ's behavior. Indeed they argue that the RBNZ estimates the neutral interest rate to implement its monetary policy.

In 2001, the Bank of Japan was the first to resort to a quantitative easing program. Since the 2008 crisis, the US Federal Reserve and lately the European Central Bank have also resorted to such unconventional monetary policies. As McKinnon (2012) points out, these policies raise the interest differential, generating carry trades. Concretely, monetary expansions in large economies (US, Europe and Japan) generate an export of liquidity to small open economies (Australia, New-Zealand and Brazil) through carry trades. This kind of investment could destabilize these small open economies through two channels. On the one hand, as modeled by Plantin and Shin

(2014), capital inflows are expansionary, thus, after an increase in incoming carry trades, the central bank raises the interest rate, increasing carry trades' returns. This mechanism generates a self-fulfilling carry-trade effect. The more there are carry trades the more they are attractive. The second source of risk comes from investors' behavior. Indeed carry traders buy the targeted currency as long as they expect its appreciation. This behavior leads to a self-fulfilling appreciation of the targeted currency. However some time after such an appreciation, investors will expect a fall in the targeted currency and sell it, which will lead to a large depreciation. This phenomenon is called carry-trades' reversal. Such capital flight, generating a depreciation of the targeted-economy currency, will affect the whole economy. This is a serious issue for small open economies; trying to mitigate the self-fulfilling effect would also reduce risk reversal. By contrast, Burnside (2013) argues that New-Zealand's risk premium is not driven by New-Zealand specific factors. He concludes that carry trades do not destabilize New-Zealand's economy. In this paper, we begin with any a priori and consider that the two points of view, both destabilizing (e.g. Plantin and Shin (2014)) and stabilizing (e.g. Burnside (2013)) carry trades are likely to appear. Then we re-open the debate on the (de)stabilizing effect of carry trades in New-Zealand. We investigate empirically through which channel carry trades affect New-Zealand's economy and whether the Reserve Bank of New-Zealand (RBNZ) reacts to such (de)stabilizing investments.

Our results point out the change in behavior of the RBNZ after the Global Financial Crisis (GFC). First, in the Pre-crisis period, Japan-sourced carry trades were self-fulfilling in New-Zealand. After the crisis, the RBNZ began to react to this self-fulfilling effect of Japanese carry trades by decreasing the interest rate. Unfortunately, even such a behavior is not sufficient to suppress the carry trades' destabilizing effect. Indeed, after the GFC, US carry trades were expansionary in New-Zealand like prior Japanese ones. Given that the RBNZ raises the interest rate after incoming US carry trades, there is still a destabilizing effect of carry trades in New-Zealand after the crisis. Interestingly, our results also reveal that during quantitative easing episodes in the US, US-funded carry trades are clearly more expansionary than when the Federal Reserve Bank implements conventional monetary policies, revealing more currency investments during QE episodes in the US.

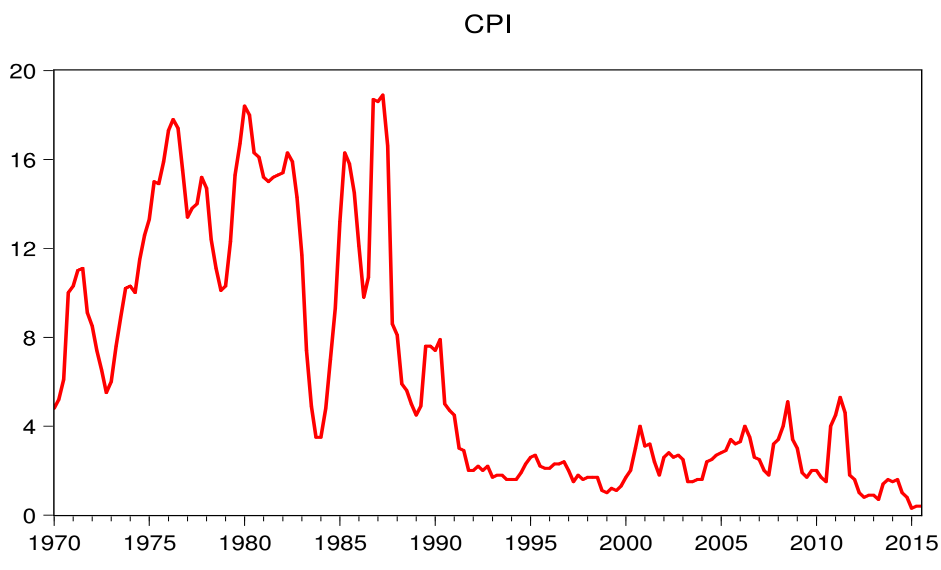
The remainder of the paper is organized as follows. Section 3.2 is devoted to stylized facts of New-Zealand's economy. Section 3.3 presents the methodology and Section 3.4 the results. Section 3.5 sheds light on the robustness of the estimations and Section 3.6 concludes.

3.2 A focus on New-Zealand's economy

In this section we present the economic environment of New-Zealand. That is an important step to understand how New-Zealand is exposed to carry trades.

At the beginning of the 1990's, New-Zealand was the first country to undertake an inflation targeting policy. Since then, a large number of both developed and developing, countries have done the same. Such an enthusiasm for inflation targeting policies reveals that it was perceived as a successful policy concerning price stabilization.

Figure 3.1: New-Zealand annual inflation (% change of the CPI)

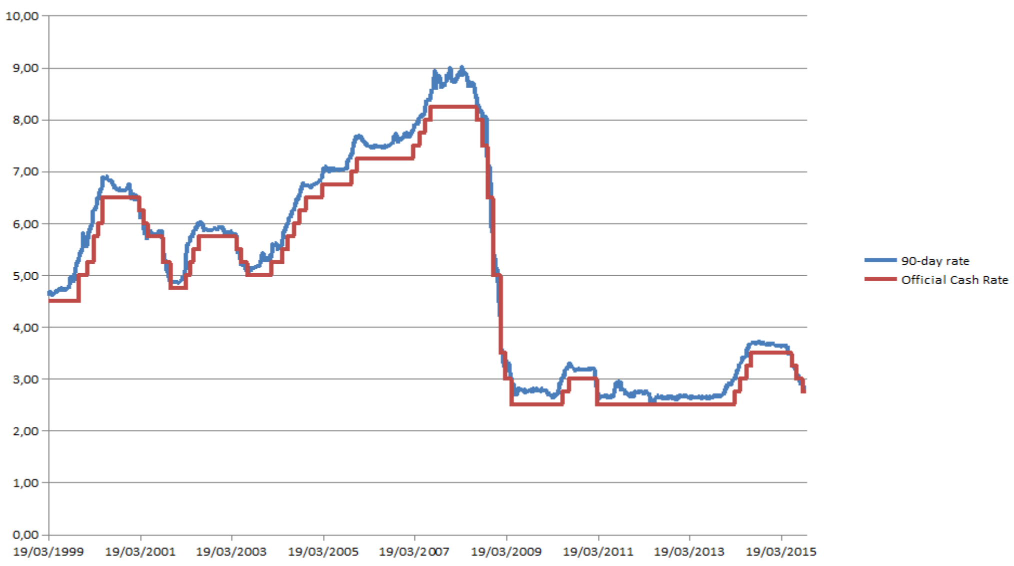


Quarterly data from the RBNZ dataset.

Figure (3.1) shows that inflation hugely decreased from 1992 onwards which corresponds to the introduction of inflation targeting. In the same vain, Walsh (2009) points out that in the Pre-inflation-targeting period the mean change in CPI was 8.36% while it was only 2.29% in the Post-inflation-targeting period. This result clearly reveals that the Reserve Bank of New-Zealand has succeeded in stabilizing prices in the sense that its aim is to keep inflation within a range of $1-3\%$ on average over the medium term. Even though the RBNZ inflation targeting policy has thus been able to stabilize prices in New-Zealand, the way the RBNZ implements this policy could destabilize the economy through stimulating carry trades.

To target inflation, central banks set an inflation target and adjust the interest rate to anchor expected inflation to the inflation target (see e.g. Svensson (1997a) and Woodford (1999)). Central banks also have an output target but weigh more towards price stabilization. The RBNZ acts on the Official Cash Rate (OCR) to try and reach its objectives.

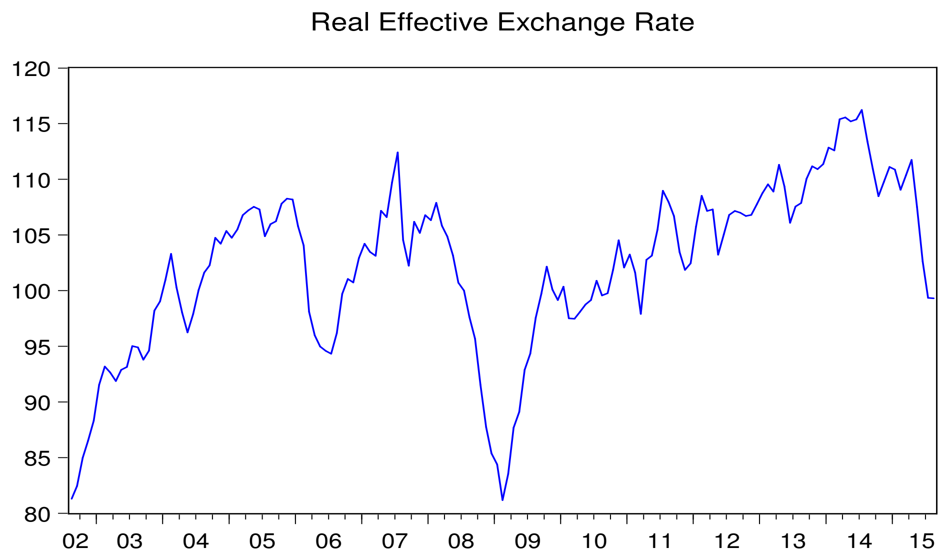
Figure 3.2: Reserve Bank of New-Zealand's monetary policy. Weekly data from the RBNZ dataset.



Figure(3.2) represents how the OCR has evolved in New-Zealand and clearly reveals that the interest rate was high before the crisis. New-Zealand's interest rate was high relative to large economies such as Japan and the

United-States. In such an environment, inflation targeting can destabilize the economy and lead to a vicious circle enhanced by carry trades. Plantin and Shin (2014) model this vicious circle, given that capital inflows are expansionary, an increase in carry trades boosts growth, leading the central bank to raise the interest rate in order to cool down the economy, which makes carry trades more attractive and leads to further capital inflows. Such a mechanism highlights the fact that the more there are carry trades in an inflation-targeting small open economy, the more they are attractive. Thus, inflation targeting in New-Zealand could expose the country to self-fulfilling carry trades and risk reversal. The reversal of carry trades appears after a long period of inward investment. In such a context, carry traders will expect a future depreciation of the New-Zealand Dollar, leading them to sell the currency, which will actually depreciate it and affect the whole economy. Figure 3.3 clearly reflects the fact that the New-Zealand Dollar has known long periods of appreciations followed by sharp depreciations. Such an observation is clearly linked to the above mentioned reversal of carry trades.

Figure 3.3: New-Zealand Dollar. Monthly data from the Bank for International Settlement.



Indeed La Marca and Flassbeck (2009) have shown that some high-yielding currencies such as, among others, the New-Zealand and Australian dollars, as well as the Brazilian real and the Icelandic krona, experienced prolonged periods of appreciation cum capital inflows disrupted by shorter periods of devaluation due to carry traders' behavior. They also shed light on the fact that a large current account deficit can lead to this reversal risk by increasing the perceived risk of carry trades, which was the case in Iceland. In the same way, in New-Zealand, the current account deficit could exacerbate the risk enhanced by carry trades.

New-Zealand has registered one of the largest and most persistent current account deficits among advanced economies. Woolford et al. (2002) and Steenkamp (2010) investigated how this persistent current account deficit affects New-Zealand's economy. The current account deficit is accompanied by a historically-low saving rate, leading New-Zealand to be hugely dependent on foreign capital. Indeed in case of carry-trades' reversal, New-Zealand would register large capital outflows, affecting the banking sector by decreasing liquidity, in turn tightening credit access and reducing growth. Overall, inflation targeting and the New-Zealand's dependence on foreign capital is a source of vulnerability for its economy and carry trades exacerbate this risk.

Another source of risk relies on private sector credit which increased after 2002 while domestic saving was low and the current account deficit also increased. Such a context could lead to a lack of liquidity in the banking sector in case of a reversal of carry trades. Fortunately, since 2013, the RBNZ has relied on macroprudential measures which aim at maintaining financial stability. *Experiences with Macroprudential Policy–Five Case Studies* (2015) shed light on the way in which New-Zealand implemented these macroprudential measures. The RBNZ uses four different tools which are a core funding ratio, a countercyclical capital buffer, sectoral capital requirements and Loan-to-value (LTV) ratios on loans to the residential property sector. The crucial benefit of such measures is to improve financial stability by keeping the financial system sound. They also avoid the potential implications of a bubble on the housing market. Nevertheless, such measures are not able to deal with the financial instability risks enhanced by carry trades.

In this section, we saw that New-Zealand's economy is exposed to carry-trades' risks. This country has drawn lessons from the GFC by implementing macroprudential measures. Such measures are not sufficient to dampen carry trades' risks. Hence, we go further in the analysis by investigating whether the RBNZ accounts for carry trades in its monetary policy.

3.3 Methodology

In this section, we present the data used for our econometric investigation. We also explain our estimation procedure and present the equations we estimate.

3.3.1 Data

We use monthly data from Datastream covering the period from August 2002 to August 2015. We choose monthly data in order to make the estimation more robust (with quarterly data, we only have 66 observations for the whole period implying in particular that sub-sample estimates would be ruled out). We calculate the potential output with data on the industrial output thanks to the use of a Hodrick and Prescott filter, see e.g. Hodrick and Prescott (1997) (with a value of the smoothing parameter $\lambda = 14400$ which is standard while using monthly data). The difference between the actual output and the trend component obtained by the HP-filter represents the monthly output gap. Concerning the data, the output is proxied by the seasonally adjusted Purchasing Managers' Index (PMI) of the manufacturing sector. Given that this variable is only available from August 2002, we begin our estimations from that date.

We want to analyze how New-Zealand's central bank reacts after changes in domestic and foreign variables. The RBNZ's monetary policy tool is the Official Cash Rate (OCR). We use monthly data of the 90-day rate which is standard while estimating reaction functions. Moreover, as shown by Figure (3.2), except during the Global Financial Crisis (GFC), the 90-day rate evolves similarly to the OCR. There could be an overlapping-data bias due to the use of the 90-day rate with monthly data, fortunately GMM is able to treat such a bias. Figure (3.2) also reveals a clear change in the RBNZ monetary policy after the 2008 crisis, leading us to consider a pre and post-crisis sample (from August 2002 to June 2008 and February 2009 to August 2015 respectively). We voluntary exclude the crisis period (from July 2008 to February 2009) in order to avoid the effect enhanced by the collapse in the interest rate.

Given that we want to investigate whether carry trades are present in the RBNZ's reaction function, it is crucial to find a correct proxy for carry trades. It is well known that carry trades are profitable only if Uncovered Interest Parity (UIP) does not hold. Burnside (2013) has shown that UIP does not hold between New-Zealand and Japan and New-Zealand and United-States (excluding the GFC period). The UIP states that the high yield currency tends to depreciate, but since Fama (1984), we know that UIP does not hold in the short run. Accordingly, the high-yield currency tends to appreciate instead of depreciating. Carry trades could be a part of the explanation of this puzzle, since they lead to further capital inflows, appreciating the high-return currency. Indeed, Brunnermeier et al. (2009)'s empirical analysis suggests that there is a strong link between carry trades and currency crash risk. They also show that an increase in the VIX (volatility index extracted from options on the US stock market index) affects the ability of the interest differential to forecast future exchange rate changes. That means that after an increase in the VIX, the interest differential is less able to explain subsequent FX returns. This finding could explain a part of the Uncovered Interest Parity (UIP) violation.

Galati et al. (2007) investigate which data to use to track carry trade activity. They show that taking data on long positions from the Chicago Mercantile Exchange has been generally appropriate to track carry trade activity. However, such data on New-Zealand Dollar (NZD) long positions are not available before 2005, leading us to use it to estimate New-Zealand's output gap and reaction function from 2009 to 2015 (Post-crisis period) only in the robustness check section. Indeed, estimating the pre-crisis period with long positions would lead to a small-sample bias. Hence, we have to find another proxy to study the impact of carry trades both for the pre and post-crisis periods.

Thus, we proxy carry trades by their profit. By doing so, it is important to specify two different sources of carry trades. As presented in figure (3.4), the interest differentials suggest the potential for carry trades sourced in turn from Japan and the United-States. In line with Kim (2015), we set the profit from a carry trade according to the deviation from UIP. The profit from a carry trade with the United-States as the source country (noted $C_{US,t}$) is the following:

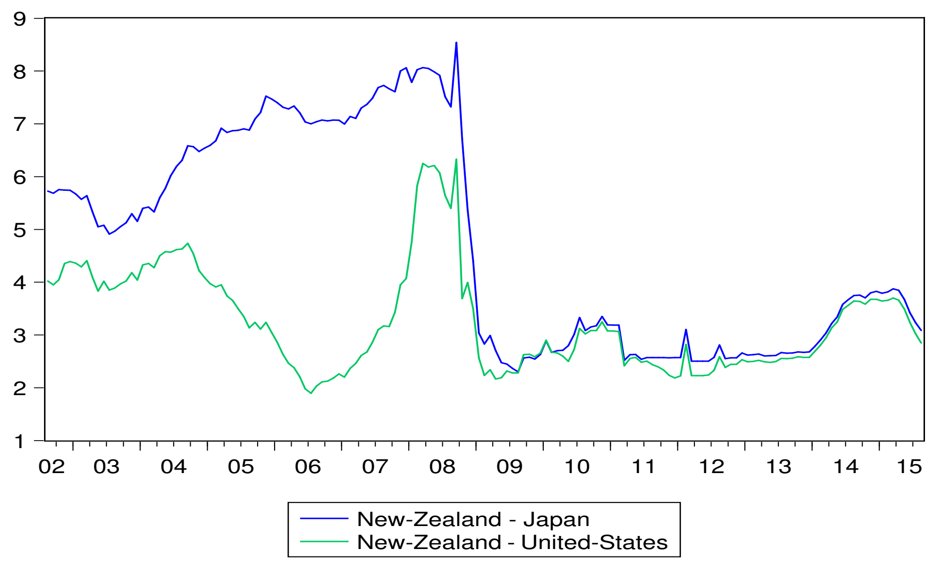
$$C_{US,t} = \left(\frac{E_t s^b_{jt+3}}{s^a_{jt}} - \frac{1 + i_{ust}}{1 + i_t} \right), \tag{3.1}$$

With $E_t s^b_{jt+3}$, the expected bid on New-Zealand Dollar versus US Dollar at time $t + 3$, s^a_{jt} the current ask and i_t and i_{ust} the New-Zealand and United-States interest rates respectively. We consider the exchange rate expectation at time $t + 3$ because we use the three month interest rate. The profit from a carry trade with Japan as the source country (noted $C_{J,t}$) is defined as follows:

$$C_{J,t} = -\left(\frac{1 + i_{jpt}}{1 + i_t} + \frac{E_t s^b_{kt+3}}{s^a_{kt}} \right), \tag{3.2}$$

With $E_t s^b_{kt+3}$, the expected bid on the Japanese Yen versus the US Dollar at time $t + 3$, s^a_{kt} the current ask and i_t and i_{jpt} the New-Zealand and Japanese interest rates respectively.

Figure 3.4: Interest differentials



The other variable in our study is expected inflation which is taken from the Reserve Bank of New-Zealand Business surveys. We also consider Bank credit in New-Zealand and Australia. We include Australian credit because a major part of New-Zealand's banks are owned by Australia[b]. Thus Australian banks' behavior affects New-Zealand's banks. We also take into account Japanese and US banks' excess reserves held with their respective central banks. These two variables are important in the sense that they increase when central banks implement a quantitative-easing program.

3.3.2 Specification and estimation

The estimation of New-Zealand's output gap equation and central bank reaction function allows us to shed light on the channel through which carry trades impact the output gap and whether the RBNZ reacts to these speculative investments. It is standard to estimate reaction functions with GMM[c]. Clarida et al. (1998) investigated the behavior of the Bundesbank, the Bank of Japan and the Fed with such an econometric method. They also accounted for exchange rate changes in their analysis. We also estimate growth in New-Zealand's banking credit both for the pre and post-crisis periods in order to investigate how the macroprudential measures undertook in 2013 have affected growth in banking credit. At last but not least, we estimate an exchange rate return equation allowing us to go further in the analysis of the carry trades effect on New-Zealand's economy.

The first step is to estimate New-Zealand's output gap equation which is specified as follows:

$$y_t = \alpha + \theta_1 y_{t-1} + \theta_2 (i_t - E_t \pi_{t+1}) + \theta_3 x_t + \theta_4 \Delta reer_t + \theta_5 \Delta cred_t + \varepsilon_t, \quad (3.3)$$

with y_t and y_{t-1} the current and lagged output gap, i_t is the short run interest rate and $E_t \pi_{t+1}$ the expected inflation, thus $(i_t - E_t \pi_{t+1})$ is the real ex-ante interest rate, x_t our proxy for carry trades, $\Delta reer_t$ changes in the real effective exchange rate, $\Delta cred$ changes in banking credit and ε_t an exogenous disturbance. Let u_t be a vector of instrumental variables. The orthogonality

[b] The data are taken from datastream and represent the private sector credit in Australia and New-Zealand respectively.

[c] See among others, e.g., Gozgor (2012), Gerdesmeier and Roffia (2004), Clarida et al. (1998).

condition is:

$$E[y_t - (\theta_1 y_{t-1} + \theta_2(i_t - E_t\pi_{t+1}) + \theta_3 x_t + \theta_4 \Delta E_t reer_{t+1}) - \theta_5 \Delta cred_t | u_t] = 0. \tag{3.4}$$

The instrumental variables are exogenous to the output gap but useful to explain it. For example, in equation 3.4, we use the lagged output gap, New-Zealand and Japan interest rates, our proxies for carry trades, New-Zealand's monetary base, Japan excess reserves with the Bank of Japan, changes in banking credit and changes in the real effective exchange rate. Notice that we do not every time use the same variables for the estimations on different periods. Accordingly some of these variables are used in the estimation of the Pre-crisis period but not for the Post-crisis period and not for the estimation with an alternative proxy for carry trades. The exhaustive list of instruments are describes in the appendices and report the number of lags considered for each variable. Notice that we use the same instrumental variables for equations presented here below. We consider also US banks excess reserve with the Federal Reserve, interest differentials with The US and Japan and log positions on New-Zealand Dollar.

The second step is to estimate the reaction function also with GMM. The standard specification is to assume that the central bank has both an output and an inflation target. The famous theoretical paper of Clarida et al. (1999) assumes that the central bank minimizes the spreads between actual and targeted inflation and potential and current output. By minimizing these spreads the central bank can react to other variables which affect growth and inflation. In this paper, our aim is to investigate whether the RBNZ reacts to inflation and other variables through their impact on the output gap. Ball (1999) emphasizes that in open economies Taylor rule and inflation targeting (reduced form) have to be modified, suggesting that central banks of such economies include the exchange rate in their reaction function. Hence we add exchange rate changes[d] in the estimation of New-Zealand's reaction function. In addition our proxy for carry trades will enable us to investigate whether the RBNZ reacts directly to carry trades. Hence, we estimate the

[d] Among others, Cermeño et al. (2012), Frommel et al. (2012), and Moura and Carvalho (2010) have empirically estimated Taylor rules with exchange rate changes.

following Equation:

$$i_t = \alpha + \beta_1 y_{t-1} + \beta_2 E_t \pi_{t+1} + \beta_3 i_{t-1} + \beta_4 x_t + \beta_5 \Delta reer_t + \varepsilon_t, \tag{3.5}$$

with i_t the 90-day rate and $E_t \pi_{t+1}$ one month forward expected inflation. Similarly to the output gap equation, the orthogonality condition is the following:

$$E[i_t - (\beta_1 y_{t-1} + \beta_2 E_t \pi_{t+1} + \beta_3 i_{t-1} + \beta_4 x_t + \beta_5 \Delta reer_t)|u_t] = 0. \tag{3.6}$$

As mentioned previously, it is useful to estimate growth in New-Zealand's banking credit in order to investigate how macroprudential measures have impacted credit in New-Zealand. This equation is also estimated with GMM and is defined as follows:

$$\begin{aligned} \Delta Cr_{NZ} = \alpha + \eta_1 \Delta Cr_{NZt-1} + \eta_2 \Delta Cr_{At-1} + \eta_3 \Delta i_{t-1} + \eta_4 \Delta M3 \\ + \eta_5 \Delta res_{US} + \eta_6 \Delta reer_t + \varepsilon_t, \end{aligned} \tag{3.7}$$

with ΔCr_{NZ} changes in New-Zealand's banking credit, ΔCR_A changes in Australian banking credit, $M3$ New-Zealand monetary base, res_{US} US bank excess reserves and $\Delta reer_t$ changes in the Real effective exchange rate. Hence, the orthogonality condition is the following:

$$\begin{aligned} E[\Delta Cr_{NZ} - (\eta_1 \Delta Cr_{NZt-1} + \eta_2 \Delta Cr_{At-1} + \eta_3 \Delta i_{t-1} + \eta_4 \Delta M3 \\ + \eta_5 \Delta res_{US} + \eta_6 \Delta reer_t)|u_t] = 0. \end{aligned} \tag{3.8}$$

The exchange rate is a highly relevant variable concerning carry trades, thus estimating an exchange rate return equation is an important step to investigate how carry trades affect the New-Zealand's economy. Such an equation is estimated with GMM as follows:

$$\begin{aligned} \Delta s_t = \alpha + \iota_1 \Delta s_{t-1} + \iota_2 (i_t - i_{USt}) + \iota_3 (i_t - i_{jpt}) + \iota_4 (E_t \pi_{t+1} - E_t \pi_{ust+1}) \\ + \iota_5 \Delta res_{USt} + \varepsilon_t, \end{aligned} \tag{3.9}$$

with Δs_t changes in the nominal exchange rate and $E_t \pi_{ust+1}$ the US expected inflation. $(i_t - i_{USt})$ and $(i_t - i_{jpt})$ are the interest differential between New-

Zealand and the US and New-Zealand and Japan respectively. The orthogonality condition is:

$$E[\Delta s_t - (\iota_1 \Delta s_{t-1} + \iota_2(i_t - i_{USt}) + \iota_3(i_t - i_{jpt}) + \iota_4(E_t\pi_{t+1} - E_t\pi_{ust+1}) + \iota_5 \Delta res_{USt})|u_t] = 0. \tag{3.10}$$

After the estimation of each equation it is straightforward to test whether our instruments are good, and we test it thanks to the test of over-identifying restrictions (see, e.g., Hansen (1982)). Then, we performed some tests[e] in order to check whether the residuals follow a normal law (Jarque-Bera), do no present heteroscedasticity (Correlogram squared residuals) and are not correlated (Correlogram). The tests reveal that the residuals are normally distributed, not correlated and do not present heteroscedasticity for all the equations estimated in this paper.

3.4 Do carry trades affect New-Zealand's economy and how?

The aim of this section is to determine whether carry trades affect New-Zealand's economy. By estimating New-Zealand's output gap equation and central bank reaction function, we quantify the channels through which carry trades could impact the economy.

3.4.1 The output gap

We begin with the estimation of the output-gap equation. The results of this estimation are reported in Table 3.1.

Full sample analysis: Before investigating precisely the determinants of the output gap in New-Zealand before and after the crisis, it is straightforward to analyze the impact of the two variables usually present in a standard IS curve ($y_t = \kappa y_{t-1} - \phi(r_t - E_t\pi_{t+1}) + g_t$), with y_t the output gap, r_t the short run interest rate and $E_t\pi_{t+1}$ expected inflation. The economic intuition predicts positive signs for the coefficients κ and ϕ. Indeed a rise in the real

[e] We do not report the results here but they are available upon request.

Table 3.1 The output gap

Variables	Pre-crisis	Post-crisis
Japanese carry trades	0.578***	0.296***
	(0.1319)	(0.0942)
United states carry trades	-0.203**	1.128***
	(0.0887)	(0.1295)
Real interest rate	-0.090***	-0.118***
	(0.0169)	(0.0256)
Δ Real effective exchange rate	0.204	1.699***
	(0.3151)	(0.3818)
Lagged output gap (1 month)	0.404***	0.297***
	(0.1299)	(0.0496)
Δ New-Zealand Credit	2.133***	-2.589*
	(0.6811)	(1.4209)
Δ Australian credit (1 month lag)	2.407**	0.675
	(1.1092)	(1.4689)
J-Stat	10.07	15.91
P-Value	[0.9669]	[0.9547]
Adjusted R-squared	0.21	0.33

(Standard errors in parentheses)
The list of instrumental variables is presented in Section 3.7

Note: For the Pre-crisis period the output gap is estimated from August 2002 to September 2008. The Post-crisis estimation covers the period from February 2009 to August 2015. *, **, *** denote coefficients different from zero at the 10%, 5% and 1% level, respectively.

interest rate, by lowering investment, decreases growth. Our results confirm the intuition for both periods. The impact of the real interest rate appears quite low but that is due to the fact that we have more variables than in the standard IS curve. Notice that McCallum and Nelson (1998) report a value of -0.164 for this coefficient in the US, which is not so different from the coefficients we find controlling for several variables[f].

Pre-crisis analysis: A rise in New-Zealand's bank credit increases the output gap through its positive impact on investment. Because the major part of New-Zealand's banks are owned by Australian's banks, the positive impact of

[f]It is not surprising not to find a coefficient equal to the one reported by McCallum and Nelson (1998) in the sense that they investigated the US and we study here the case of a small open economy.

lagged changes in Australian credit is due to the fact that it increases access to credit in New-Zealand, which boosts output.

Let us now analyze the impact of carry trades. Our proxy for carry trades funded in United-States reveals a negative coefficient. That means that the deviation from UIP between New-Zealand and the United-States decreases the output gap. This negative impact is not due to carry trades but to the NZ dollar appreciation which reduces growth. Figure (3.4) clearly reveals that the return from a carry trade funded in Japan was higher than the one funded in the US (ceteris paribus). Thus, in this pre-crisis period Japanese-Yen carry trades were more attractive than US-Dollar carry trades, explaining part of the negative coefficient of our proxy of US carry trades. Indeed, it seems straightforward that at that time US carry trades had a lower impact on New-Zealand economy than Japanese carry trades. Notice that, for this period, the major part of carry trades was funded in Japan. Interestingly, our results suggest that Japanese carry trades were expansionary.

This is a first ingredient concerning the destabilizing effect of carry trades. Indeed, given that capital inflows brought by carry trades are expansionary, they will raise inflation. Thus, we expect that, in order to try and counter such a destabilizing output effect, the central bank will increase the interest rate further to try and reduce inflation, increasing carry trades' return. We will analyze the central bank's behavior in the next section and determine whether this destabilizing effect was present in New-Zealand.

Post-crisis analysis: Considering the interest differentials (all else equals), after the GFC, Figure (3.4) suggests that US carry trades seem as attractive as Japanese carry trades. Our results still reveal a positive impact of Japanese carry trades on New-Zealand's output gap. Table (3.1) also sheds light on the expansionary effect of US carry trades.

Similarly to the Pre-crisis period, lagged changes in Australia's bank credit have a positive impact on New-Zealand's output gap. Positive changes (reflecting an appreciation) in NZ dollar's real effective exchange rate also lead to a higher output gap. This expansionary effect comes from the fact that such an appreciation increases the carry trades' returns, leading to further expansionary capital inflows.

Changes in New-Zealand's bank credit reduce growth, which is counterintuitive. This negative coefficient can be explained by the macroprudential measures introduced in New-Zealand from 2013. Among these measures, the counter cyclical capital buffer seems to be an explanation of the decreasing output gap enhanced by a growing credit. Such a measure would limit credit access during periods of increasing credit. We estimate changes in bank-credit for the Pre and Post-crisis periods in order to show whether lagged changes in New-Zealand's credit affect current changes in this variable.

Table 3.2 Growth in New-Zealand's banking credit

Variables	Pre-crisis	Post-crisis
Δ New-Zealand's banking credit (1 month lag)	0.107*	-0.156*
	(0.0598)	(0.0789)
Δ Australian banking credit (1 month lag)	0.409***	0.117*
	(0.0752)	(0.0672)
Δ Lagged interest rate (1 month)	-0.113***	-0.013**
	(0.0263)	(0.0061)
Δ M3	0.5469***	0.247***
	(0.0781)	(0.0347)
Δ US reserves (1 month lagged)	-0.008	0.011*
	(0.0104)	(0.005)
Δ Real effective exchange rate	0.095***	0.048***
	(0.0179)	(0.0145)
J-Stat	9.14	17.54
P-Value	[0.9925]	[0.9531]
Adjusted R-squared	0.31	0.15
(Standard errors in parentheses)		
The list of instrumental variables is presented in Section 3.7		

Note: The Post-crisis estimation covers the period from February 2009 to August 2015. *, **, *** denote coefficients different from zero at the 10%, 5% and 1% level, respectively.

Focusing on lagged changes in New-Zealand's bank-credit in table 3.2, we note that during the Pre-crisis period, an increase in this variable increased growth in New-Zealand's banking credit while it decreased it in the Post-crisis period. Such a result clearly reveals that the negative impact of lagged changes in the NZ's bank-credit is due to macroprudential measures in the sense that in case of increasing credit, such measures will reduce it in the future which will cool down the economy.

For both periods, the negative impact of past changes in the interest rate seems logical in the sense that a higher interest rate means a higher cost of credit. Both past changes in Australian bank credit and current changes in the New-Zealand's monetary base increase domestic bank credit. Concerning the monetary base, it is straightforward that after positive changes in this variable credit rises, thanks to more liquidity in the banking system. A major part of New-Zealands' banks are owned by Australians' banks, thus a higher access to credit in Australia facilitates credit in New-Zealand.

Interestingly, for the post-crisis period, table 3.2 reports a positive impact of past changes in US Bank excess reserves with the Fed, this is linked to carry trades. When US banks' excess reserves increase (with a low US interest rate) carry trades correspond to the export of liquidity from the US to New-Zealand, increasing New-Zealand's bank credit, suggesting that macro-prudential measures are not able to act on the increasing liquidity enhanced by QE episodes in the US. However, for the pre-crisis period this variable is not significant. Such a result is not surprising in the sense that liquidities will hugely move from the US to New-Zealand during QE episodes in the US and such episodes do not appear in the pre-crisis period.

Table 3.2 reveals a positive sign of a NZ Dollar appreciation for the two periods studied, such an effect comes from carry trades. Indeed an appreciation of the domestic currency raises carry trades' returns, leading to further incoming carry trades, increasing current credit.

We have shed light on the expansionary effect of capital inflows which is at the basis of the carry trades' vicious circle, and will now investigate whether the RBNZ counters or stimulates this expansionary effect of speculative capital inflows.

3.4.2 The Central Bank reaction function

The results of the estimation of New-Zealand's Central bank reaction function are reported in Table (3.3), both for the Pre and Post-crisis periods.

Table 3.3 The reaction function (90-day rate)

Variables	Pre-crisis	Post-crisis
Japanese carry trades	0.448***	-0.683***
	(0.0753)	(0.1305)
United states carry trades	0.181***	0.196**
	(0.0335)	(0.0893)
Lagged interest rate (1 month)	0.838***	0.881***
	(0.0357)	(0.0216)
Δ Real effective exchange rate	-0.168***	0.786**
	(0.0569)	(0.3059)
Expected inflation	0.266***	0.106***
	(0.0594)	(0.0223)
US interest rate	-0.008***	-0.036***
	(0.0031)	(0.0113)
Lagged output gap (1 month)	0.158***	0.089*
	(0.0254)	(0.0517)
J-Stat	12.86	13.59
P-Value	[0.9550]	[0.9933]
Adjusted R-squared	0.98	0.78
(Standard errors in parentheses)		
The list of instrumental variables is presented in Section 3.7		

Note: For the Pre-crisis period the output gap is estimated from August 2002 to September 2008. The Post-crisis estimation covers the period from February 2009 to August 2015. *, **, *** denote coefficients different from zero at the 10%, 5% and 1% level, respectively.

Full sample analysis: In a closed economy, and considering that the central bank adjusts the interest rate gradually (so-called interest rate smoothing), equation (3.5) becomes

$$i_t = (1 - \beta_3)(\beta_1 y_{t-1} + \beta_2 E_t \pi_{t+1}) + \beta_3 i_{t-1} + u_t,$$

and the Taylor principle states that $\beta_1 = 0.5$ and $\beta_2 = 1.5$. Indeed, the literature estimating reduced form reaction function clearly reveals that $\beta_1 > 0$ and $\beta_2 \approx 1.5$. In line with Clarida et al. (1998) we find a coefficient β_3 close to 0.9 for both periods. Notice that the coefficients reported in table 3.3 are $(1 - \beta_3)\beta_1$ and $(1 - \beta_3)\beta_2$ for the output gap and expected inflation respectively. In the Pre-crisis period, the long run coefficient for the output gap (β_1) is equal to 0.98. That is not exactly what stated by the Taylor principle[g] but it lies between 0 and 1 which is consistent with the theory. In addition, for the Pre-crisis period, the long run coefficient associated to expected inflation (β_2) is equal to 1.64 which is in line with the Taylor principle. Concerning the Post-crisis period $\beta_1 = 0.75$ which is again close to what is associated with the Taylor principle. The long run coefficient of expected inflation is less than one, $\beta_2 = 0.92$ which does not satisfy the Taylor principle. However, we can explain this low coefficient by the GFC. It is obvious that the RBNZ reacted less aggressively to inflation after the GFC.

Pre-crisis analysis: According to the RBNZ's statements and the paper of Kendall and Ng (2013), the RBNZ seems to respond to the United-States' Fed funds interest rate. Hence, we include the latter variable in the estimation of New-Zealand's reaction function. The coefficient of the Fed funds rate appears negative and significant for the pre-crisis period, meaning that the RBNZ took US monetary policy into account while implementing its own monetary policy. More precisely, a rise in the US interest rate was perceived as a sign of slowdown in US growth, leading the RBNZ to cut its own interest rate so as not to suffer from the slowing activity in the US.

Table (3.3) reports that following an increase in Japanese carry trades' returns, New-Zealand's central bank raises the interest rate. This result is crucial since it sheds light on the destabilizing effect of carry trades. As seen previously, higher returns of Japanese carry trades are expansionary, which increases inflation, leading the RBNZ to raise the interest rate, making carry trades more attractive. In light of this result, we can argue that, between 2002 and 2008, the more there were carry trades funded in Japan, the more they were attractive in New-Zealand.

The positive sign of the carry trades funded in the US reveals that even if the whole impact of the proxy on the output gap is negative, carry trades funded in the US are also destabilizing for New-Zealand's economy. This result is not trivial and needs to be clarified. The deviation from UIP has a

[g]Notice that here we consider a small open economy. Thus, there are more variables than in a standard Taylor rule. Hence, it would not be surprising to find coefficients not exactly equal to what stated by the Taylor principle.

negative impact on the output gap through the exchange rate appreciation but the effect of carry trades is still present. The central bank reacts to the effect of carry trades brought by the deviation from UIP, leading to a higher interest rate.

Post-crisis analysis: After the crisis, the US interest rate still has a negative and significant effect on New-Zealand's rate. We observe a positive impact of changes in the real effective exchange rate, which is due to carry trades. Indeed, a domestic currency appreciation makes carry trades more attractive, raising inflation, and leading the RBNZ to increase the interest rate.

After the crisis, the RBNZ changed its response to carry trades. The negative coefficient of Japanese carry trades suggests that New-Zealand's central bank has in mind the destabilizing effect of carry trades. The RBNZ cuts the interest rate after a rise in the return of Japanese carry trades in order to reduce carry trades' attractiveness and incoming flows. With such a reaction, the self-fulfilling effect of Japanese carry trades can be suppressed. By contrast, our results reveal that the RBNZ reacts positively to US carry trades. Thus, after the crisis, the more there are US carry trades, the more they are attractive.

Discussion: Our results clearly show that carry trades have been a source of instability in New-Zealand since 2002. We also shed light on the fact that the RBNZ took this possibility into account only after the crisis by decreasing the interest rate after a rise in the return of Japan-sourced carry trades. However, despite this central bank's reaction, carry trades funded in the US are still destabilizing for New-Zealand. Indeed a rise in US-sourced carry trades leads the RBNZ to raise the interest rate, increasing US-sourced carry trades' returns. Thus, in this environment, the more there are US carry trades, the more they are attractive.

3.4.3 The United-States' quantitative easing (QE) episodes

We have seen that the RBNZ has been able to break the vicious circle enhanced by Japan-funded carry trades. However US-funded carry trades still destabilize New-Zealand's economy. Morgan (2011) has shown that the QE episodes in the United-States led to an export of liquidity out of the US. We suspect that a part of this liquidity fed US-sourced carry trades. Thus, on the one hand, we exclude the US QE episodes from the estimation, and on the other, we exclude the periods during which the US were engaged in conventional monetary policies. Then, we include a dummy variable in the output gap estimation defined as follows:

$$D_{QE} = 0, \textit{ during US QE episodes}$$
$$D_{QE} = 1, \textit{ otherwise}$$

Hence, multiplying D_{QE} by the return from carry trade, we are able to investigate how US-funded carry trades affect New-Zealand's output gap when the US implement a conventional monetary policy. Then, reestimating the output gap equation with $(1 - D_{QE}) * C_{US,t}$ allows us to investigate how US-funded carry trades affect New-Zealand's output gap during QE episodes in the US. Thus, in a first step we estimate the output gap in the post crisis period by excluding US QE episodes. Then multiplying the carry trades proxy by $(1 - D_{QE})$, we investigate how carry trades affect the output gap when the US implement a conventional monetary policy. Table 3.4 reports the results of these two estimations.

Given that we have already shown that Japan-funded carry trades were not destabilizing in the Post-crisis period, we exclude this variable from the estimation in order to focus on US-sourced carry trades.

The results reported in table (3.4) reveal that carry trades are expansionary in both cases. Interestingly carry trades' effect on the output gap is more than twice larger during US QE episodes. This result clearly sheds light on the fact that US QE episodes increase carry trades in New-Zealand and enlarge their destabilizing effect. Such a conclusion has major policy implications in the sense that New-Zealand monetary authorities should pay particular attention to US-funded carry trades when the US implement a quantitative easing policy.

Table 3.4 The output gap excluding QE episodes

Variables	Excluding US QE	US QE
Lagged output gap (1 month)	0.662***	0.476***
	(0.0885)	(0.0624)
Real interest rate	-0.044*	-0.063***
	(0.0235)	(0.0202)
Δ Real effective exchange rate	0.706*	0.804*
	(0.3827)	(0.4214)
Δ New-Zealand's Credit	-3.611**	-2.556***
	(1.5052)	(0.9057)
Δ Australian's Credit	1.908**	4.144***
	(0.8567)	(0.8832)
$D_{QE} * (US\ Carry\ trades)$	0.389**	–
	(0.1761)	–
$(1 - D_{QE}) * (US\ Carry\ trades)$	–	0.915***
	–	(0.1076)
J-Stat	16.91	16.53
P-Value	[0.9503]	[0.9421]
Adjusted R-squared	0.36	0.39
(Standard errors in parentheses)		
The list of instrumental variables is presented in Section 3.7		

Note: We introduce a dummy variable which considers each quantitative easing episode in the US, QE1: from March 2008 to October 2009, QE2: from November 2010 to June 2011 and QE3: from September 2012 to December 2013. Notice that both dummy are significant at the 5% confidence interval. *, **, *** denote coefficients different from zero at the 10%, 5% and 1% level, respectively.

3.4.4 The exchange rate channel

According to the literature on carry trades, the exchange rate is a crucial driver of carry trade returns (see e.g. Miranda Agrippino and Rey (2013), Hassan (2015), and Chung and Jordà (2009)). The point is that the risk reversal could lead to currency crashes. Carry trades appreciate the targeted currency until investors expect a decreasing return to carry trades, depreciating the targeted currency. Some authors argue that through this depreciation, carry trades make the UIP to hold and are stabilizing (see e.g. Felcser and Vonnák (2014) and Kisgergely (2012)). However, in this paper we argue that this depreciation enhanced by carry trades is transitory and does not stop at all the carry trades' destabilizing effect (at least in New-Zealand). The data on the nominal effective exchange rate are taken from the Bank for International Settlements. An increase in the nominal effective exchange rate reflects an appreciation of the New-Zealand Dollar.

Table 3.5 Changes in the expected nominal exchange rate

Variables	Pre-crisis	Post-crisis	Excluding US QE	US QE
Δ Nominal effective exchange rate	0.358***	0.309***	0.024	0.288***
	(0.0356)	(0.0928)	(0.0981)	(0.0931)
Interest rate differential (NZ-US)	-0.012**	-0.017***	–	–
	(0.0054)	(0.0054)	–	–
Interest rate differential (NZ-jap)	0.002**	0.004	–	–
	(0.0009)	(0.0049)	–	–
Expected inflation differential	0.007***	0.008*	0.016***	0.0129***
	(0.0037)	(0.0041)	(0.0037)	(0.0023)
Δ US excess bank reserves	0.042***	0.053***	0.077***	0.073***
	(0.0144)	(0.0149)	(0.0211)	(0.0146)
$D_{QE} * (NZ - US)$	–	–	-0.007***	–
	–	–	(0.0023)	–
$(1 - D_{QE}) * (NZ - US)$	–	–	–	0.006***
	–	–	–	(0.0015)
J-Stat	8.48	16.16	13.97	15.59
P-Value	[0.9705]	[0.9099]	[0.9277]	[0.9455]
Adjusted R-squared	0.31	0.21	0.15	0.16

(Standard errors in parentheses)
The list of instrumental variables is presented in Section 3.7

Note: For the Pre-crisis period the output gap is estimated from August 2002 to September 2008. The Post-crisis estimation covers the period from February 2009 to August 2015. Note that the estimation with dummies for QE and non QE are run for the post crisis period. *, **, *** denote coefficients different from zero at the 10%, 5% and 1% level, respectively.

We estimate an exchange rate returns equation and table 3.5 reveals that New-Zealand has known depreciations enhanced by carry trades' reversal. Indeed, the negative effect of the interest differential between New-Zealand and the US shows that during both (pre and post-crisis) periods carry trades depreciated the New-Zealand Dollar. However, the expected inflation differential between New-Zealand and the US appreciates the targeted currency. This effect is entirely linked to carry trades in the sense that a higher expected inflation in New-Zealand is followed by a rise in the interest rate which increases carry trades returns, appreciating the domestic currency. Moreover, we also observe an appreciation of the targeted currency when

US excess bank reserves increase.

The estimation of expected changes in the nominal effective exchange rate reveals that carry trades depreciate New-Zealand dollar. However, other economic variables, such as the expected inflation differential and US reserves, feed carry trades by appreciating the targeted currency. Thus even if carry trades' reversals are present they do not suppress the carry trades' destabilizing effect.

To go further in the analysis of the effect of carry trades on exchange rate changes, it is useful to reestimate the equation both excluding QE episodes in the US and excluding non QE episodes in the US. We estimate such an exchange rate return equation by introducing a dummy similarly as in the previous section.

The analysis of the impact of the interest differential on changes in the nominal exchange rate reveals that, during QE episodes in the US, a higher interest differential between New-Zealand and the US appreciated the NZ-Dollar. Importantly, such a result sheds light on the fact that during QE episodes in the US, there is no evidence of carry trades' reversal. By contrast, when the US use a conventional monetary policy (which means less funding currency for US-sourced carry trades), we find evidence of carry trades' reversal. Such a result is in line with the literature which informs that during financial stress carry trades are less profitable.

Overall, the results reported in table 3.5 confirm our findings concerning increasing carry trades and carry trades attractiveness in New-Zealand during QE episodes in the US. Such results should lead New-Zealand monetary authorities to counter carry trades destabilizing effect during QE episodes in the US.

3.5 Robustness check

3.5.1 An alternative proxy for carry trades

We re-estimate the output gap equation and the reaction function with an alternative proxy for carry trades, the long positions on the NZ dollar. This variable is a good proxy for carry trades in the sense that it represents the volume of capital inflows due to NZ Dollar purchases. We estimate the output gap equation and the reaction function for the post-crisis period because long positions on NZ Dollar are only available from 2005. The two Equations are estimated twice, on the one hand with carry trades' profit, on the other with long positions on the New-Zealand Dollar.

Table 3.6 The output gap – Post-crisis estimation

Variables	Long positions on NZ Dollar	Profit from carry trades
Real interest rate	-0.024*	-0.115***
	(0.0132)	(0.0208)
Δ Real effective exchange rate	0.325***	1.827***
	(0.1907)	(0.3741)
Lagged output gap (1 month)	0.495*	0.302***
	(0.0422)	(0.0546)
Δ New-Zealand Credit	-2.019*	-2.309*
	(1.0310)	(1.2407)
Long positions	0.002***	–
	(0.0004)	–
Japanese carry trades	–	0.349***
	–	(0.1054)
United states carry trades	–	1.166***
	–	(0.1313)
J-Stat	18.56	15.58
P-Value	[0.9966]	[0.9605]
Adjusted R-squared	0.33	0.33
(Standard errors in parentheses)		
The list of instrumental variables is presented in Section 3.7		

*, **, *** denote coefficients different from zero at the 10%, 5% and 1% level, respectively.

The output gap: Firstly, Table (3.6) reports the same coefficients' signs for all the variables with the two proxies. The most important point is the positive sign of the different carry trades' proxies. Notice that the coefficient is lower for changes in long positions on the NZ Dollar. That is due to the fact that such long positions account for carry trades but also for other kind of investments which could affect differently the output gap. By contrast, with the other proxy, long positions on the NZ Dollar reflect all investments in the currency and not only carry trades. Thus, there is a part of these investments which leads to a reduction of the output gap, which explains the lower coefficient with this proxy. The main point here is that we find an expansionary effect of carry trades with the two proxies. Moreover, we find approximately the same values for the other coefficients, which allows us to conclude that our output gap estimations are robust.

Table 3.7 The reaction function (90-day rate) – Post-crisis estimation

Variables	Long positions on NZ Dollar	Profit from carry trades
Lagged interest rate (1 month)	0.968***	0.881***
	(0.0090)	(0.0216)
Δ Real effective exchange rate	0.289***	0.786**
	(0.0851)	(0.3059)
Expected inflation	0.064***	0.106***
	(0.0085)	(0.0223)
US interest rate	-0.034***	-0.036***
	(0.0054)	(0.0113)
Lagged output gap (1 month)	0.034*	0.089*
	(0.0199)	(0.0517)
Long positions	-0.006***	–
	(0.0014)	–
Japanese carry trades	–	-0.683***
	–	(0.1305)
United states carry trades	–	0.196**
	–	(0.0893)
J-Stat	19.01	13.59
P-Value	[0.9994]	[0.9933]
Adjusted R-squared	0.86	0.78
(Standard errors in parentheses)		
The list of instrumental variables is presented in Section 3.7		

Note: *, **, *** denote coefficients different from zero at the 10%, 5% and 1% level, respectively.

The reaction function: As a first step, let us consider all the variables except carry trades' proxies. Table (3.7) reveals that all the coefficients have the same signs with the two alternative proxies. Concerning carry trades, our results suggest that the RBNZ increased the interest rate after a rise in US-sourced carry trades and cut it after an increase in Japan-sourced carry trades. The estimation with the alternative proxy reveals that on the post crisis period the RBNZ decreased the interest rate after a rise in long positions on the NZ-Dollar. Such a result is not surprising in the sense that as suggested with the other estimation the RBNZ cut the interest rate after Japanese sourced carry trades. Nevertheless, even if the RBNZ responded to Japanese incoming carry trades, US incoming carry trades are still destabilizing in the sense that they boost growth and lead the RBNZ to increase the interest rate, bringing further capital inflows.

Our alternative estimations allow us to conclude that our output gap and reaction function estimations are robust to an alternative proxy for carry trades (long positions on NZ Dollar).

3.6 Conclusion

New-Zealand is a small open economy targeting inflation, exposing it to carry trades. Indeed, such a policy increases the interest differential vis a vis large economies implementing quantitative easing. The destabilizing effect of carry trades is a crucial issue in New-Zealand due to its high dependence on foreign capital. The objective of this paper was to investigate whether the RBNZ is able to deal with such destabilizing effects while implementing its monetary policy.

Our results suggest that carry trades from Japan were highly expansionary in the Pre-crisis period, leading the New-Zealand central bank to respond in a destabilizing way, raising the interest rate after incoming capital flows. This first result points out that risk was enhanced by Japanese carry trades during this period. Interestingly, after the crisis, our results show that such a destabilizing response of the RBNZ was discontinued, in a much as it reduced the interest rate after increasing incoming Japan-sourced carry trades. Such a behavior reduced carry trades' returns after incoming flows, which stopped the vicious circle enhanced by Japan-funded carry trades.

However, we find that in the post-crisis period there is still a risk coming from United-States funded carry trades. Indeed, US-sourced carry trades are still destabilizing due to the rise in the NZ interest rate as a response to incoming flows. Hence, even if after the crisis the RBNZ was able to stop the self-fulfilling effect of Japan-funded carry trades, the destabilizing effect of US-funded carry trades persisted and was stronger. In line with this result, we argue that the RBNZ should also respond to US-sourced carry trades to break the risks enhanced by carry trades. We also show that the destabilizing effect of carry trades is fed by United-States' QE episodes. Indeed, our results reveal that during QE episodes in the US the expansionary effect of carry trades is more than doubled and that the NZ-Dollar appreciated after a rise in the interest differential (increasing carry trades attractiveness). By contrast with Burnside (2013), we argue that carry trades destabilize New-Zealand economy. Our results clearly reveal that the US unconventional monetary policies done after the crisis are the main ingredient of this destabilizing effect. We are not telling that the findings of Burnside (2013) are wrong but its empirical analysis stops in 2010 which excludes two US QE episodes. Our findings clearly points out the crucial effect of such policies on the impact of carry trades on New-Zealand's economy. Such a result suggests that after the crisis the unconventional monetary policy in the US fed carry trades in New-Zealand and generated a higher self-fulfilling effect. Accordingly, our results confirm the finding of the literature which states that unconventional monetary policies export liquidities in small open economies. Then, we argue that the RBNZ should particularly pay attention to the destabilizing effect of carry trades during QE episodes in the US.

In this paper we investigated whether the RBNZ responded to incoming carry trades. In light of our results, we can conclude that the RBNZ began to account for it after the GFC but not enough. The way the central bank can mitigate the self-fulfilling effect of carry trades is presented in this paper. It is straightforward that further research should investigate whether and how macroprudential measures could hamper on these self-fulfilling investments.

3.7 Appendix

3.7.1 The instruments

The instrumental variables used for the estimations of the output gap equation, the reaction function, changes in banking credit and changes in expected exchange rate returns are presented in the following tables. The variable cred represents bank credit in New-Zealand; credA is bank credit in Australia; M3 represents New-Zealand's monetary base; and share, New-Zealand's stock prices. We also include Japanese and US banks excess reserves (resjp and resus respectively) with their central bank because these two variables are important for carry trades in the sense that they are affected by QE programs. .

Table 3.8 The output gap

Instruments	Pre-crisis	Post-crisis	Post-crisis (Long positions)
Output gap	–	t-1 to t-6	t-1 to t-8
Δres_{jp}	t-1 to t-6	t-1 to t-4	–
i	t-1 to t-3	t-1 to t-5	t-1 to t-6
i_{jp}	t-1 to t-6	–	–
$C_{US,t}$	t-1 to t-4	–	t-1 to t-8
$C_{j,t}$	t-1	–	t-1
$\Delta M3$	t-1 to t-3	t-1 to t-4	t-1 to t-6
$\Delta cred_A$	t-1 to t-3	t-1 to t-5	t-1 to t-2
$\Delta cred$	–	t-1	t-1 to t-6
$\Delta REER$	–	t-1 to t-8	t-1 to t-4

Table 3.9 The reaction function

Instruments	Pre-crisis	Post-crisis	Post-crisis (Long positions)
Output gap	t-1 to t-6	–	–
i_{jp}	t-1 to t-4	t-1 to t-2	t-1 to t-2
i_{US}	t-1	–	–
i	–	–	t-1 to t-8
Δres_{jp}	t-1 to t-8	t-1 to t-5	
Δres_{US}	–	t-1 to t-6	t-1 to t-4
$\Delta share$	–	t-1 to t-5	–
$\Delta M3$	t-1 to t-6	t-1 to t-3	t-1 to t-6
$\Delta REER$	t-1 to t-3	t-1 to t-6	t-1 to t-4
$\Delta cred_A$	–	–	–
$\Delta cred$	t-1 to t-4	–	–

Table 3.10 Growth in New-Zealand's Bank-credit

Instruments	Pre-crisis	Post-crisis
Output gap	t-1 to t-8	–
i	t-2 to t-8	–
$\Delta REER$	t-1 to t-6	t-2 to t-7
$\Delta cred_A$	t-2 to t-5	t-2 to t-4
$\Delta cred$	t-2 to t-5	t-2 to t-5
Δres_{jp}	–	t-1 to t-7
$C_{US,t}$	t-1	t-1 to t-6
$C_{j,t}$	t-1	t-1 to t-5
$i - i_{jp}$	t-1 to t-3	–
$i - i_{US}$	t-1 to t-4	–

Table 3.11 Changes in the expected nominal exchange rate

Instruments	Pre-crisis	Post-crisis
$\Delta REER$	–	t-2 to t-6
$\Delta cred$	t-21to t-3	t-2 to t-4
Δres_{jp}	t-1 to t-4	–
Δres_{US}	t-2 to t-4	t-1 to t-5
$C_{US,t}$	t-1 to t-7	t-1 to t-2
$C_{j,t}$	–	t-1 to t-5
Long positions	t-1 to t-5	t-1 t-8
$i - i_{US}$	–	t-1 to t-2

General conclusion

Since 2008 and the GFC, quantitative easing policies have become the normal in large economies. Indeed as presented before Japan has been engaged in such unconventional monetary policies since 2001. The United-States decided to implement such a monetary policy right after the crisis (in March 2008). The European Central Bank also resorted tu such unconventional monetary policies in 2015. The point is that these policies inform potential investors on the Foreign exchange market that the interest rate will remain close to its zero lower bound all along the policy. Having this information in mind, investors observe the potential gain from borrowing in large economies (with a low interest rate) and investing in small open economies (with a high interest rate). Given that exchange rates are one of the component of a carry trade's return, it appears crucial to understand how such a variable behave. Indeed, the exchange rate affect carry trades' return but it is also affected by carry trades. Moreover in such a context, small open economies have to be aware of the potential destabilizing effect of carry trades. Once they are aware of it, the authority should know how to avoid such destabilizing effects. First, the aim of my thesis is to shed some light on the theoretical determinants of exchange rates in the long run. Second, the goal is to know how monetary authorities should deal with carry trades in small open economies. Finally, the aim is to analyzes the New-Zealand's case in order to show how monetary authorities react to carry trades and whether they could do a better job to avoid the destabilizing effect of carry trades.

In the first chapter, we show that long run common dynamics between exchange rates mainly depend on the degree of integration of the economies and on the way the central banks define their monetary policy. More precisely, when the central banks do not have the same preferences in terms of real exchange rate targets, the exchange rates of the two countries diverge on the long run. Thus, this chapter suggests that monetary authorities which wants to stabilize exchange rates in the long run should cooperate between themselves.

In the second chapter, our results suggest that a strict inflation monetary policy destabilizes small open economies subject to carry trades. Then, we also show that when the central has both an inflation and an output gap target under discretion, the destabilizing effect of carry trades is mitigated. Importantly, the central bank can totally suppress the carry trades vicious circle by targeting both the inflation and capital inflows under discretion. We also show , by considering non fully rational agents, that when the central bank is not transparent concerning its long run target, the economy is even more destabilized by carry trades. Overall, this chapter suggests that small open economies subject to carry trades could suppress there vicious circle by targeting both the inflation and capital inflows being transparent concerning their long run capital inflows target.

The third chapter focuses on New-Zealand which is a receiver of carry trades. In this empirical work, we find that the RBNZ responded in a destabilizing way to Japan-funded carry trades before the GFC. Interestingly, our results reveal that after the crisis, the RBNZ changed is behavior by decreasing the interest rate following incoming Japanese carry trades. However, we also show that after the GFC crisis, the RBNZ responded to United-States sourced carry trades in a destabilizing way. Ou results also suggest that US sourced carry trades are more destabilizing for New-Zealand during US quantitative easing episodes. Thus, this chapter suggest that the RBNZ should respond to US-sourced carry trades by decreasing the interest rate after incoming flows. Importantly, the RBNZ should pay a particular attention to these investments during episodes of quantitative easing in the US.

Even if the results of my thesis are relevant, the work never ends. For further research, it would be interesting to go further in the analysis of the way to suppress carry trades destabilizing effect. It would be also interesting to investigate what happened in source countries of carry trades.

A nice paper would be an extension of the second chapter in which I would consider different tools to suppress carry trades' vicious circle. Accordingly it would be interesting to investigate how macroprudential measures, taxes on the foreign exchange market, control of capital inflows or taxes on capital inflows affect carry trades. Such an extension would be in line with the model presented in chapter 2 but would deserve a more microfounded model. Another research question in line with my thesis is the effect of carry trades in Japan which has been the main funding country for such investments. An empirical investigation of the impact of carry trades on the effectiveness of quantitative easing would be really interesting. The idea is to model the Japanese economy through a VAR model and analyze how a quantitative easing shock would affect capital outflows.

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