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TAUX DE CHANGE D'ÉQUILIBRE ET DÉSÉQUILIBRES MACROÉCONOMIQUES

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Introduction Générale

La hausse des taux directeurs de la Réserve fédérale des États-Unis (FED)¹, amorcée au début de l'année 2016, a eu de lourdes conséquences sur les économies Argentine et Turquie, lesquelles présentaient déjà des signes de vulnérabilité macroéconomique significative^{2,3}. Ce resserrement de la politique monétaire américaine a, ainsi, contribué aux sorties massives de capitaux, observées en 2018, dans ces deux économies émergentes⁴. Ces sorties massives de capitaux se sont traduites par l'apparition de crises de change sévères en Argentine et en Turquie. Au cours de l'année 2018, la lire Turquie a vu sa valeur se déprécier de près de 40% contre le dollar américain, tandis que le peso Argentin s'est effondré de plus de 50%. Ces très fortes dépréciations ont renchéri le prix des importations, nourrissant l'inflation domestique. La chute de la valeur de ces deux devises émergentes s'est également traduite par des effets de bilan négatifs affectant très fortement les entreprises dont la dette est libellée en dollars. La réapparition des crises de change dans les

¹Les *federal funds rates* sont passés de 0,34% en janvier 2016 à 2,27% en décembre 2018 (source FRED).

²L'économie Turquie est fortement dépendante du financement externe, la rendant particulièrement vulnérable à un changement des conditions financières globales. Le taux d'endettement des ménages Turques a cru très fortement sur la période 2002-2015, passant de 4,7% de leur revenu disponible en 2002 à 52% en 2015 (Akçay et Ali Riza, 2019). L'économie Turquie se caractérise également par une très forte dollarisation. On observe une augmentation très marquée des emprunts en devises étrangères de la Turquie, passant de 18% de ses obligations en 2010 à 46% en 2017 (Burger et al., 2018 : <https://voxeu.org/article/re-emerging-currency-mismatches>).

³Castillo-Ponce et Lai (2020) expliquent que les vulnérabilités financières observées pour l'Argentine trouvent leurs origines dans la politique économique menée par Cristina Kirchner de Décembre 2007 à Novembre 2015. La mise en place de son programme électoral s'est traduite par un creusement significatif du déficit public, largement financé par des emprunts en devises étrangères. La banque centrale a également été mise à contribution pour financer ce déficit, se soldant par une croissance rapide de la masse monétaire et l'apparition d'une inflation élevée.

⁴Il convient de noter que ces sorties de capitaux constituent un phénomène multifactoriel. Les sorties de flux de capitaux observées en Turquie sont, par exemple, également imputables à l'apparition de tensions géopolitiques majeures avec les États-Unis au cours de l'année 2018. L'Argentine a aussi vu sa situation économique se dégrader considérablement entre 2017 et 2018 en raison de sévères sécheresses. Ces dernières ont mis à mal sa capacité à exporter des matières premières agricoles dont elle dépend fortement pour l'obtention de devises étrangères.

économies émergentes fournit une illustration des canaux par lesquels le taux de change peut affecter l'économie, soulignant son rôle clé en macroéconomie internationale.

Cette thèse s'inscrit précisément dans ce champ de la macroéconomie internationale et vise à étudier de façon approfondie la dynamique et les déterminants des taux de change, en accordant une attention particulière à leurs effets sur les déséquilibres internes et externes.

Le Taux de Change Réel (TCR) est ainsi un indicateur fondamental en macroéconomie internationale, fortement scruté par les décideurs politiques. Afin de suivre l'évolution de la compétitivité d'une économie par rapport à un unique partenaire commercial, le TCR *bilatéral* est l'indicateur adéquat. Cependant, si l'objet d'intérêt est la compétitivité de l'ensemble de l'économie, le Taux de Change *Effectif* Réel (TCER) se montre plus pertinent car il prend en compte l'évolution du taux de change de tout ou partie des partenaires commerciaux. Cheung et al. (2007) notent ainsi que « . . . trade weighted rates are to be preferred to bilateral rates since the reliance on the latter can lead to misleading inferences about overall competitiveness ». Le taux de change effectif s'obtient comme une moyenne géométrique pondérée des taux de change bilatéraux d'un pays par rapport à ses partenaires commerciaux. Différents schémas de pondérations existent. Le choix le plus fréquent consiste à utiliser les volumes commerciaux bilatéraux (la somme des exportations et importations, exprimée comme proportion du total des exportations et importations ; Chinn, 2006). Afin de prendre en compte la concurrence indirecte, il est également possible de calculer des doubles « poids d'exportation ». En plus de capter la concurrence directe, cette approche permet en outre de capturer la concurrence entre les exportateurs de deux pays sur les marchés

tiers⁵. Le développement récent de bases de données macroéconomiques, disponibles à un niveau sectoriel plus ou moins fin, a suscité un regain d'intérêt pour la création de mesures alternatives de pondération⁶. Ces dernières sont d'autant plus pertinentes que le recours à des pondérations commerciales peut-être inapproprié car basées sur de fortes hypothèses (Patel et al., 2019). En effet, l'utilisation de poids commerciaux présente le défaut de ne pas distinguer les biens intermédiaires des biens finaux car tous les biens sont considérés comme appartenant à la même catégorie. Bems et Johnson (2015) et Patel et al. (2019) soutiennent que cette hypothèse est de plus en plus discutable en raison du fort développement de la chaîne des valeurs. C'est pourquoi Bems et Johnson (2015) relâchent cette hypothèse, en autorisant les échanges de biens intermédiaires dans leur méthode de pondération. Quant à eux, Patel et al. (2019), prennent également en compte l'hétérogénéité sectorielle dans leur calcul du TCER.

L'obtention de la valeur *réelle* du taux de change nécessite par ailleurs le recours à un déflateur. Ce choix peut dépendre de la question de recherche investiguée (Driver et Westaway, 2004 ; Ahn et al., 2017), mais est plus généralement dicté par un impératif de disponibilité des données. Cette contrainte explique le recours très fréquent à l'Indice des Prix à la Consommation (IPC) qui présente l'avantage d'être disponible pour un grand nombre de pays sur un horizon temporel large. Si l'objectif est le suivi de la compétitivité-coût de l'économie domestique par rapport aux partenaires commerciaux, le coût unitaire de la main d'œuvre constitue un déflateur adéquat⁷. Cependant, cet indicateur est majoritairement disponible pour les économies avancées et quelques économies émergentes, expliquant son utilisation parcimonieuse. Afin d'obtenir la valeur réelle du taux de change, il est également possible d'utiliser le déflateur du Produit Intérieur Brut (PIB).

⁵Voir Turner et Van't dack (1993) pour les détails concernant le calcul de ces doubles « poids d'exportations ».

⁶Nous pouvons mentionner la disponibilité de la base de données EU KLEMS (Adarov et Stehrer, 2019) et de la base de données Input-Output (Timmer et al., 2015).

⁷Le coût unitaire de la main d'œuvre est calculé comme le coût moyen du travail par unité de production.

Pour comparer l'évolution du prix relatif des biens et services échangeables, le recours à l'Indice des Prix à la Production (IPP) ou à l'Indice des Prix de Gros (IPG) est à privilégier. Cependant, ce choix peut s'avérer problématique car, comme l'a souligné Chinn (2006), l'IPP et l'IPG peuvent inclure des biens intermédiaires importés. Ainsi, le taux de change réel obtenu en utilisant l'IPP ou l'IPG ne mesure pas uniquement la compétitivité de l'économie domestique.

La valeur du TCR n'apporte en elle-même que très peu d'informations sur l'existence d'éventuel(s) déséquilibre(s) dans l'économie domestique, d'où l'intérêt suscité par le calcul de sa valeur d'équilibre. Ainsi, le Taux de Change Réel d'*Equilibre* (TCEQ) peut, par exemple, servir à fixer la valeur du taux de change d'entrée pour les économies adhérant à une union monétaire (Driver et Westaway, 2004). De plus, il fournit également de potentielles informations sur l'évolution future des taux de change. Cependant, il n'existe pas de définition consensuelle du TCEQ, celle-ci dépendant plutôt de l'horizon temporel considéré : court, moyen ou long terme (Driver et Westaway, 2004 ; López-Villavicencio et al., 2012). Driver et Westaway (2004) définissent le TCEQ de court terme comme celui qui existerait si les fondamentaux se situent à leurs valeurs observées après avoir corrigé de l'influence de potentiels effets aléatoires. On considère que le TCR est à sa valeur d'équilibre de moyen terme lorsque les équilibres interne et externe sont simultanément atteints. L'équilibre interne est vérifié si la déviation du PIB de l'économie domestique à son niveau potentiel (*output gap*) est proche de zéro, et si le taux de chômage se situe à son niveau n'accélérant pas l'inflation (NAIRU). L'équilibre externe, quant à lui, désigne la situation dans laquelle le compte courant est à un niveau compatible avec une convergence à un équilibre stock-flux. Lorsque cet équilibre stock-flux est vérifié pour chaque agent de l'économie, le TCR est à sa valeur de long terme (Driver et Westaway, 2004).

Le TCEQ étant inobservé, il est nécessaire de l'estimer. Plusieurs méthodologies existent à cette fin. La première consiste à appliquer la Parité de Pouvoir d'Achat (PPA). La « version absolue » de la PPA affirme que le taux de change doit se fixer à une valeur telle qu'il y ait égalité entre les niveaux de prix domestique et étranger, une fois ces prix exprimés dans la même monnaie. Toute déviation du taux de change par rapport au niveau assurant la PPA doit tendre à se corriger d'elle-même. Par conséquent, à long terme, le taux de change réel est constant et égal à l'unité. Cependant, les examens empiriques concluent à la violation de la PPA, donnant naissance à la célèbre « énigme de la PPA » de Rogoff (1996). Selon cette énigme, le retour au taux de change PPA est très lent⁸. Plusieurs explications à la violation de la PPA ont été proposées par la littérature (voir Rogoff (1996) pour une discussion) : existence de coûts de transaction, non-négociabilité de certains biens, présence de barrières tarifaires et non tarifaires.

Selon le point de vue Casselien, le taux de change peut dévier de la valeur PPA en raison d'écarts de taux d'intérêt non nuls entre pays. C'est pourquoi l'approche PPA a été augmentée de la parité non couverte des taux d'intérêt, donnant naissance à la modélisation *Capital Enhanced Equilibrium Exchange Rate* (CHEER). Cette approche trouve son origine dans les travaux de Juselius (1991, 1995) et MacDonald (2000) note qu'il s'agit plutôt d'un concept de moyen terme car la cohérence stock-flux n'est pas imposée dans le modèle.

Une autre méthodologie populaire est l'approche *Fundamental Equilibrium Exchange Rate* (FEER, Williamson, 1994). Il s'agit d'une approche de moyen terme car le FEER suppose que les équilibres interne et externe sont vérifiés dans l'économie domestique. Deux méthodologies

⁸Il convient de noter que la PPA est vérifiée à très long terme pour les économies avancées (Bénassy-Quéré et al., 2010). Voir les revues de la littérature proposées par Rogoff (1996) et Burstein et Gopinath (2014).

distinctes existent dans la littérature pour estimer le FEER : le recours à un modèle macro-économétrique, ou l'utilisation d'une modélisation en équilibre partiel. Ce second choix nécessite de définir le niveau soutenable du compte courant et de fixer la valeur des élasticités-prix des importations et exportations. Il est donc intéressant de se pencher sur les effets de modifications de la cible du compte courant, ainsi que sur les changements dans la valeur des élasticités-prix. Driwer et Wren-Lewis (1999) montrent que les estimations du FEER sont sensibles à l'hypothèse choisie pour trois grandes devises (dollar américain, mark allemand et yen). Une modification du niveau soutenable du compte courant de 1% (en proportion du PIB) peut produire des changements dans la valeur du FEER d'environ 5%. Une incertitude entoure également l'estimation des élasticités-prix des exportations et importations en raison de l'absence d'une formulation unique des équations commerciales utilisées pour les estimer. Dunaway et al. (2009) et Cheung et al. (2009) mettent en évidence une plus ou moins forte sensibilité des estimations FEER du renminbi (RMB) aux valeurs retenues. Bien qu'étant sensible aux choix des hypothèses, l'approche FEER présente une amélioration par rapport à la PPA car les estimations du FEER sont cointégrées avec le TCER (Barisone et al., 2006), impliquant une absence d'écart durable entre les deux valeurs.

En raison de sa simplicité, l'approche PPA a été largement critiquée car elle ne considère pas les déterminants « réels » du taux de change (Jeong et al., 2010) et ne tient pas compte de la présence d'effets de stock (MacDonald, 2000). Pour faire face à ces faiblesses, l'approche *Behavioral Equilibrium Exchange Rate* (BEER, Clark et MacDonald, 1999) constitue une alternative prometteuse. Dans le cadre de l'approche BEER, le TCEQ est obtenu grâce à l'estimation d'une relation de cointégration entre le TCER et ses déterminants. L'exemple d'application le plus célèbre de cette méthodologie est dû à Clark et MacDonald (1999) qui calculent le TCEQ du dollar américain,

du yen japonais et du mark allemand. Pour cela, ils utilisent les trois fondamentaux suivants : un proxy pour l'effet Balassa-Samuelson, la position extérieure nette et les termes de l'échange. L'approche BEER a été critiquée pour son manque de fondements théoriques et la sensibilité de ses estimations aux fondamentaux retenus (Lopez-Villavicencio et al., 2012). Fisher et Hossfeld (2014) jugent que l'incertitude entourant la spécification économétrique rend une interprétation des valeurs estimées en tant que norme « douteuse ». La sensibilité de l'approche BEER est investiguée en détail par Bénassy-Quéré et al. (2009) pour les économies du G20. Elles étudient sa robustesse à une batterie de changements : mesures alternatives pour l'effet Balassa-Samuelson, modification du panel de pays, changement du numéraire et utilisation d'une dimension temporelle alternative. Elles montrent que les estimations BEER sont relativement robustes à ces différents tests, bien que les estimations de mésalignements de change⁹ peuvent varier de plusieurs points de pourcentage. Bien que généralement opposées dans la littérature, les approches BEER et FEER sont davantage complémentaires que substituables car elles correspondent au même modèle théorique appliqué à des horizons différents (Bénassy-Quéré et al., 2010).

Une alternative aux approches précédemment proposées consiste à utiliser les propriétés statistiques du TCR. Ainsi, en recourant à la décomposition de Beveridge-Nelson ou au filtre Hodrick-Prescott, il est possible de décomposer le TCR en deux composantes distinctes : une composante permanente et une composante transitoire. La composante permanente est assimilée au TCEQ, tandis que la composante transitoire représente le mésalignement de change. Du fait de son absence de fondement théorique, cette approche a été qualifiée d'approche du taux de change d'équilibre permanent athéorique (APEER). Elle a, par exemple, été utilisée par Béreau et al. (2012) et Grekou (2015) comme alternative à l'approche BEER dans leurs études de la relation

⁹Le mésalignement de change est calculé comme la différence entre le taux de change observé et sa valeur d'équilibre.

entre mésalignements de change et croissance.

Afin de disposer d'une estimation des déséquilibres externes de l'économie, il est nécessaire de calculer la déviation du TCER par rapport à sa valeur d'équilibre, c'est-à-dire d'évaluer le mésalignement de change. D'un point de vue macroéconomique, il est d'une importance primordiale car, selon le consensus de Washington, tout mésalignement de change est préjudiciable à la croissance économique (Williamson, 1990). D'une part, les surévaluations de change doivent être évitées car elles peuvent se traduire par des déséquilibres externes qui prennent la forme de déficits de compte courant élevés. Cette vue du consensus de Washington est confirmée par Gnimasoun et Mignon (2016) qui montrent que des surévaluations plus élevées creusent les déficits des comptes courants des économies avancées. D'autre part, les sous-évaluations doivent être corrigées car elles peuvent être à l'origine de déséquilibres internes prenant la forme d'une surchauffe de l'économie. Des pressions inflationnistes excessives peuvent également voir le jour à cause d'une devise sous-évaluée. Ainsi, selon le consensus de Washington, les sous-évaluations tout comme les surévaluations doivent être contenues.

Comme souligné par Razin et Collins (1997), les mésalignements de change peuvent avoir un effet différent sur la croissance selon qu'ils reflètent une sur- ou une sous-évaluation du TCER. C'est pourquoi une distinction entre les effets d'une monnaie sous-évaluée et surévaluée est généralement effectuée dans la littérature. Ainsi, un premier champ des recherches sur le sujet s'intéresse plus particulièrement aux conséquences d'une surévaluation du taux de change. La littérature s'accorde sur l'existence d'un effet négatif d'une devise surévaluée sur la croissance (voir Razin et Collins, 1997 ; Gala et Lucinda, 2006 ; MacDonald et Vieira, 2012 ; entre autres).

Les effets d'une monnaie sous-évaluée sont moins consensuels, et font encore l'objet de débats entre économistes. Différents canaux de transmission ont été proposés par la littérature pour éclairer la relation entre la sous-évaluation d'une devise et la croissance. Gala (2008) propose deux canaux de transmission pour expliquer l'impact positif (resp. négatif) des sous-évaluations (resp. des surévaluations) sur la croissance. Selon le premier canal, intitulé le "canal d'accumulation du capital", une monnaie sous-évaluée entraîne une augmentation du prix des biens échangeables. Cela se traduit par une baisse des salaires réels, ce qui augmente les marges bénéficiaires des entreprises. Cette hausse favorise les investissements améliorant, à son tour, la croissance économique. La pertinence de ce canal de transmission est confirmée par Glüzmann et al. (2012) et Levy-Yeyati et al. (2013). Ils trouvent qu'une augmentation de la sous-évaluation améliore l'épargne et l'investissement domestique. Le deuxième canal proposé par Gala (2008) s'intitule le canal de la « productivité totale des facteurs ». Suivant ce canal de transmission, une monnaie sous-évaluée augmente la croissance car elle favorise l'expansion du secteur des biens échangeables (Rodrik, 2008), à l'origine d'innovations dans l'économie du fait des externalités positives que ce secteur génère. L'existence de ce canal de transmission a formellement été testée par Mbaye (2013), qui montre que la productivité totale des facteurs induite par une monnaie sous-évaluée améliore la croissance économique.

En lien avec ce second canal de transmission, la littérature explique également la relation entre sous-évaluation et croissance à la lumière d'une stratégie de croissance tirée par les exportations. En effet, une monnaie compétitive se traduit par un renchérissement du prix des importations. Une monnaie sous-évaluée se caractérise par une réorientation de la demande intérieure vers des

biens produits localement, et une augmentation de la demande étrangère pour les biens produits localement, c'est-à-dire à la fois par la promotion des exportations et la substitution des importations (Guzman et al., 2018). Ce canal de transmission est confirmé par Nouira et al. (2011) qui montrent qu'une monnaie sous-évaluée favorise la compétitivité des exportations de produits manufacturés. Peu après Nouira et al. (2011), Gluzmann et al. (2012) et Levy-Yeyati et al. (2013) échouent à trouver une association positive entre sous-évaluation et croissance des exportations.

Un point commun à toutes les études citées précédemment est l'hypothèse d'une relation linéaire entre sous-évaluations de change et croissance. Toutefois, cette hypothèse peut être trompeuse car les effets des sous-évaluations ou des surévaluations peuvent dépendre de leurs niveaux. Ce point de vue est confirmé par Razin et Collins (1997) qui montrent la présence de non-linéarités dans la relation mésalignements-croissance. Selon eux, seules les sous-évaluations élevées favorisent la croissance, tandis que les sous-évaluations faibles, moyennes et les sous-évaluations très fortes n'ont pas d'effet significatif. Contrairement aux conclusions précédentes, Aguirre et Calderón (2005) ont mis en avant un lien positif entre les faibles sous-évaluations et la croissance, tandis que les fortes sous-évaluations entravent le développement économique. Estimant des modèles à changement de régime, Béreau et al. (2012) et Aflouk et al. (2013) trouvent que les sous-évaluations, à partir d'un certain seuil, sont propices à la croissance, tandis que les faibles sous-évaluations et les surévaluations l'entravent. Enfin, Nouira et Sekkat (2012) échouent à confirmer l'effet positif d'une monnaie sous-évaluée. Schröder (2013) confirme le résultat de Nouira et Sekkat (2012) et attribue cet échec à l'utilisation de méthodologies économétriques inadéquates.

La littérature a également exploré les canaux de transmission par lesquels une sous-évaluation

du taux de change entraverait la croissance économique. Une monnaie sous-évaluée peut avoir un effet contractionniste en raison des pressions inflationnistes qui y sont associées (Calvo et al., 1995; Haddad et Pancaro, 2010; Chen, 2017; Grekou, 2018). Ces pressions inflationnistes ont pour origines une surchauffe de l'économie et un renchérissement du prix des importations. En lien avec ces tensions inflationnistes, Chen (2017) s'intéresse à l'effet d'une sous-évaluation du taux de change sur les dépenses en Recherche et Développement (R&D). Il montre, pour un échantillon de pays avancés et émergents, qu'une hausse de la sous-évaluation réduit les dépenses en R&D du fait de l'augmentation des coûts des entreprises. Grekou (2015, 2018) propose un deuxième canal de transmission par l'intermédiaire duquel une monnaie faible pénaliserait la croissance économique. Il montre que le canal de la compétitivité est mitigé par ce qu'il appelle le canal de la dette libellée en devises étrangères. Ce résultat provient du fait qu'une sous-évaluation plus élevée augmente la dette étrangère, réduisant la croissance pour les pays de la zone CFA (Grekou, 2015).

L'intérêt et la pertinence d'étudier le mésalignement de change ne s'arrêtent pas à la croissance. En effet, le mésalignement de change bénéficie d'un pouvoir prédictif pour les crises de change. Une surévaluation du taux change plus élevée est associée à plus grande probabilité de crise de change (Holtemöller et Mallick, 2013)¹⁰. Une plus forte surévaluation est le signe d'une détérioration de la qualité des prêts accordés aux banques nationales. Elle peut aussi être le signe d'une forte entrée de flux de capitaux dans l'économie domestique¹¹. Le TCER sert également de mécanisme d'ajustement d'externe de l'économie domestique grâce à un mécanisme d'« expenditure switching » (Obstfeld et Rogoff, 2000; Obstfeld, 2001). Suite à une dépréciation de la monnaie domestique, le prix des biens importés devient plus élevé et la compétitivité des biens nationaux s'accroît sur

¹⁰La première tentative dans cette direction inclut Kaminsky et al. (1998) qui utilisent le taux de change comme indicateur prédictif de crise de change future.

¹¹L'apparition d'une surévaluation du taux de change peut provenir d'une entrée massive de flux de capitaux. Comme le montrent Combes et al. (2012), une entrée de flux de capitaux se traduit par une appréciation de la monnaie domestique.

le marché international. À mesure que les biens étrangers deviennent plus chers, les consommateurs nationaux peuvent choisir de réorienter leurs dépenses en biens étrangers en faveur des biens produits localement. Ce mécanisme d'« expenditure switching » dépend du Passage du Taux de Change (PTC), c'est-à-dire de la façon dont une dépréciation de la monnaie nationale se mute en baisse des prix domestiques. Si la tarification s'effectue dans la monnaie locale, le PTC peut être incomplet. Autrement dit, les variations du taux de change n'auront peu ou aucune incidence sur les prix domestiques. En présence d'une tarification dans la monnaie du producteur, le PTC est complet. Dans cette situation, les variations du taux de change se répercutent entièrement sur les prix pratiqués sur le marché local. Ce mécanisme d'ajustement a récemment fait l'objet de nouvelles investigations empiriques. Gervais et al. (2016) et Ahn et al. (2017) confirment l'existence de celui-ci. En effet, en recourant à différentes méthodologies, ils trouvent qu'une dépréciation du TCER se traduit par une amélioration du compte courant des économies examinées.

L'interaction entre le taux de change et les déséquilibres externes a, récemment, refait son apparition dans le cadre de la guerre commerciale entre la Chine et les États-Unis. Le 5 août 2019, le président des États-Unis d'Amérique, Donald Trump, a tweeté que “China dropped the price of their currency to an almost a historic low. It's called “currency manipulation.” Are you listening Federal Reserve? This is a major violation which will greatly weaken China over time!” Ce tweet du président américain, réalisé dans le contexte de l'escalade de la guerre commerciale entre la Chine et les États-Unis¹², illustre le vif intérêt suscité par le niveau du taux de change qui peut être à l'origine de tensions géopolitiques majeures. La définition d'un partenaire commercial comme un manipulateur de devises dans la législation américaine se base sur la vérification de trois critères:

¹²La guerre commerciale entre les États-Unis et la Chine commence au début de l'été 2018 lorsque les deux pays ont augmenté les droits de douane d'environ 50 milliards de dollars sur les biens des uns et des autres.

un fort excédent de la balance courante mondiale, un important excédent commercial bilatéral avec les États-Unis, et la persistance des interventions à sens unique sur les marchés des changes¹³. Cette accusation de Donald Trump a pour origine la forte dépréciation du RMB observée au cours des dernières années, mais elle n'a pas été confirmée par le rapport du département du Trésor américain. Cependant, cette institution a maintenu la Chine sur sa liste de surveillance renforcée en raison du « mésalignement et de la sous-évaluation du Renminbi par rapport au dollar » (Département du Trésor américain)¹⁴. Quant à lui, le Fonds monétaire international (FMI) est en contradiction avec le point de vue du Trésor Américain. Le 13 août 2019, James Daniel, le directeur adjoint du département Asie-Pacifique du FMI, affirme que « [...], we see RMB, in 2018, as broadly in line with medium term fundamentals and desirable policies, i.e. not significantly over or undervalued. »¹⁵.

Cette guerre commerciale entre la Chine et les États-Unis illustre l'incertitude entourant l'estimation du TCEQ, ainsi que le lien entre mésalignements de change et apparition de déséquilibres externes. S'inscrivant dans ces différentes thématiques, **cette thèse a pour objectif l'étude des effets macroéconomiques des déséquilibres externes et internes, ainsi que l'examen des déterminants de long terme du taux de change.** A cette fin, notre thèse est organisée en trois chapitres. Le premier chapitre se consacre à l'impact de l'adoption de la monnaie unique sur la vulnérabilité du compte courant de la zone euro face aux déséquilibres externes et internes. Le deuxième chapitre s'intéresse à un déterminant particulier fondamental du taux de change, à savoir l'effet Balassa-Samuelson. Le dernier chapitre propose quant à lui d'introduire trois nouveaux déterminants du taux de change, basés sur les infrastructures.

¹³Ces critères sont extraits de la section 3004 de la loi "omnibus trade and competitiveness" de 1988.

¹⁴Le rapport du Département du Trésor américain est disponible sur le lien suivant : <https://home.treasury.gov/system/files/206/2019-05-28-May-2019-FX-Report.pdf>

¹⁵Voir <https://www.imf.org/en/News/Articles/2019/08/13/tr08092019-transcript-of-the-press-conference-on-china-article-iv-consultations-report>

Avant de préciser de façon plus détaillée le contenu de ces trois chapitres, soulignons qu'ils font appel à deux bases de données conçues par nos propres soins : EQCHANGE et RPROD. EQCHANGE (Couharde et al., 2018) est ainsi la première base de données exhaustive sur les taux de change effectifs, mise à disposition gratuitement en ligne. Elle comprend pour la quasi-totalité des pays du monde, des données sur (i) les taux de change effectifs nominaux et réels, et (ii) les taux de change effectifs réels d'équilibre et les mésalignements de change correspondants pour les pays avancés, émergents et en développement. Plus précisément, la première sous-base de données fournit des taux de change effectifs pour 187 pays qui sont calculés selon trois systèmes de pondération différents et deux panels de partenaires commerciaux (186 pays et les 30 principaux partenaires) sur la période 1973-2019. La deuxième sous-base de données fournit des estimations du taux de change d'équilibre comportemental (BEER) et des mésalignements correspondants pour 182 économies au cours de la période 1974-2019. La deuxième base de données que nous avons conçue, la base RPROD (Couharde et al., 2019), est quant à elle centrée sur l'effet Balassa-Samuelson. Elle propose en effet, pour chaque pays inclus dans la base EQCHANGE et par rapport à ses principaux partenaires commerciaux, cinq mesures alternatives de l'effet Balassa-Samuelson: (i) PIB par tête, (ii) productivité du travail, (iii) rapport des prix à la consommation aux prix à la production, (iv) déflateur de la valeur ajoutée basée sur trois secteurs et (v) déflateur de la valeur ajoutée basée sur six secteurs. En mettant à disposition ces différents indicateurs, nous contribuons ainsi aux recherches sur l'effet Balassa-Samuelson et rendons possible la comparaison des estimations de taux de change réels d'équilibre et des mésalignements correspondants selon les mesures.

Le premier chapitre s'intéresse à l'effet du passage à l'euro sur la vulnérabilité du compte courant à des chocs de demande et de mésalignements de change. Il analyse également comment l'adhésion à l'Union Économique et Monétaire affecte la correction des déséquilibres externes dans la zone euro. Pour répondre à ces différentes questions, ce chapitre débute par le calcul du compte courant d'équilibre et du TCEQ pour deux sous périodes : 1980-1998 et 1999-2016. Le TCEQ est obtenu en utilisant l'approche BEER pour laquelle deux déterminants du TCER sont retenus : l'effet Balassa-Samuelson et la position extérieure nette. Puis, un modèle *Panel Vector AutoRegressive* (PVAR) incluant l'*output gap*, le mésalignement de change et le déséquilibre du compte courant¹⁶ est estimé pour un panel de onze pays de la zone euro pour les deux sous périodes. Nos résultats montrent qu'avec l'adoption de la monnaie unique, la vulnérabilité du compte courant aux chocs de demande et de mésalignements de change augmente considérablement. La correction des déséquilibres externes au sein de la zone euro devient également plus difficile en raison de la disparition de la dévaluation comme outil d'ajustement.

Ce premier chapitre inclut le mésalignement de change en tant que variable endogène, calculé comme la déviation du TCER à sa valeur d'équilibre. Cependant, comme le montre le cas chinois, il existe une incertitude entourant l'estimation du TCEQ. Cette incertitude est d'autant plus importante qu'il est reproché à l'approche BEER sa sensibilité aux fondamentaux retenus ; sensibilité renforcée par le fait qu'il n'existe pas de mesure consensuelle pour appréhender l'effet Balassa-Samuelson (BS). Ainsi, un examen détaillé de la robustesse de l'effet BS au choix du proxy revêt une grande importance. Le deuxième chapitre de la thèse analyse en profondeur la robustesse de l'effet BS pour un panel de 38 économies en développement et émergentes sur la période 1980-2016. Cette investigation est fondamentale car, comme le notent Couharde et al.

¹⁶Le déséquilibre du compte courant est calculé comme la différence entre le compte courant observé et sa valeur d'équilibre.

(2018), l'effet BS constitue le principal moteur de la dynamique à long terme du TCER. Cependant, la littérature empirique existante souffre de deux défauts majeurs. Premièrement, elle échoue à contrôler pour la présence de dépendance inter-individuelle dans les données. Deuxièmement, aucune étude systématique sur la robustesse au choix du proxy n'a été effectuée pour les économies en développement et émergentes. Le deuxième chapitre de la thèse se propose donc de dépasser ces limites et d'apporter un éclairage nouveau sur l'effet BS pour ces économies. Nous examinons les versions interne et externe de l'hypothèse BS en nous basant sur cinq mesures différentes de l'effet BS^{17,18}. S'appuyant sur l'estimateur *Cross Sectional-Distributed Lag* (CS-DL), nous montrons que la version interne de l'effet BS n'est vérifiée que si le différentiel de productivité du travail entre les secteurs échangeables et non échangeables est utilisé, plutôt que le PIB par travailleur. Nous trouvons également un effet robuste du prix relatif des biens non échangés par rapport aux biens échangés sur le TCER et identifions les déterminants du prix relatif des biens non échangeables dans les économies en développement et émergentes.

Alors que le deuxième chapitre s'intéresse à la robustesse d'un déterminant du taux de change déjà identifié dans la littérature, le chapitre 3 propose trois nouveaux déterminants du taux de change. Ce chapitre étudie les effets non linéaires des infrastructures sur le TCER pour un échantillon de 31 pays, sur la période 1973-2014. A cette fin, un modèle *Panel Smooth Transition Regression* (PSTR) est estimé, visant à mettre en avant un impact différencié des infrastructures sur le TCER selon la valeur prise par une variable de transition. Nous considérons trois variables de transition différentes : le stock de télécommunications pour 1000 travailleurs, la Capacité de Production d'Electricité (CPE) pour 1000 travailleurs et la qualité du réseau électrique. Cette

¹⁷La version interne de l'effet BS suppose une relation positive entre le différentiel de productivité entre le secteur échangeable et non échangeable et le prix relatif des biens non échangeables.

¹⁸La version externe de l'effet BS est la relation positive entre le prix relatif des biens non échangeables et le TCER.

dernière est mesurée en utilisant les pertes de distribution électrique¹⁹. Nos résultats mettent en évidence la présence d'un impact non-linéaire de la CPE et des télécommunications sur le TCER. Lorsque le réseau n'est pas achevé ou que le stock d'infrastructures est faible, une augmentation des CPE et du stock de télécommunications déprécie le TCER, tandis que la dépréciation supplémentaire est plus faible ou inexistante une fois le réseau établi. Les résultats obtenus sont discutés à la lumière de plusieurs canaux de transmission. Le canal jugé le plus pertinent, pour expliquer les résultats, est celui de la productivité, selon lequel une amélioration du réseau de télécommunications et une hausse des CPE améliorent la productivité marginale des inputs. Cette amélioration réduit le coût unitaire de production, diminuant le niveau des prix domestiques et conduisant à l'apparition d'une dépréciation du TCER. Lorsque le réseau est arrivé à maturité, une augmentation du stock de télécommunications et des CPE ne se traduit pas par une dépréciation supplémentaire car la majorité des gains de productivité est concentrée lors de la phase de construction du réseau. Enfin, en ce qui concerne la qualité du réseau électrique, nous montrons que des pertes d'énergie électrique plus importantes sont associées à une dépréciation du TCER particulièrement marquée lorsqu'elles sont élevées. La qualité du réseau électrique affecte le TCER par l'intermédiaire de deux canaux de transmission antagonistes. Pour faire face à la dégradation de la qualité du réseau électrique, les entreprises mettent en place des mesures d'adaptation qui augmentent leurs coûts de production poussant à la hausse le niveau général des prix. Suivant ce canal des *mesures d'adaptation*, suite à la dégradation du réseau électrique, le TCER devrait se déprécier. Le second canal, intitulé le canal de la *demande*, pose que la chute de revenus occasionnée par une dégradation du réseau électrique réduit la demande dans l'économie. Cette baisse a pour effet de diminuer la demande s'adressant aux entreprises, contribuant à une réduction du niveau général des prix, se traduisant, *in fine*, par une dépréciation de la monnaie domestique.

¹⁹Une hausse des pertes de distribution électrique signifie que le réseau électrique se dégrade.

Nos résultats montrent que le canal de la *demande* domine celui des *mesures d'adaptation*.

Chapitre 1

On the impact of the launch of the euro on EMU macroeconomic vulnerability[†]

[†]Une première version de ce chapitre a été publiée en tant que Document de travail : Morvillier F. (2018), "On the impact of the launch of the euro on EMU macroeconomic vulnerability", Working Paper EconomiX 2018-51. Je suis très reconnaissant envers Valérie Mignon pour ses précieux commentaires et suggestions. Je remercie également Angsar Belke, Jean-Charles Bricongne, Cécile Couharde, Benjamin Egron et Jamel Saadaoui pour leurs remarques et suggestions. Ce chapitre a aussi bénéficié des commentaires des participants à la 16ème journée doctorale Augustin Cournot, à la 36ème journée Internationales d'Economie Monétaire, Bancaire et Financière et au 68ème congrès de l'Association Française de Science Economique. Une première version de ce chapitre a obtenu le prix du meilleur article des journées doctorales Augustin Cournot en 2019.

1.1 Introduction

The adhesion to the Economic and Monetary Union (EMU) of the European Union constitutes an important challenge for the macroeconomic stability of its members countries. Indeed, they lost their monetary policy independence and have only a limited management of their exchange rate policies. Thus, on the one hand, the macroeconomic adjustment of the eurozone members to idiosyncratic shocks becomes harder as they are not able to use their interest rate as a tool. On the other hand, the reduction of external imbalances is also much more complicated as EMU members can not rely on devaluations, leading to additional difficulties to regain lost competitiveness (Gnimassoun and Mignon, 2015; Staehr and Vermeulen, 2018). This is particularly painful for the Southern eurozone countries that widely relied on devaluations during the period preceding the inception of the euro (Fernández-Villaverde et al., 2013; Garcià Solanes et al., 2017).

These different sacrifices were expected to have only limited effects as the launch of the euro should have encouraged widespread structural reforms in the Southern countries (see Fernández-Villaverde et al., 2013), which were not implemented in practice calling for further policies at the present time (see Bénassy-Quéré et al., 2018). Furthermore, the launch of the EMU also caused convergence in interest rates between the core and peripheral countries (Fernández-Villaverde et al., 2013; Honkapohja, 2014; Eichengreen et al., 2014), contributing to the creation of consequent imbalances in the eurozone through a credit boom. At the same time, the inception of the euro is also associated with an increase in the level and persistence of currency misalignments for eurozone members (Coudert et al., 2013).¹ It raises the crucial question of vulnerability of eurozone countries in a situation characterized by an interaction between the internal and external imbalances

¹Currency misalignments are defined as the gap between the real effective exchange rate and its equilibrium level (see *infra*). The correction of this macroeconomic disequilibrium comes at the cost of severe austerity programs, appearing thus as unsustainable as mainly driven by demand compression rather than by an improvement in the fundamentals (Saadaoui, 2018).

(Gnimassoun and Mignon, 2016).

However, only a few contributions exist on the role played by the introduction of the euro on the external imbalances adjustment and vulnerability of the eurozone. Berger and Nitsch (2010) and Lane (2010) show that the inception of the euro is associated with a widening and increasing persistence of intra-euro trade imbalances. The launch of the euro also led to a considerable increase in the level and persistence of current account imbalances (Schoder et al., 2013; Hope, 2016). Furthermore, these disequilibria are more persistent in the case of low overvaluations for the eurozone members (Gnimassoun and Mignon, 2015). However, several crucial questions on the role played by the euro on a variety of issues remain unanswered. How evolves current account vulnerability to demand and exchange rate misalignment shocks? How the adhesion to the EMU affects the correction of external imbalances in the eurozone? Does the relation between internal and exchange rates disequilibria changed since the launch of the single currency?

This chapter aims at answering these different questions through an in-depth empirical analysis over the pre-euro (1980-1998) and EMU (1999-2016) periods. After the computation of current account imbalances on these two sub-periods, we estimate panel Vector Autoregressive (PVAR) models which include output gaps, current account disequilibria and exchange rate misalignment. Our main results are the following. After the inception of the euro, the current account vulnerability to domestic and exchange rate misalignment shocks increases significantly. Furthermore, the advent of the eurozone implies a harder current account correction because of the disappearance of devaluations as adjustment tools.

Our article contributes to the literature in several ways. We adopt a dynamic perspective as we investigate the evolution of vulnerability of the current account to internal and external shocks. Considering the switch from a flexible to a fixed exchange rate regime also allows us to document the role played by the exchange rate regime in the current account adjustment dynamic. In addition, we contribute to the literature studying the roots of current account discrepancies in the eurozone. Indeed, we estimate the relative contributions of the competitiveness and demand channels in the build-up of current account imbalances. Moreover, the possible interaction between demand shocks and Real Effective Exchange Rates (REER) is also tackled thanks to the estimation of the PVAR model.

The rest of our article is organized as follows. Section 1.2 offers an overview of the main drivers of the current account imbalances in the euro area. Section 1.3 provides a brief survey of the key current account determinants for the industrialized economies. The dataset and the methodology implemented are described in Section 1.4. Section 1.5 displays and discusses our econometric results, and also provides some robustness checks. Finally, Section 1.6 concludes the article and gives several policy implications.

1.2 Current account imbalances' drivers in the euro area

The origins of the build-up of current account imbalances within the euro area remain an open question that gave birth to an extensive literature. Several drivers have been identified, but a lack of consensus exists about the main causes of these disequilibria.

1.2.1 Current account imbalances in the euro area: a catching-up process?

The emergence of current account imbalances in the euro area can be potentially driven by the presence of a catching-up process. Indeed, in accordance with standard macroeconomic theory, capital should flow from rich to poor countries because of higher marginal capital productivity in less developed countries. Hence, current account deficits experienced by Southern countries and surpluses for Northern, appear as a "natural process". In line with the previous affirmation, Blanchard and Giavazzi (2002) argue that the apparition of deficits in Greece and Portugal was the result of "good imbalances", rather than "bad imbalances", as they come from high growth prospects leading to higher investment.

In this context, the importance of over-optimistic expectations about future growth is emphasized by Lane and Pels (2012) and Lane (2013). They show that such expectations played a significant role in the apparition of deficits in the Southern euro area countries. Considering an intertemporal current account (ICA) model, Campa and Gavilan (2011) find a similar result. They provide evidence that the creation of the EMU increases expectations of future growth relative to existing output for France, Italy, Portugal and Spain, which worsen their current accounts. Considering also an ICA model, Ca'Zorzi and Rubaszek (2012) investigate the relevance of the catching-up process hypothesis. They show that a "moderate pace of catching-up" explains the divergence in the current accounts' dynamic within the euro area. Using the Gros Domestic Product Per Capita (GDP PC) to examine this hypothesis, Belke and Dreger (2013) find only low support for the existence of a catching-up process.

Decomposing the euro trade balances in two components (intra-euro and extra-euro balances),

Schmitz and Von Hagen (2011) show that, since the introduction of the euro, the elasticity of net capital flows to per capita income increases for euro area countries. However, controlling for additional intra-balance determinants, Niemen (2015) fails to find a similar result.

1.2.2 Domestic demand and credit booms

The launch of the single currency led to a significant shift in the macroeconomic environment faced by the eurozone members, explaining the emergence of credit and demand booms. Indeed, the elimination of the exchange rate risk interlinked with an accommodating monetary policy result in a large drop of interest rates for the peripheral members (Fernández-Villaverde et al., 2013) which converge to the level of the core countries (Fernández-Villaverde et al., 2013; Honkapohja, 2014; Eichengreen et al., 2014). This evolution has been pointed out to be at the roots of the build-up of current account imbalances in the euro area (Barnes, 2010; Holinski et al., 2012; Honkapohja, 2014).

The abundance of cheap money for the Southern countries fuels a credit boom which deteriorates their current account balances (Honkapohja, 2014; Hale and Obstfeld, 2016). More precisely, the flows of bank loans to the non financial private sector impact negatively the current account position of the euro area countries over the period 1999-2013 (Unger, 2017). This additional liquidity was mainly used in an unproductive manner in the non-tradable sector (Eichengreen, 2010; Giavazzi and Spaventa, 2011; Lane, 2013), contributing thus to explain why the strong housing investment is an important determinant of the current account deficits for Spain and Ireland over the last decade (Barnes et al., 2010).

The role of domestic demand booms is also emphasized by Comunale and Hessel (2014) who

study the relative importance of the financial cycle and competitiveness channel in the shape of current account imbalances in the euro area. Using a panel error-correction model, they conclude that domestic demand booms driven by the financial cycle are at the root of current account imbalances in the eurozone. Finally, Sanchez and Varoudakis (2013) also find that the sharp increase in demand leads to a worsening of current accounts for monetary union members.

1.2.3 Competitiveness channel

The role played by the competitiveness channel in the build-up of current account imbalances remains a question widely discussed in the literature. Loss of competitiveness is seen as a consequence of the domestic demand booms and not as the cause of the current account imbalances (Gros, 2012; Gaullier and Vicard, 2012; Wyplosz, 2013).

While weak evidence in favor of the competitiveness channel are found (Sanchez and Varoudakis, 2016; Staehr and Vermeulen, 2018), Belke and Dreger (2013) show that the lack of competitiveness is the main explanation for rising European current account imbalances. Their result is confirmed by Arghyrou and Chortareas (2008) and Comunale and Hessel (2014) who find a negative impact of the REER on the current account balances. Durcova and Mirdala (2017) also provide evidence that the external competitiveness determinants were the main driver of current account imbalances before the crisis.

Gnimassoun and Mignon (2016) are interested in the effects of currency misalignments within the euro area. They show that a rise in overvaluations leads to a worsening of the current account. Based on panel causality tests, they also establish a strong and robust causal link from overvaluations to current-account imbalances.

1.3 Current account determinants in industrialized countries: an overview

Since the beginning of the 2000s, we observe a resurgence of global imbalances in the world economy, underlining the importance of understanding current account dynamics. International institutions such as the International Monetary Fund (IMF) and the European Commission have developed methodologies to monitor current accounts' evolutions. The first institution relies upon the External Balance Assessment² (EBA) methodology (2012), to document current account developments in 49 countries.³ Turning to the European Commission, it has implemented the Macroeconomic Imbalance Procedure (MIP, 2011) to look at macroeconomic imbalances' evolutions in the European Union, including the current account imbalances. As can be seen from the renewed interest of institutions for current account balances, identifying their determinants remains a crucial point.

Given the important numbers of potential current account determinants, we rely on the Bayesian Model Averaging (BMA) approach to select the most relevant ones. In the following, we present the different potential current account determinants by focusing only on determinants specific to industrialized countries.⁴ Furthermore, we do not consider short-run determinants as we are interested in imbalances arising in the medium to long term.

The empirical literature mainly uses structural equations which are estimated relying on the saving-

²The EBA approach succeeds to the Consultative Group on Exchange Rate Issues methodology in 2012.

³To this aim, the EBA approach uses a wide range of current account determinants such as structural factors, financial factors and cyclical factors in panel regressions.

⁴Some current account determinants are relevant only for developing countries and we do not consider such variables (see Calderón et al., 2002 for a survey.)

investment approach.⁵ By definition:

$$CA = S - I = S^P + S^G - I \quad (1.1)$$

$$CA = S^P + T - G - I \quad (1.2)$$

Where CA is the current account, S denotes national savings and I stands for national investment. S^P (resp. S^G) denotes private (resp. government) savings. T and G set for the government current receipts and G government current expenditures, respectively.

As can be seen from equations (1.1) and (1.2), the variables affecting both investment and savings decisions can be potential current account determinants. Let us now review the set of those possible determinants.

1.3.1 Borrowing constraints channel

Jappeli and Pagano (1994) argue that regulation can lead to borrowing constraints for households with a potential effect on the current account. In the following, we present the main determinants used to assess the borrowing constraints channel and its impacts.

1.3.1.1 Financial development

Several proxies are employed to investigate the role of financial development on the current account.⁶ Chinn and Ito (2008) use the private credit to GDP ratio, while Ca'Zorzi et al. (2012) rely upon the sum of foreign assets and liabilities.⁷ From a theoretical point of view, the effect

⁵In this approach, most of the variables are computed as the deviation from the main trading partners (Lane and Milesi-Ferretti, 2012).

⁶The impact of financial openness has also been investigated. Chinn and Ito (2013) show that a raise in the Chinn-Ito index improves the current account, while Saadaoui (2015) obtains an opposite result.

⁷Another proxy frequently used is M2 to GDP ratio (see Gnimassoun and Mignon, 2015).

of financial development on the current account is ambiguous. On the one hand, higher financial development may increase possibilities to save (Barnes et al., 2010, Ciocyte and Rojas-Romagosa, 2015) due to a larger availability of financial instruments (Moral-Benito and Roehn, 2016). On the other hand, the relaxation of the borrowing constraints reduces precautionary savings (Mendoza et al., 2009; Lane, 2010) and raises investment, impacting negatively the current account. Thus, the relationship between both variables is not clearcut. Based on an overlapping-generations model with households facing liquidity constraints, Jappelli and Pagano (1994) show that such constraints rise saving by interacting with growth. This is confirmed by the fact that a rise in the Loan To Value (LTV) ratio⁸ leads to a decline in net national savings. More recently, Chinn and Prasad (2003) and Cheung et al. (2013) fail to find a significant effect of financial deepening on a sample of industrialized countries, while Gninaassoun and Mignon (2015) provide only weak evidence for this channel.

1.3.1.2 Financial (de-)regulation

Financial (de-)regulation encompasses different aspects going from credit controls to security markets regulation.⁹ Financial deregulation can influence current account balances in several ways. As suggested above, it can reduce precautionary savings but could also increase savings by lowering "transaction costs, offering a wider range of saving instruments" (Moral-Benito and Roehn, 2016). Relying on a BMA approach, Moral-Benito and Roehn (2016) provide evidence that financial regulation constitutes a relevant determinant for a sample of 30 industrialized and emerging countries. Different aspects of financial (de-)regulation present differentiated effects on the current

⁸The LTV ratio is defined as the ratio between the Mortgage Amount and the appraised value of a property. A rise in this ratio is interpreted as a strengthening of the borrowing constraints faced by households as a higher LTV leads to a higher down payment, resulting in an increase in forced savings.

⁹In their article, Moral-Benito and Roehn (2016) use different variables to take into account several aspects of regulation: credit controls, bank entry barriers, privatization of the banking sector, prudential regulation and supervision of the banking sector and securities market regulation.

account. In line with the borrowing constraints view, they find that easing bank entry barriers worsen the current account, while deregulating securities markets and privatizing banks have a positive impact.¹⁰

1.3.2 Demographics

Countries' demographic profiles can affect the current account by their influence on domestic savings. The life cycle theory proposed by Modigliani (1966) allows us to understand the effect of a modification in the age distribution on savings' behaviour. Indeed, young (resp. active) people have a negative (resp. positive) saving rate, while retired households dissave. The importance of such determinant is confirmed by Higgings (1998) showing a strong effect of demographics on the current account.¹¹ In the following, we present the main determinants used to investigate demographics' influence.

1.3.2.1 Ageing speed

The ageing speed is a "relatively new" current account determinant due to Lane (2010).¹² Ageing speed is measured as the "expected change in the old-age dependency ratio in the future" (Lane and Milesi-Ferretti, 2012).¹³ This variable is able to influence the current account as a population getting old more rapidly tends to save more (Lane and Milesi-Ferretti, 2012). It constitutes a relevant determinant for the current account dynamics as illustrated by Lane and Milesi-Ferretti (2012), IMF (2013), Tressel and Wang (2014) and Gnimassoun and Mignon (2015) who find a significantly positive coefficient.

¹⁰The explanation is that these reforms enhance private savings, contributing positively to the current account.

¹¹It should be noted that demographic profiles matter for the current account as soon as they differ across countries (Chinn and Prasad, 2003).

¹²He identifies a significantly negative effect of this variable on the Net Foreign Asset position, justifying the use of this variable as a potential current account determinant.

¹³Contrary to Lane and Milesi-Ferretti (2012), Lane (2010) defined ageing speed as the difference between current working-age population and the projected future working-age population. This different methodology explained the counter-intuitive sign obtained in his article.

1.3.2.2 Dependency ratio

A higher dependency ratio (ratio of people younger than 15 or older than 64 to the working-age population) leads to an increase in consumption relative to income which reduces private savings. This determinant should exert a negative influence on the current account. Barnes et al. (2010) provide evidence that the dependency ratio presents the expected sign found in the literature (see Chinn and Prasad, 2003; Jaumotte and Sodsriwiboon, 2010; Cheung et al., 2013). However, over the period 1969-2008, Lane and Milesi-Ferretti (2012) fail to find support for this determinant.

1.3.2.3 Old dependency ratio

According to the life cycle hypothesis, the old dependency ratio (ratio of people older than 64 years to the working-age population) could negatively impact the current account, as older people tend to deplete their savings. Kamin and Gruber (2007) and Jaumotte and Sodsriwiboon (2010) confirm Modigliani (1966)'s view as they show that a higher old dependency ratio worsens significantly the current account. On a sample of 22 industrialized countries, Gninaassoun and Mignon (2015) find no support for this determinant.

1.3.2.4 Population growth

A higher population growth is expected to deteriorate the current account because of the lack of savings among the very young (Gninaassoun and Mignon, 2015). Furthermore, a rise in the fertility rate increases the future labor force, which can foster foreign investment and then worsen the current account (Ciocyte and Rojas-Romagosa, 2015). As expected, Gninaassoun and Mignon (2015) show that a rise in population growth relatively to the main trading partners has a strongly significant and negative effect on the current account. Considering 11 euro area countries, Decressin and Stavrev (2009) find a similar result.

1.3.2.5 Young dependency ratio

An increase in the young dependency ratio (ratio of people younger than 15 years to the working-age population) can be interpreted as a rise in the future labor force, increasing investment. So, it should weaken the current account balance. Restricting their sample to industrialized countries, Chinn and Prasad (2003) show that the young dependency ratio is only weakly negatively significant. Barnes et al. (2010) find contrasted evidence for this determinant as a rise in the young dependency ratio can both worsen or improve the current account balance.

1.3.3 Economic development

Countries at different stages of development present different growth prospects. Such heterogeneity can have differentiated impacts on their current accounts. In the following, we review the main variables used to investigate the economic development channel.

1.3.3.1 Economic growth

A high growth rate is associated with higher expected incomes which increase current consumption at the expense of savings. As a rise in future demand is expected, domestic investment follows the same path. So, it is expected that greater economic growth worsens the current account. However, from an empirical point of view, economic growth does not constitute a robust current account determinant (Barnes et al., 2010); Kamin and Gruber (2007) and Decressin and Stavrev (2009) finding only weak evidence for this variable.

1.3.3.2 Gross Domestic Product Per Capita (GDP PC)

According to standard economic theory, low-income countries should run current account deficits while rich countries are expected to experience surpluses. High investment opportunities in poor

countries favorize capital inflows going from rich to low-income countries. Hence, it is expected that an increase in GDP PC improves the current account balance. This determinant is found to be robust among different specifications (Barnes et al., 2010). On a sample of industrialized countries, Giavazzi and Blanchard (2002), Kamin and Gruber (2007) and Chinn and Ito (2008) find that higher GDP PC is associated with a higher current account position.

1.3.3.3 Squared relative income

Squared relative income is used to investigate the "stage of development hypothesis" (Debelle and Faruquee, 1996; Roldos, 1996). Following this hypothesis, the GDP PC-current account relationship is expected to take the form of an U-shaped curve.¹⁴ In other words, low income countries run current account deficits while rich countries experience a surplus. Masson al. (1998), Chinn and Prasad (2003) and Cheung et al. (2013) present no support for this hypothesis as a significantly negative sign is obtained for the squared relative income.¹⁵

1.3.3.4 Productivity

Productivity shocks are one of the main determinants of the current account (Glick and Rogoff, 1995; Bussière et al., 2010). Temporary and permanent shocks have differentiated impact on the current account. Following Gossé and Serranito (2014), a permanent productivity shock negatively impacts the current account as higher productivity rises investment because of higher return to capital. Moreover, the expectation of higher yields decreases savings. Considering a temporary and positive productivity surge, it should improve the current account as this shock raises the output. To assess the importance of this determinant, Gossé and Serranito (2014) rely upon labor productivity in the total economy and GDP PC. With the second proxy, they find a significantly

¹⁴To investigate this hypothesis, GDP PC and its squared value are used as regressors of the current account. To validate the "stage of development hypothesis", GDP PC and relative income squared must be positively signed.

¹⁵This result is rather in line with the Lucas' paradox as an inversed U-shape is obtained.

negative effect of productivity on the current account, while a rise in labor productivity improves it. Contrary to Gossé and Serranito (2014), Gnimassoun and Mignon (2015) failed to find support for this determinant.

1.3.4 International environment

The international environment faced by a country can affect its current account by influencing its capacity to repay its external debt.

1.3.4.1 Long term interest rate

The long term interest rate affects both domestic savings and investment, but antagonist effects are at play. To discuss the mechanism beyond this variable, we follow Obstfeld and Rogoff (chapter 1, 1996) and distinguish three effects of the interest rate on the current account:

- Substitution effect: A rise in the interest rate increases the opportunity cost of present consumption. Hence, it should cause substitution toward future consumption, improving the current account.

- Income effect: A rise in the interest rate leads to an increase in the feasible consumption pushing people to raise current consumption, reducing their saving rate. Following the income effect, a rise in the interest rate should negatively impact the current account.

- Wealth effect: A rise in the world real interest rate lowers the market discount factor and, therefore, the present value of lifetime income. This negative wealth effect acts to reduce present consumption and to improve the current account.

In addition to the effect on households, investment is also penalized by a rise in the interest rate. As stressed above, the substitution effect and the wealth effect tend to improve the current account balance, while the income effect goes in the opposite direction. Hence, the sign of the long term interest rate is ambiguous. Barnes et al. (2010) find strong support for this determinant showing that long term interest rate positively affects the current account. Belke and Dreger (2013) also confirm this result showing that a rise in this variable increases the surplus of the euro area countries, except for the deficit members where the inverse is observed.

1.3.4.2 Net foreign asset (NFA) position

To understand the effect of NFA on the current account, we use the augmented balance of payment identity which sets:

$$CA_t = \underbrace{(NFA_t - NFA_{t-1})}_{\text{NFA variation}} - VE_t \quad (1.3)$$

CA_t is the current account balance at year t and VE_t stands for the valuation effects. NFA_t (resp. NFA_{t-1}) denotes the NFA position of a country at year t (resp. year $t-1$). As can be seen from equation (1.3) a year to year improvement in the NFA position should positively impact the current account.

However, Ciocyte and Rojas-Romagosa (2015) argue that the NFA effect on the current account is ambiguous. On the one hand, as a higher NFA position rises the net investment incomes, it improves the external position. On the other hand, it also increases resources available in the economy which can deteriorate the current account. The empirical literature shows that the positive effect largely outweighs the negative one, as an improvement in the NFA ameliorates the

current account position (see Chinn and Prasad, 2003; Chinn and Ito, 2008; Gninaassoun and Mignon, 2015; among others).

1.3.5 Fiscal policy: government budget balance

The government budget balance¹⁶ constitutes a key determinant of the current account position (Chinn and Ito, 2008; Bussière et al., 2010; Moral-Benito and Roehn, 2016). From a theoretical point of view, the government budget balance-current account nexus receives important considerations (see Sachs, 1981 ; Frenkel and Razin, 1986; Glick and Rogoff, 1995; among others). Sachs (1981) stresses the importance of distinguishing between temporary and permanent shocks in the government deficits as different effects can arise from both shocks. The relevance of this distinction is confirmed by Glick and Rogoff (1995) who show that a temporary increase in budget deficits leads to a deterioration of the current account while a permanent rise has no effect.¹⁷ Allowing for the presence of non-Ricardian behavior, Bussière et al. (2010) find that country-specific innovations in the primary government balance may affect the current account position.

The link between both variables can be apprehended through the "twin deficits hypothesis", according to which a government deficit translates into a trade balance deficit (see Bernheim, 1998 for a discussion). To better understand this hypothesis, we consider the following national income accounting identities:

$$Y = C + S^P + T \tag{1.4}$$

¹⁶This variable is suspected by Fair (2017) to be an endogenous regressor. To argue about the possible endogeneity of government spendings, he considers a negative consumption shock which reduces income and thus leads to a reduction in government savings. It is worth noting that this potential endogeneity has been tackled by the IMF in its EBA approach by instrumenting government budget balance by several variables as the output gap, the lagged world cyclically adjusted fiscal balance and the exchange rate regime.

¹⁷A permanent rise in government spending will be fully offset by a permanent reduction of consumption.

$$Y = C + I + G + (X - M) \quad (1.5)$$

Combining equations (1.4) and (1.5) and simplifying, it comes:

$$\underbrace{T - G}_{\text{Budget surplus}} = \underbrace{(X - M)}_{\text{Trade balance}} + I - S^P \quad (1.6)$$

Y stands for income, C for consumption, T for taxes and S^P for private savings. Equation (1.6) states that government budget surplus is the sum of 2 components, namely the trade balance and the difference between investment and private savings.

Assuming no modification in investment and private savings, equation (1.6) shows that a reduction in the government budget surplus leads to a deterioration of the trade balance in line with the twin deficits hypothesis. More precisely, in the absence of Ricardian equivalence,¹⁸ a 1% increase in the budget balance leads to a lowering of the current account of 1% (else things being equal).¹⁹ Controlling for the presence of structural breaks, Katrakilidis and Trachanas (2013) find strong support for the twin deficits hypothesis for four Eurozone countries. More recently, Litsios and Pilbeam (2017) also validate this hypothesis showing the existence of a cointegration relationship between fiscal balance and the current account in Greece, Portugal and Spain.

1.3.6 Labor market

The extent to which the labor market is regulated can influence countries' current account position.

Regulation can affect household savings' behaviour and also domestic and foreign investment.

¹⁸Ricardian equivalence (Ricardo, 1817 and Barro, 1974) sets that the effect of a rise in the government budget balance can be offset by private households' reaction. In fact, under several assumptions, they increase their savings to face the future increase in taxations coming from the present increasing deficit.

¹⁹Generally, the presence of Ricardian behaviour is empirically confirmed as the government budget balance's coefficient is frequently below 1.

1.3.6.1 Ratio of minimum wage to mean wage

The ratio of minimum wage to mean wage matters for the current account through its effect on countries' competitiveness (Ivanova, 2012). Indeed, a higher minimum wage may hurt competitiveness by increasing labor costs. Considering a sample of 49 advanced and emerging countries, Jaumotte and Sodsriwiboon (2010) show that higher minimum wage lowers the current account. On a sample of OECD countries, Ivanova (2012) confirms this finding.

1.3.6.2 Social protection level

The level of social protection offered by a country can influence household savings' behaviour. The relevance of this determinant is investigated using public health expenditures (IMF, 2013; Tressel and Wang, 2014), or the gross unemployment replacement rate (Ivanova, 2012). IMF (2013) and Tressel and Wang (2014) show that higher public health expenditures significantly lower the current account by reducing the need for precautionary savings. Relying on the gross unemployment replacement rate to proxy social protection policy, Ivanova (2012) finds a somewhat different result. She provides evidence that a rise in this variable improves the current account arguing that it encourages precautionary savings.²⁰

1.3.6.3 Structural rigidities

The presence of structural rigidities in the labor market plays on firms' incentive to invest in the home economy. Substantial rigidities can discourage foreign investment and then improve the current account balance. In the empirical literature, investigation concerning this determinant receives only a little attention. This channel has been explored by Barnes et al. (2010) using the

²⁰She argued that, according to the empirical literature, increasing gross unemployment replacement rate leads to a higher unemployment rate and increases the probability of becoming unemployed. Hence, to face this rising risks, households increase their savings.

Non Accelerating Inflation Rate of Unemployment (NAIRU) to proxy for the structural rigidities. As expected, they find that a rise in the NAIRU helps to ameliorate the external position.

1.3.7 Macroeconomic uncertainty

While macroeconomic uncertainty seems to be considered as a quite new current account determinant;²¹ Gosh and Ostry (1997) have already proposed a model allowing to deal with its effects. They show that a rise in uncertainty about "national cash flow" increases precautionary savings improving, in turn, the current account.

1.3.7.1 Standard deviation of the real GDP

From an empirical point of view, Fogli and Perri (2015) measure uncertainty as the standard deviation (SD) of countries' quarterly real GDP from the average of SD over a ten years interval,²² while Brzozowski and Prusty (2013) simply use the SD of real GDP growth. Fogli and Perri (2015) show that a rise in volatility relatively to the trading partners improves countries' NFA position. Their empirical result is also encompassed in a standard macroeconomic model allowing for precautionary motive. Brzozowski and Prusty (2013) find a somewhat similar result on a sample of 19 OECD countries, higher uncertainty improving the current account position.

1.3.7.2 Terms Of Trade (TOT) volatility

TOT volatility²³ can be used to proxy macroeconomic uncertainty. This determinant impacts the current account through several mechanisms. Households facing more volatile TOT might save more for precautionary reasons in order to smooth their consumption streams (Chinn and Prasad,

²¹Besides the variables detailed in the following, note that macroeconomic uncertainty can also be measured using the Jurado et al. (2015) index and the VXO stock market volatility index of Bloom (2009).

²²In the next section, we detail the computation of the uncertainty proxy proposed by Fogli and Perri (2015).

²³TOT volatility is generally computed as the standard deviation of the TOT index as in Chinn and Prasad (2003). It can also be estimated using a Generalized AutoRegressive Conditional Heteroskedasticity (GARCH(1,1)) model (see Bleaney and Greenaway, 2001).

2003). At the same time, domestic investment can decrease as higher uncertainty is synonym of riskier investment. Moreover, countries facing volatile TOT are also less attractive to capital flows. All in all, a positive sign is expected for this variable. In the empirical literature, only mixed evidence for this determinant is present. Chinn and Prasad (2003) find that higher TOT volatility worsens the current account position, while Chinn et al. (2013) show that the external position is unaffected.

1.3.8 Trade integration

Trade integration covers several aspects which can affect current account dynamics. It can influence the capacity of a country to repay its external debt and its vulnerability to external shocks. In the following, we review the main variables used to investigate the relevance of trade integration.

1.3.8.1 Terms Of Trade

The use of the Terms Of Trade (TOT)²⁴ as a current account determinant relies upon the well-known Harberger-Laursen-Metzler (HLM hereafter) effect (1950). Considering a small Keynesian open economy, they show that a rise in TOT improves the current account: an amelioration in TOT increasing domestic output, it leads to a rise in private savings because of a propensity to consume less than unity. Considering a large number of small open economies, Otto (2003) finds support for the HLM effect. On the contrary, Bouakez and Kano (2008) show no significant effect of TOT fluctuations on the current account in Australia, Canada and the United Kingdom.²⁵

²⁴Terms of trade are defined as the ratio of export prices to import prices.

²⁵See Singh (2007) for a survey on intertemporal optimizing models of trade and current account balances.

1.3.8.2 Trade openness

Higher trade openness can be interpreted as lifting trade barriers which increase countries' attractiveness and investment opportunities (Gomes et al., 2017). Furthermore, Chinn and Prasad (2003) argue that more open economies have a higher capacity to generate foreign exchange earnings through exports, signalling a better ability to service external debt. Thus trade openness' sign is ambiguous because of these two opposite effects. In the empirical literature, it is shown that the second effect prevails over the first one, as a rise in openness improves current account balances (see Chinn and Ito, 2008; Lane and Milesi-Ferretti, 2012 ; Gninaassoun and Mignon, 2015; among others).

1.3.9 Institutional quality

Institutional quality can impact the current account by affecting domestic savings, but also domestic and foreign investment. Several mechanisms are at play. An improvement in institutional quality should increase countries' attractiveness for foreign investments (Gninaassoun, 2015). Moreover, better protection of property rights can worsen the current account balance as it reduces uncertainty (Ciocyte and Rojas-Romagosa, 2015) diminishing the need for precautionary savings. Following De Santis and Lührmann (2008), Ca'Zorzi et al. (2012) argued that a positive sign is expected for this determinant as "legal rights, functioning markets and efficient institutions should all ease access to international capital markets". From an empirical point of view, civil liberties are used to measure institutional quality (see Ca'Zorzi et al., 2012; Gninaassoun, 2015). Relying on a BMA approach, Ca'Zorzi et al. (2012) provide evidence that civil liberties constitute a robust current account determinant and is positively signed. Hence, according to them, better institutional quality helps to improve the current account position.

1.3.10 Oil dependency

Countries' oil dependency can affect the current account as oil balance is one of its components. This determinant should also have a differentiated impact depending on whether the economy under consideration is a net-oil importer or net oil-exporter. Using a BMA approach, Ca'Zorzi et al. (2012) and Moral-Benito and Roehn (2016) show that oil balance belongs to the robust current account drivers. This finding is confirmed by several studies (Decressin and Stavrev, 2010; Gossé and Serranito, 2014; Gnimassoun and Mignon, 2015) showing that an amelioration in the oil balance improves the current account. As highlighted above, it is essential to distinguish between net exporters and importers.²⁶ For net oil exporters (resp. importers), a rise in the oil price translates into an increase (resp. decrease) in oil balance, improving (resp. worsening), in turn, their current account position. Considering a panel of 91 countries over the period 1984-2009, Hufington (2015) provides evidence that net oil exports are a significant factor in explaining current account surpluses, but that net oil imports influence current account deficits only for relatively rich countries. Finally, it is worth mentioning that, as shown by Couharde et al. (2014), the effect of oil price on oil exporters' current account depends on the degree of financial development.

1.3.11 Dummy variables

In the empirical literature, dummy variables are sometimes used to control for the occurrence of different events such as financial crises and major structural changes. In the following, we briefly present the main dummies used and their relevance.

²⁶See Morsy (2009) for the current account determinants specific to oil-exporting countries.

1.3.11.1 Euro area

To control for the effect of the adoption of the euro and the adhesion to the EMU, Barnes et al. (2010) and Jaumotte and Sodwisroom (2010) use several dummy variables in their regressions. Barnes et al. (2010) show that the adoption of the euro by the peripheral countries boosts their deficits, while there is no significant effect for the core countries.²⁷ Jaumotte and Sodwisroom (2010) find a similar result on the first group of countries, but provide evidence that euro's adoption by Northern countries has significantly negatively impacted their current accounts. They also show that adhesion to the EMU improves current account balances for Northern countries, while there is no effect for Southern economies.

1.3.11.2 Financial and banking crises

On the one hand, financial and banking crises negatively impact the current account by affecting countries' ability to finance their external deficits (Ca'Zorzi et al., 2012). On the other hand, they can disrupt the access to capital markets and improve the current account balance (Lane and Milesi-Ferretti, 2012). Hence, the sign expected for this determinant is ambiguous. According to Kamin and Gruber (2007), the occurrence of financial crises significantly lowers the current account.

1.4 Data and methodology

1.4.1 Empirical strategy

In the empirical strategy detailed below, the procedure used to compute current account imbalances is applied to the 1980-1998 and 1999-2016 sub-samples. The same holds for the panel unit root

²⁷Barnes et al. (2010) used the following classification for core (Austria, Belgium, France, Germany, Italy, Luxembourg and the Netherlands) and peripheral countries (Finland, Greece, Ireland, Portugal, Slovak Republic and Slovenia).

tests and the estimation of PVAR models.

1.4.1.1 Current account imbalances computation

First step: Selection of the robust current account determinants

As illustrated by our overview of the potential current account determinants, there is substantial uncertainty surrounding model's specification. To tackle this uncertainty, we rely on the Bayesian Model Averaging (BMA) procedure to select the most relevant variables.²⁸ The determinants found to be robust are then used in the second step. We consider two sub-samples (1980-1998 and 1999-2016) as the switch to the euro, as well as the modification of the macroeconomic environment faced by countries are likely to modify the forces beyond the current account dynamic. Hence, using results issued from the application of the BMA approach over the whole period can lead to misleading results for both sub-periods.

Second step: Structural current account regressions

As highlighted in the literature (Lane and Milesi-Ferretti, 2012; Cheung et al., 2013; Gninaou, 2015; Gninaou and Mignon, 2015), it is not the evolution of the current account which matters but its deviation from its equilibrium level. Thus, we compute the medium term equilibrium level after having regressed the current account on its determinants obtained from the previous step:

$$CA_{i,t} = \alpha + f_t + \beta X_{i,t} + \epsilon_{i,t} \quad (1.7)$$

i stands for country and t for time. $CA_{i,t}$ denotes the current account (in % of GDP), $X_{i,t}$ is the vector of current account determinants, f_t is temporal dummy variable and $\epsilon_{i,t}$ is an i.i.d error term.

²⁸The methodological choices, as well as the list of determinants retained, are detailed in the next subsection.

Following the usual practice in the context of current account regressions, equation (1.7) is estimated relying on the pooled Ordinary Least Squares (OLS) estimator (see Chinn and Prasad, 2003; Chinn and Ito, 2007; Gruber and Kamin, 2007; Lane and Milesi-Ferretti, 2012; Gninaassoun and Mignon, 2015; Coulibaly, Gninaassoun and Mignon, 2018; among others).²⁹ This estimator is widely used because, as shown by Chinn and Prasad (2003), a substantial part of current account variations arises from cross-section variations. In such a context, using the within estimator is inadequate as it sweeps out these variations by removing the cross-sectional means. Another important feature is the presence of strong current account autocorrelation (IMF, 2013) which could affect our results if not properly taken into account. Following the IMF (2013) and Moral-Benito and Viani (2017), we use the Feasible Generalized Least Squares (FGLS) estimator with an AR(1) autocorrelation structure for the error term.³⁰

Third step: current account equilibrium computation

The third step of our empirical strategy consists to compute the current account equilibrium using the results from the FGLS estimations.³¹ The current account medium term equilibrium level, denoted $\overline{CA}_{i,t}$ is computed as follows:

$$\overline{CA}_{i,t} = \widehat{\beta^{FGLS}} * Z_{i,t} \quad (1.8)$$

$\widehat{\beta^{FGLS}}$ is the estimated vector of coefficients of the current account determinants and $Z_{i,t}$ denotes

²⁹See Desbordes et al. (2018) for a discussion on the relevance to pool individuals in the context of current account regressions.

³⁰To deal with current account autocorrelation, its lagged value can be used as a regressor. However, inclusion of the lagged endogenous variable leads to the well-known Nickell's bias (1981) and also to potential endogeneity issues. To deal with the first issue, estimators correcting for this bias can be used (see Kiviet (1995) for example). Although correcting for Nickell's bias, such estimators do not correct for endogeneity issues and, most importantly, endogeneity issues may arise as the lagged current account and its determinants are included in the same regression. This potential endogeneity issue can be solved relying on the Generalized Method of Moments (see Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998). Given our panel, this methodology is not appropriate as it is mostly designed for panel data where the individual dimension is superior to the temporal one.

³¹We exploit the results arising from the FGLS estimator, rather than the pooled OLS estimator as the former allows us to take into account autocorrelation in the current account.

the significant current account determinants.

Fourth step: Current account imbalances computation

The last step involves the computation of current account imbalances, denoted $CA_{i,t}^D$. Using results from the previous step, we get:

$$CA_{i,t}^D = CA_{i,t} - \overline{CA_{i,t}} \quad (1.9)$$

As the current account disequilibrium is viewed as a temporary process, the current account imbalance is normalized so that its mean equals 0 over the period under consideration.

1.4.2 Methodology

1.4.2.1 Bayesian Model Averaging (BMA) procedure

The starting point of the BMA methodology is to consider a linear regression model as follows:

$$Y = X\beta + \epsilon \quad (1.10)$$

Where Y is the vector of the dependent variable, X the matrix of explanatory variables and β ($q \times 1$) contains the q parameters to be estimated. ϵ stands for the error term which is i.i.d and normally distributed. Assuming that it is possible to set some components of β to be equal to zero, there is a set of 2^q candidate models to be estimated indexed by M_j for $j=1, \dots, 2^q$. The posterior distribution for β given the data D , denoted as $P(\beta|D)$, calculated using M_j is computed as follows:

$$P(\beta|D) = \sum_{j=1}^{2^q} P(\beta|D, M_j)P(M_j|D) \quad (1.11)$$

$P(M_j|D)$ is the posterior model probability for model j , given data D .

As can be seen from equation (1.11), the posterior density is a weighted average of the posterior model probabilities for all models including a given variable weighted by the posterior model probability for all models.

Using Bayes rule and for a given prior model probability ($P(M_j)$), the posterior model probability for model M_j is given by:

$$P(M_j|D) = \frac{P(D|M_j)P(M_j)}{\sum_{j=1}^{2^q} P(D|M_j)P(M_j)} \quad (1.12)$$

This posterior model probability for a given model can be seen as a measure of relative data fit (Moral-Benito and Roehn, 2016) and is used to compute the posterior inclusion probability (PIP). More specifically, it is computed as the sum of the posterior models' probabilities for all the models including a variable X_k :

$$PIP = P(\beta_k \neq 0|D) = \sum_{\beta_k \neq 0} P(M_j|D) \quad (1.13)$$

The PIP for a variable can be interpreted as the probability attached to models that include the variable X_k . To rank the potential growth determinants according to their relevance, we refer to the classification proposed by Raftery (1995).³² More generally, a PIP over 0.50 indicates a

³²According to Raftery (1995), a PIP between 0.75 and 0.95 denotes positive evidence of a regressor having an effect. A PIP between 0.95 and 0.99 denotes very strong evidence and a PIP over 0.99 denotes a decisive evidence of a regressor.

robust variable.

The BMA methodology requires the specification of a prior on the model and parameter space.³³ Concerning the prior on the parameter space, we follow Fernández et al. (2001a) and use the Risk Inflation Criterion (RIC) and the Unit Information Prior (UIP). For the model space, we consider an uniform prior assuming that every model has the same *a priori* probability (see Fernández et al., 2001b for example). Following Ley and Steel (2009), we also specify a binomial beta prior as it allows us to reduce the sensitivity of the posterior model probabilities compared to the uniform prior (Moral-Benito, 2015).

1.4.2.2 Panel unit root tests

The estimation of the PVAR model requires stationarity of the considered variables. We apply three different panel unit root tests: the Levin, Lin and Chin (LLC) test (2002), the Im, Pesaran and Shin (IPS) test (2003) and the CIPS test proposed by Pesaran (2007). LLC is a three step procedure testing the null hypothesis of unit root among each individual time-series, against the alternative that each time-series is stationary (Baltagi, 2008). As noted by Baltagi (2008), this test is restrictive in the sense that it is based on the assumption of homogeneity across individuals. To overcome this limit, we also perform the IPS test to control for heterogeneity. While in the case of the LLC test the coefficient associated to the autoregressive coefficient is homogeneous, the IPS test allows for a heterogeneous coefficient. Under the null hypothesis, all the individuals have a unit root, while under the alternative hypothesis some individuals may have a unit root.

LLC and IPS belong to the first generation of panel unit root tests which is based upon the

³³A large panel of priors has been proposed by the literature (see Moral-Benito (2015) for a survey).

assumption of independence across individuals. As in practice this assumption can be violated, we also implement the CIPS test which controls for the presence of cross section dependence (CSD). The method proposed by Pesaran (2007) consists to augment the usual Augmented Dickey–Fuller regression with the lagged cross-sectional mean and its first-difference, allowing to capture the presence of CSD. As an alternative to the CIPS test, we also ride out potential CSD by subtracting the cross section means.

1.4.2.3 Panel Vector Autoregressive approach

The PVAR model can be seen as a combination of (i) the traditional Vector AutoRegressive (VAR) which treats all variables as endogenous and interdependent and (ii) a cross-sectional dimension. The reduced PVAR model is defined as follows :

$$Y_{i,t} = \alpha_i + \Gamma(L)Y_{i,t} + \epsilon_{i,t} \quad (1.14)$$

where i ($i=1,\dots,N$) denotes the country, and t ($t=1,\dots,T$) the time. $Y_{i,t}$ stands for the vector of endogenous variables, $\Gamma(L)$ represents the matrix polynomial in the lag operator L , α_i is the country fixed effects and $\epsilon_{i,t}$ the vector of error terms.

A maybe strong assumption behind the PVAR model is that all individuals share the same underlying process. As in practice, this assumption could be violated (Love and Zicchino, 2006), we include country fixed effects to control for unobserved heterogeneity. As we have a dynamic panel data model, the fixed effects estimator is inconsistent (see Nickell, 1981). To overcome the Nickell’s bias, we use the generalized method of moments (Arellano and Bond, 1991 and Blundell and Bond, 1998) suitable for dynamic panel data specifications. This approach uses the lagged

endogenous variables as well as their first difference as instruments. The fixed effects are removed using the Helmert procedure/forward orthogonal deviation procedure (Arellano and Bover, 1995). It consists to subtract the mean of the remaining future observations available in the sample and to equalize the variance. This transformation allows us to use the lagged regressors as instruments as orthogonality between the transformed variables and lagged regressors is conserved. Moreover, to check the validity of these instruments, we apply the Hansen test. To be able to interpret our Impulse Response Functions (IRFs), we use the Cholesky decomposition which requires to order the VAR variables from the most exogenous to the most endogenous ones. As discussed earlier, our PVAR model encompasses three different variables: output gap ($OG_{i,t}$), current account imbalances ($CA_{i,t}^D$) and currency misalignments ($MIS_{i,t}$). Considering these three variables, our PVAR model is specified as follows:

$$Y_{i,t} = (OG_{i,t}, CA_{i,t}^D, MIS_{i,t})' \quad (1.15)$$

Given our ordering, the output gap impacts contemporaneously the current account gap and the misalignment. We assume that the misalignment is the most endogenous variable because as in Gnimassoun and Mignon (2015), it is jointly determined by the productivity through the Balassa-Samuelson effect, and by the external position (NFA). Thus, it depends crucially on the current account and output gap. Furthermore, we assume that the output gap affects contemporaneously the current account misalignment. This assumption is relevant as it is the excess demand booms which fuel the current account imbalances in the euro area (Sanchez and Varoudakis, 2013. Comunale and Hessel, 2014), justifying the second place devoted to this variable. The optimal lag numbers are selected using the usual information criteria (Akaike information criterion and Bayesian information criterion). Then, we derive the orthogonalized IRF and also perform a vari-

ance decomposition analysis. This latter allows us to show the percent of the variation in one variable that is explained by the shock to another variable, accumulated over time.

1.4.3 Data

1.4.3.1 The sample

Our sample is composed of eleven countries, namely Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain, which joined the EMU in 1999, except Greece in 2001. Our dataset spans from 1980 to 2016.

1.4.3.2 Current account determinants

A detailed description of the data sources, as well as additional information about the variables, are available in Table 1.A.1 in Appendix.³⁴ The current account position (% GDP) is extracted from the Organisation for Economic Co-operation and Development (OECD) and from the World Economic Outlook (WEO) provided by the IMF. Demographic and economic development determinants³⁵ are extracted from the World Development Indicators (WDI) database of the World Bank, except the ageing speed. As in Lane and Milesi-Ferretti (2012), ageing speed is defined as the difference between the prediction of the old age dependency ratio in $t+20$ and the actual dependency ratio. The prediction of the old age dependency ratio comes from the United Nations population projections. The long term interest rate and the government budget balance are issued from the OECD. The instrumental variable for the government budget balance, extracted from IMF (2013), is obtained with the following variables: lagged world cyclically adjusted fiscal bal-

³⁴Due to data availability issues, the following current account determinants cannot be considered: financial regulation variables, gross unemployment replacement rate, health expenditures, labor productivity, M2 to GDP ratio, NAIRU, private credit to GDP ratio and ratio of minimum wage to mean wage.

³⁵Our set of demographic and economic development determinants include the following variables: the young and old dependency ratio, the dependency ratio and the population growth, the GDP PC, the squared GDP PC and the growth rate of GDP PC.

ance, the exchange rate regime, the polity index, GDP per capita, lagged U.S. corporate credit spread, lagged world growth, lagged output gap, lagged world output gap, and the time average of fiscal balance.³⁶ The lagged NFA (% GDP) position is extracted from the Lane and Milesi-Ferretti database (2007). The civil liberties index comes from the Freedom House. The Terms Of Trade (TOT) are taken from the OECD. The trade openness, calculated as the sum of exports and imports (% GDP), arises from the WDI database. The financial and banking crisis dummies are constructed using the Laeven and Valencia (2012) database. Following Gruber and Kamin (2007), these dummies are set to one during the crisis year and in the two following years, and zero otherwise. A dummy to discriminate between Northern and Southern euro area countries is also created. This dummy is equal to 1 for Northern countries, 0 otherwise.³⁷ Capital account openness is extracted from the Chinn and Ito (2006) database. Using Lane and Milesi-Ferretti database (2007), we compute financial integration as the sum of assets and liabilities (% GDP). To proxy macroeconomic uncertainty, we use TOT volatility and GDP relative volatility. TOT volatility is estimated using a GARCH(1,1) model (Bleaney and Greenaway, 2001). GDP relative volatility's computation follows Fogli and Perri (2015). Denoting $s(t)$ the first quarter of year t and let $g_{i,s}$ be the log difference of real GDP of country i between quarter s and $s-1$. Macroeconomic relative volatility in country i at year t , denoted as $\sigma_{i,t}$ is computed as follows:

$$\sigma_{i,t} = \left(\sum_{j=-20}^{+20} g_{i,s(t)+j}^2 - \overline{g_{i,s(t)}} \right)^{1/2} \quad (1.16)$$

where $\overline{g_{i,s(t)}} = \frac{1}{41} \sum_{j=-20}^{+20} g_{i,s(t)+j}$

³⁶This instrumental variable is only available from 1986 (1999 for Ireland) to 2013.

³⁷The Northern countries are: Austria, Belgium, France, Finland, Germany, and the Netherlands. Southern is composed of the following economies: Italy, Ireland, Greece, Portugal and Spain.

GDP relative volatility, denoted $\sigma_{i,t}^r$ is then given by:

$$\sigma_{i,t}^r = \sigma_{i,t} - \frac{1}{N(t)} \sum_{j \neq i} \sigma_{j,t} \quad (1.17)$$

where $N(t)$ indicates the number of countries that have an observation for volatility in year t .

Quarterly GDP series used in the computation are extracted from OECD.³⁸ As the indicator obtained is quarterly, we average it year by year to obtain usable series. GDP relative volatility series are displayed in Figure 1.C.2 in Appendix.

Oil dependency is approximated using the oil balance (% GDP), which is computed using the net oil trade from the International Energy Agency (IEA), the crude oil prices from British Petroleum (BP) and GDP series from OECD. As noticed in the previous section, some variables have to be expressed as a deviation from the weighted average trade partners series as it is the evolution relatively to the rest of the world which matters (Moral-Benito and Roehn, 2016).³⁹ For each country, we consider the top fifteen trading partners. Time-invariant weighting scheme representative of foreign trade between 2008-2012 from the Centre D'études Prospectives Et D'informations Internationales (CEPII) is used (Couharde et al., 2018).

Concerning the data required to estimate the Equilibrium Exchange Rates (EER), we extract the REER from the EQCHANGE database (Couharde et al., 2018) as well as the proxy for the Balassa-Samuelson (BS, hereafter) effect using time invariant trade weights representative of the 2008-2012 period. Finally, output gap is taken from the OECD and WEO databases.

³⁸Due to data availability, our computation is based on the following list of commercial partners: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea republic, Luxembourg, Mexico, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Thailand, Turkey, the United Kingdom and the United States of America.

³⁹See Table 1.A.1 in the Appendix for the list of variables computed in relative terms.

1.4.3.3 Computation of currency misalignments

Currency misalignments are estimated relying on the Behavioral Equilibrium Exchange Rate (BEER) approach proposed by Clark and MacDonald (1999) based on the existence of a long run, cointegrating relationship between the REER and its long term determinants. Following Alberola et al. (1999), Alberola (2003) and Coudert et al. (2013) a stock-flow consistent model is estimated :

$$reer_{i,t} = \mu_i + \beta_1 rprod_{i,t} + \beta_2 NFA_{i,t} + \epsilon_{i,t} \quad (1.18)$$

Where μ_i stands for country-fixed effects. $reer$ is the logarithm of the REER. $rprod$ is the logarithm of a proxy for the BS effect.⁴⁰ NFA denotes the Net Foreign Asset position (% GDP). As previously discussed, two PVAR models are estimated. Hence, to obtain consistent misalignments, equilibrium exchange rates are estimated over the 1980-1998 and 1999-2016 periods. As in Couharde et al. (2018), we perform the estimations relying on the Pooled Mean Group (PMG) estimator (Pesaran et al., 1999) which allows the short-run coefficients and error variances to differ across countries. Results are available in Table 1.B.1 and in Figure 1.C.4 in the Appendix.

As shown in Table 1.B.1, the error correction term is significant at the 1% level and negatively signed confirming the mean-reverting behaviour of the REER. Regardless of the sub-samples considered, the coefficient of the proxy for the BS effect is correctly signed, a rise in relative productivity leading to an exchange rate appreciation. The relation between NFA and REER is less clearcut with significant differences between both sub-periods. On the one hand, before the launch of the common currency, a 1% improvement in the NFA position is associated with a REER depreciation

⁴⁰The BS effect is proxied using countries' relative GDP PC in Purchasing Power Parity (see Couharde et al., 2018).

of 0.205%. Assuming that the portfolio of the home country agents is mainly composed of domestic assets, the REER can depreciate through an increasing demand for foreign currency. On the other hand, our estimation over the 1999-2016 period shows that a rise in the NFA appreciates the REER in line with Ricci et al. (2013)'s findings. Considering an economy intertemporal budget constraint, an improvement in the NFA resulting in a build-up of current account surplus has to be associated with an appreciation of the currency to restore equilibrium through an adjustment of the trade balance. Finally, our results also point out a faster adjustment toward equilibrium over the pre-euro area period.

1.5 Econometric results

Section 1.5.1 presents the findings of the BMA analysis. Section 1.5.2 discusses the current account regressions results and the computation of the current account imbalances is presented in Section 1.5.3. Finally, we display and discuss in Section 1.5.4 the results of our PVAR estimations.

1.5.1 BMA results

1.5.1.1 BMA results: 1980-1998 period

Table 1.1 below displays the results of the BMA methodology over the 1980-1998 period. Among our initial set of twenty-one current account determinants, seven emerge as robust, i.e. having a PIP over 0.50. Our estimations provide very strong support for including GDP relative volatility, while TOT volatility presents a very low PIP. We confirm the decisive role of the oil balance in the current account dynamic as previously evidenced (Ca'Zorzi et al., 2012; Gnimassoun, 2015; Moral-Benito and Rohen, 2016) with a PIP almost equals to 1 in the different specifications.

Our estimations also corroborate the great influence of the government budget balance and

Table 1.1 Posterior Inclusion Probabilities: 1980-1998

Model prior	Random	Random	Fixed	Fixed	Uniform
Parameter prior	UIP	RIC	UIP	RIC	UIP
Posterior Inclusion Probability					
GDP relative volatility	1.000^a	1.000^a	1.000^a	1.000^a	1.000^a
Oil balance	1.000^a	0.999^a	0.999^a	0.999^a	0.999^a
Government budget balance	0.691	0.696	0.570	0.572	0.699
Lagged NFA	0.687	0.689	0.654	0.652	0.702
Population growth	0.659	0.668	0.500	0.493	0.661
Real interest rate	0.531	0.545	0.293	0.298	0.532
GDP PC	0.525	0.543	0.226	0.235	0.524
Dependency ratio	0.473	0.493	0.273	0.277	0.469
Squared GDP PC	0.424	0.446	0.149	0.149	0.427
Kaopen	0.398	0.412	0.192	0.195	0.423
Young dependency ratio	0.386	0.378	0.283	0.285	0.392
TOT	0.369	0.378	0.192	0.190	0.381
Crisis	0.361	0.363	0.215	0.218	0.367
Old dependency ratio	0.291	0.301	0.171	0.183	0.295
Ageing speed	0.269	0.277	0.090	0.099	0.270
TOT volatility	0.227	0.231	0.109	0.101	0.232
Openness	0.212	0.214	0.108	0.099	0.210
Growth	0.170	0.169	0.063	0.064	0.168
Financial integration	0.168	0.175	0.075	0.083	0.179
Civil liberties	0.161	0.163	0.061	0.062	0.176
Euro dummy	0.153	0.152	0.058	0.055	0.155

Note: The results are based on 100.000 burn-ins and 200.000 draws. Simulations are made using birth-death MCMC sampler. "^a" denotes a PIP over 0.99 and decisive evidence of a regressor. Numbers in bold denote PIP over 0.50 and evidence of robustness. RIC=Risk Inflation Criterion. UIP= Unit Information Prior. We use the BMS (Feldkircher and Zeugner, 2015) package.

lagged NFA. Considering the set of demographic determinants, population growth appears as the only relevant one. We also find support for the long term interest rate as it displays a PIP over 0.50 in three of our five specifications. Our initial set of potential determinants also includes variables related to countries' economic development. Among them, only GDP PC appears as a

robust variable, while the influence of the relative income (squared and growth) is not supported. Furthermore, during the pre-euro area period, TOT and openness do not belong to the decisive current account determinants. The relevance of the financial development channel is also invalidated as illustrated by the small PIP of financial integration. Moreover, the BMA methodology infirms the influence of the financial and banking crises and the relevance of the financial openness. Finally, the euro area dummies and the civil liberties index are the two variables displaying the lower PIP.

1.5.1.2 BMA results: 1999-2016 period

Table 1.2 below displays our results regarding the 1999-2016 period. A first striking result is the presence of both notable similarities and divergences between the two sub-periods. Such differences confirm thus our methodological choice. We start our discussion by highlighting the similarities between the two sub-periods under consideration. As previously, we find support for the inclusion of government budget balance, lagged NFA, population growth and GDP relative volatility. All these determinants have a PIP over 0.75 confirming their relevance. Moreover, three of these four variables present higher PIP than over the period 1980-1998. Again, the oil balance robustness is confirmed by our estimations as this determinant has a PIP over 0.50 in three of our five specifications.

One major difference with the previous estimations is the disappearance of the long term interest rate and GDP PC as decisive current account determinants. They displayed a PIP ranging from 0.115 to 0.469. Contrary to the pre-EMU period, the young dependency ratio and the openness ratio have a strong influence on the external position. This result is in line with Moral-Benito and Roehn (2016) who also provide strong support for the trade integration channel. We note the

Table 1.2 Posterior Inclusion Probabilities: 1999-2016

Model prior	Random	Random	Fixed	Fixed	Uniform
Parameter prior	UIP	RIC	UIP	RIC	UIP
Posterior Inclusion Probability					
Population growth	1.000^a	1.000^a	1.000^a	1.000^a	1.000^a
Lagged NFA	0.997^a	0.996^a	0.995^a	0.995^a	0.997^a
Government budget balance	0.982^a	0.978^a	0.972^a	0.964^a	0.982^a
Young dependency ratio	0.981^a	0.983^a	0.945^b	0.945^b	0.986^b
GDP relative volatility	0.929^b	0.926^b	0.784^b	0.801^b	0.929^b
Openness	0.907^b	0.904^b	0.775^b	0.769^b	0.898^b
Oil balance	0.688	0.665	0.374	0.358	0.674
Old dependency ratio	0.672	0.656	0.641	0.624	0.662
Squared GDP PC	0.609	0.606	0.340	0.342	0.614
Dependency ratio	0.602	0.608	0.445	0.454	0.599
Ageing speed	0.578	0.563	0.224	0.214	0.577
Crisis	0.552	0.549	0.249	0.271	0.561
Kaopen	0.526	0.528	0.275	0.275	0.523
GDP PC	0.469	0.456	0.220	0.216	0.440
Real interest rate	0.431	0.417	0.115	0.116	0.423
Financial integration	0.398	0.391	0.105	0.113	0.410
TOT volatility	0.341	0.335	0.093	0.095	0.343
TOT	0.326	0.317	0.093	0.091	0.327
Growth	0.295	0.292	0.090	0.091	0.296
Euro dummy	0.275	0.275	0.071	0.066	0.271
Civil liberties	0.273	0.275	0.079	0.065	0.285

Note: The results are based on 100.000 burn-ins and 200.000 draws. Simulations are made using birth-death MCMC sampler. "^a" denotes a PIP over 0.99 denotes and decisive evidence of a regressor. "^b" indicates a PIP between 0.75 and 0.95 denoting a positive evidence of a regressor having an effect. Numbers in bold denote PIP over 0.50 and evidence of robustness. RIC=Risk Inflation Criterion. UIP= Unit Information Prior. We use of the BMS (Feldkircher and Zeugner, 2015) package.

proliferation of variables having a PIP over 0.50 as soon as a fixed prior for the model space is not considered. More precisely, among our initial set of determinants, thirteen fulfill this criterion.⁴¹

Thus, our results provide indications of robustness for the demographic channel as illustrated by

⁴¹The relevance of the inclusion of all these variables in our regressions is discussed further in the article.

the PIP of the ageing speed, dependency ratio and old dependency ratio. Finally, contrary to the pre-euro period, the capital account openness and the crisis dummy seem to constitute relevant variables as illustrated by their PIP.

1.5.2 Current account regressions

To investigate the robustness of our findings to potential endogeneity issues, we consider three different specifications. Our first specification includes all the determinants obtained thanks to the BMA methodology, except GDP relative volatility. Indeed, as shown by Fogli and Perri (2015) this variable is a driver of the NFA position leading to a potential model misspecification if both variables are included simultaneously.⁴² Our second specification augments the first one with the GDP relative volatility. Finally, as stressed by the IMF (2013) and Fair (2017), the government budget balance is suspected to be an endogenous regressor. To tackle this potential endogeneity, our third specification replaces the government budget balance with its instrumental variable provided by the IMF (2013). These three different models are estimated using pooled OLS and FGLS estimators.

1.5.2.1 Current account regressions: 1980-1998 period

Table 1.3 below presents the results of our current account regressions for the 1980-1998 period. Our first specification shows that only lagged NFA is a significant current account determinant. Its significance and effect are almost unaffected by the inclusion of GDP relative volatility. Indeed, considering our first specification, a 1% increase in the lagged NFA improves the current account position by 0.067% against 0.077% if GDP relative volatility is included. Our results are consistent with Gninafon and Mignon (2015)'s findings who get a coefficient equals to 0.055 for this

⁴²This misspecification is likely to be mitigated as we use the lagged NFA rather than its present value.

variable. Thus, the interaction between lagged NFA and GDP relative volatility seems not to be a crucial issue.

Table 1.3 CA regressions 1980-1998

	Pooled OLS	Pooled OLS	Pooled OLS	FGLS	FGLS	FGLS
	(1)	(2)	(3)	(4)	(5)	(6)
Government budget balance	0.0511 (0.0377)	0.0248 (0.0345)		0.0462** (0.0194)	0.0428** (0.0186)	
Instrumental variable			0.0365 (0.140)			0.0331 (0.0816)
Lagged NFA	0.0677*** (0.0119)	0.0777*** (0.0119)	0.0679*** (0.0165)	0.00576 (0.0107)	0.0111 (0.00988)	-0.0167 (0.0104)
Relative volatility		-0.0586*** (0.0117)	-0.0543*** (0.0134)		-0.0440*** (0.0125)	0.0454*** (0.00601)
Oil balance	0.386 (0.314)	0.415 (0.315)	-0.835 (0.638)	0.942*** (0.187)	0.996*** (0.183)	1.778*** (0.508)
Population growth	-0.155 (0.243)	-0.461 (0.290)	-0.219 (0.377)	0.0712 (0.118)	-0.0579 (0.117)	-0.0525 (0.103)
GDP PC	0.0355 (0.0990)	0.0671 (0.0961)	0.230* (0.125)	0.0828*** (0.0293)	0.0706** (0.0290)	0.0502** (0.0251)
Real interest rate	-0.0548 (0.112)	-0.0919 (0.106)	-0.365** (0.148)	-0.109*** (0.0405)	-0.110*** (0.0402)	-0.112*** (0.0319)
Constant	2.896*** (1.095)	3.204*** (1.107)	0.528 (1.238)	0.161 (0.297)	0.333 (0.304)	1.095* (0.571)
Observations	209	209	127	209	209	90
R-squared	0.401	0.445	0.317			
Number of countries	11	11	11	11	11	10
Time series dummies	YES	YES	YES	YES	YES	YES

Note: ***, **, and * denote the levels of statistical significance at 1, 5, and 10%, respectively. Robust standard errors are reported in parentheses. Coefficients in bold denote estimations used in the computation of the current account imbalances.

Furthermore, strong evidence in favor of the uncertainty channel is supported by results in

columns (2), (3), (5) and (6) showing that GDP relative volatility worsens the current account position. This result contradicts Fogli and Perri (2015)'s findings showing that higher uncertainty leads to an improvement in the NFA position.⁴³ However, our result is consistent with Chinn and Prasad (2003) finding that TOT volatility improves the current account position for a sample industrialized economies.

Once government budget balance endogeneity is addressed, GDP PC and long term interest rate become significant current account drivers (see column (3)) presenting the expected sign.⁴⁴ In line with previous studies (Chinn and Ito, 2008; Barnes et al., 2010), our third specification shows that higher GDP PC is associated with an improvement in the current account position as richer countries tend to run current account surpluses. Contrary to Barnes et al. (2010), a higher long term interest rate lowers the current account. From a theoretical perspective, this result suggests the dominance of the income effect over the wealth and substitution effects discussed in the Section 1.3. Surprisingly, considering regressions (1) and (2), the government budget balance and the oil balance are not correlated with the current account. After having addressed the issue of autocorrelation (columns (4) and (5)), both determinants turn out to be significant. A 1 % increase in the government budget balance, relatively to the main trading partners, improves the current account position by 0.0428 %. As Jaumotte and Sodsriwiboon (2010), Gossé and Serranito (2014) and Gnimassoun and Mignon (2015), an improvement in the oil balance has a positive effect on the external position. We also find evidence of a very strong effect for this determinant, a 1% increase in the oil balance enhances the current account by 0.966% consistent with the consequent crude oil price fluctuations over the 1980-1998 period. Indeed, the sharp decrease of crude oil prices between

⁴³To our best knowledge, this is the first time that this proxy is used in current account regressions.

⁴⁴It is difficult to know if this difference between the second and third estimations comes from endogeneity as the instrument substantially reduces the number of observations available for this sub-period.

1985 and 1986 improves significantly the oil balance of euro area countries (see Figure 1.C.5 in Appendix), allowing them to ameliorate their current account position. Finally regressions (1) to (6) show no significant effect of population growth on the current account position.

1.5.2.2 Current account regressions : 1999-2016 period

Table 1.4 displays the results associated with the current account regressions on the post-euro period. As the number of variables found to be robust is high, we follow Desbordes et al. (2018). We only consider as relevant the determinants having a PIP over 0.75. The justification behind this methodological choice is twofold. First of all, our preference goes to a more parsimonious specification as it allows us to track more easily the origins of the current account equilibrium's evolution. Secondly, the inclusion of this large set of variables can also be the source of high collinearity between our regressors, especially the demographic ones. Using them simultaneously is a major issue as the dependency ratio is directly used in the computation of the ageing speed.

As previously, the interaction between lagged NFA and relative volatility does not affect the effect of lagged NFA (see columns (1.1) and (2.2)). As discussed earlier, a higher GDP relative volatility lowers the current account position. Compared to the previous estimations, the effect of the uncertainty channel seems to be greater after the inception of the euro with a coefficient ranging from -0.0575 to -0.116. The regression (2.2) shows that all our variables are significant except openness, which becomes significant as soon as endogeneity is tackled. In line with Chinn and Prasad (2003)'s intuition, a higher openness relatively to the main trading partners improves the current account position by 0.0426%. This regression also shows that a 1 % increase in the population growth leads to a deterioration of the current account of 2.413%.⁴⁵ The young de-

⁴⁵This estimation is very close to that reported in Gninaoune and Mignon (2015) who find a marginal effect ranging from a low of 2.714 to a high of 2.829.

Table 1.4 CA regressions 1999-2016

	Pooled OLS	Pooled OLS	Pooled OLS	FGLS	FGLS	FGLS
	(1.1)	(2.2)	(3.3)	(4.4)	(5.5)	(6.6)
Government budget balance	0.600** (0.235)	0.541*** (0.187)		0.0317 (0.0396)	0.0892** (0.0448)	
Instrumental variable			0.918*** (0.198)			0.619*** (0.119)
Lagged NFA	0.0230** (0.00920)	0.0285*** (0.00719)	0.0356*** (0.0110)	-0.00619 (0.00437)	0.00959* (0.00491)	-0.00444 (0.00403)
GDP relative volatility		-0.116*** (0.0217)	-0.0682*** (0.0237)		-0.0575*** (0.0140)	-0.0683*** (0.00898)
Population growth	-1.270*** (0.373)	-2.413*** (0.444)	-2.095*** (0.419)	-0.316** (0.132)	-0.691*** (0.175)	-0.902*** (0.122)
Young dependency	-0.384*** (0.0997)	-0.220** (0.0888)	-0.269** (0.118)	-0.0316 (0.0204)	-0.0235 (0.0237)	-0.0612*** (0.0201)
Openness	0.0850*** (0.0235)	0.0323 (0.0212)	0.0426* (0.0251)	0.00443 (0.00550)	-0.00104 (0.00631)	0.00729 (0.00445)
Constant	6.524*** (1.353)	8.302*** (1.212)	5.229*** (1.474)	2.150*** (0.301)	5.059*** (0.323)	4.165*** (0.341)
Observations	198	198	165	198	198	165
R-squared	0.386	0.496	0.531			
Number of countries	11	11	11	11	11	11
Time series dummies	YES	YES	YES	YES	YES	YES

Note: ***, **, and * denote the levels of statistical significance at 1, 5, and 10%, respectively. Robust standard errors are reported in parentheses. Coefficients in bold denote estimations used in the computation of the current account imbalances.

pendency ratio is negatively correlated with the external position because of the low propensity to save among the very young. Compared to our estimation over the pre-euro area period, we find evidence of a stronger effect of government budget balance consistent with Katrakilidis and Trachanas (2013) and Litsios and Pilbeam (2017)'s findings. A 1% increase in the government budget balance, relatively to the main trading partners, improves the current account by 0.0892%

(0.0428% for the pre-euro period). More interestingly, our results are robust to potential endogeneity arising from the government budget balance. Indeed, our variables remain significant and their coefficients are not strongly affected by this issue. Finally, the government budget balance instrumental variable displays high significance among our different regressions (columns (3.3) and (6.6)).

1.5.3 Current account imbalances computation

1.5.3.1 Current account imbalances before the launch of the euro

As detailed in the empirical strategy, the current account equilibrium is computed as follows:

$$\overline{CA}_{i,t} = \widehat{\beta^{FGLS}} * Z_{i,t}$$

Using the results from column (5) extracted from Table 1.3, we get:

$$\begin{aligned} \overline{CA}_{i,t} = & 0.0428 * Gov_{i,t} - 0.0440 * Volatility_{i,t} + 0.996 * Oilb_{i,t} + 0.0706 * GDP\ PC_{i,t} \\ & - 0.110 * rir_{i,t} \end{aligned} \tag{1.19}$$

Where GOV denotes the government budget balance, Volatility the GDP relative volatility, Oilb the oil balance, and rir the real interest rate. The current account position, its equilibrium level and the corresponding misalignment values are available in Figure 1.C.4 in the Appendix. We also display the evolution of the fitted fundamentals to understand the current account equilibrium's behaviour. A first observation is the presence of mainly negative current account equilibrium values explained both by the fundamentals' coefficients and by their values. GDP relative volatility and the long term interest rate negatively influence the current account. They also take a large majority of positive values which drive the equilibrium into a negative position. Although the net lending and the oil balance display positive coefficients, they also contribute to push down

the current account equilibrium because of the majority of negative values for both determinants. Only GDP PC pushes up the current account equilibrium.

Let us now briefly present the current account equilibrium evolutions common to all countries. At the beginning of the 1980s, we note the presence of high negative values ranging from -7% for Portugal to around -4% for France, explained by a strongly negative oil balance coming from the second oil shock in 1979.⁴⁶ Few years later, we observe a significant improvement in countries' oil balance explained by the shrink in oil prices explaining the convergence of the current account equilibrium around 0.

1.5.3.2 Current account imbalances after the launch of the euro

Using estimation in column (5.5) from Table 1.4, the current account equilibrium is given by:

$$\overline{CA}_{i,t} = 0.0892 * Gov_{i,t} + 0.00959 * NFA_{i,t} - 0.0575 * Volatility_{i,t} - 0.691 * popg_{i,t} \quad (1.20)$$

where popg denotes the growth rate of the population. The observed current account, its equilibrium, the current account imbalances and the fundamentals are available in Figure 1.C.5 in the Appendix.

As for the previous period, the large majority of current account equilibrium estimates present negative values explained by the combination of negative coefficients and positive values for the variables. The inverse combination is also relevant to understand the sign of this variable. More precisely, in addition to its positive effect, NFA mainly takes negative values except for Belgium,

⁴⁶The crude oil price has been multiplied approximately by 2.7 between 1978 and 1980.

Germany and the Netherlands. At the same time, the government budget balance as well as the population growth rate display negative values. All in all, this contributes to the existence of a negative equilibrium.

Concerning the current account equilibrium dynamic, we note a sizeable difference between the core and the periphery. The former presents quasi-systematically lower current account equilibrium values than the latter. Greece, Portugal and Spain experience largely negative equilibrium current accounts fluctuating around 2%. Greece experiences a sharp decrease following the subprime crisis. This divergence between these two groups of countries has two main explanations. On the one hand, Southern economies have higher budget deficits pushing down their current account equilibrium. On the other hand, they also rely more on foreign economies to finance their current account deficits.

1.5.4 PVAR analysis

1.5.4.1 Panel unit root tests

Panel unit root tests results are presented in Table 1.B.2 in the Appendix. The first generation of panel unit root tests (IPS and LLC) are suitable for a panel dataset where there is no CSD. Thus, both tests are applied on current account imbalances and currency misalignments as cross-sectional mean has been removed from these variables. As shown in Table 1.B.2, LLC and IPS tests both indicate that the current account imbalances and currency misalignments are stationary on the two sub-samples.⁴⁷

Concerning the pre-euro area period, the CIPS test shows that the output gap is stationary,

⁴⁷One exception is the current account misalignment for which the IPS test (model with a trend and a constant) concludes to the presence of a unit root.

except the model with a constant. Moreover, the LLC test also indicates that the output gap is stationary. Turning to the post-euro area period, we find only low evidence of stationarity for the output gap as the CIPS test fails to reject the null hypothesis although the output gap is stationary over the 1980-2016 period. As soon as the first difference of the output gap is employed, our tests show that this variable is stationary. Hence, to tackle possible instability in our PVAR model, we consider the first-difference of output gap in our estimation over the 1999-2016 period.

1.5.5 IRFs and variance decomposition

This section is devoted to the presentation of our PVAR results.⁴⁸ The IRFs are available in Figure 1.1 below and the variance decomposition results are displayed in Table 1.5. Considering the pre-euro area period, the IRF shows a weakly negative effect of an output gap shock on the current account imbalances. In other words, an economy overheating deepens the current account deficits during a very short time period explaining almost 6% of the variance. Following the introduction of the euro, the role played by the demand shock is reinforced. Over the 1999-2016 period, there is evidence of a negative and more lasting effect of the output gap on external imbalances. Our findings are in line with previous studies (Lane and Pels, 2013; Phillips et al, 2013; Gninafon and Mignon, 2016) and are explained in light of two sets of mechanisms. On the one hand, an economy with limited resources facing rising internal demand is expected to increase its imports because of the inability of national firms to satisfy this growing demand. Thereby, this negatively affects the current account position through the trade balance. On the other hand, an overheating is associated with lower savings and higher investment deepening the current account deficits (Phillips et al., 2013).⁴⁹ The switch to the euro also significantly increases the contribution of the domestic overheating to the current account disequilibria variance, allowing us to explain 10.97%

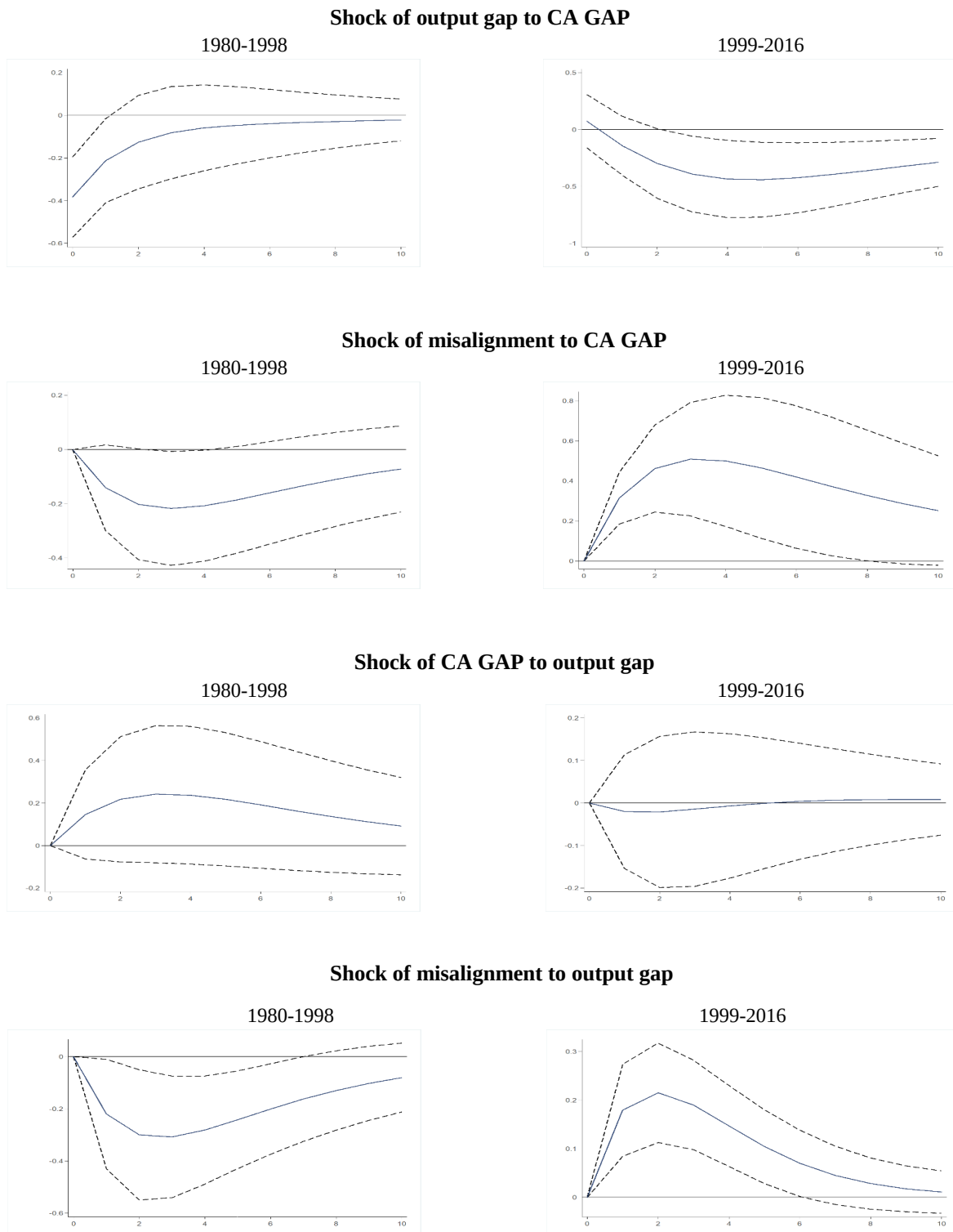
⁴⁸One lag has been retained for the estimation, as suggested by usual information criteria.

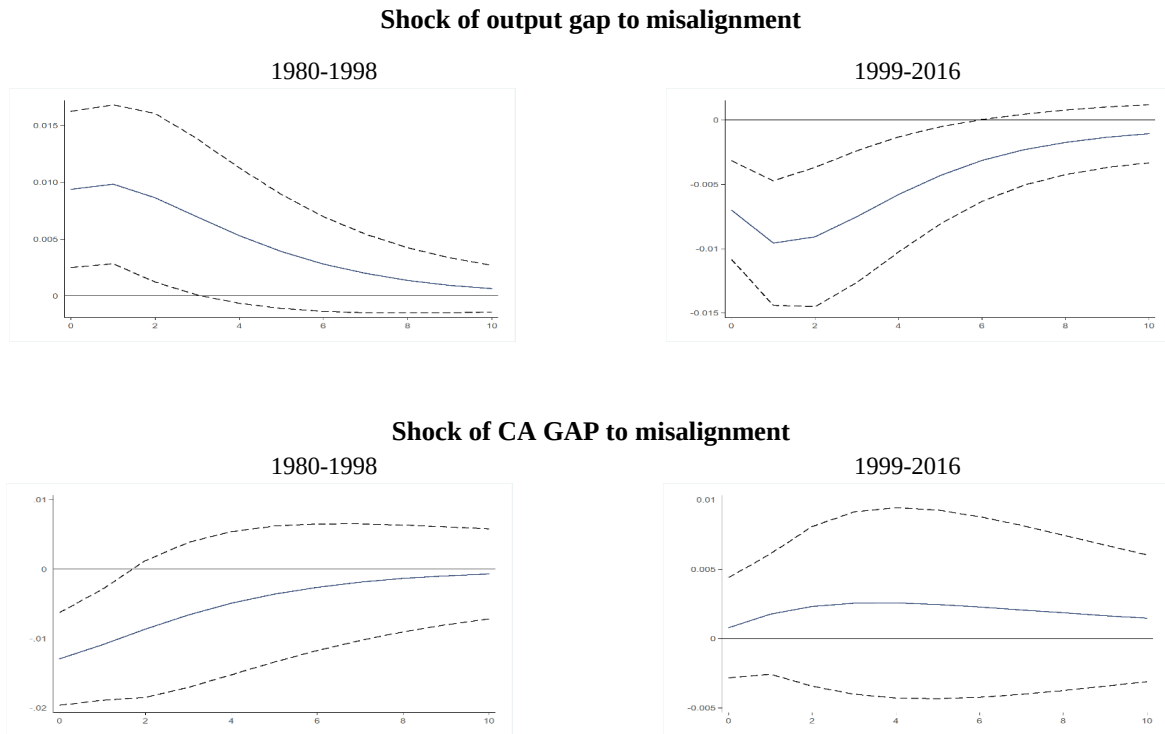
⁴⁹This mechanism mainly operates through an adjustment of domestic investment which is more volatile than domestic savings.

of its variation. Thus, our PVAR estimation confirms the major role played by the demand channel in the build-up of external imbalances in the euro area (Comunale and Hessel, 2014). All in all, our results show an increasing vulnerability of the current account to demand shocks as euro area members lost their ability to change their interest rate.

The switch to the euro also drastically influences the adjustment of the current account to a misalignments shock. While on the 1980-1998 period, misalignments have no effect, they become the most important driving force beyond the build-up of external imbalances in the euro area explaining 12.9% of their variation. More specifically, a higher misalignment is associated with a current account improvement. Such results can not be understood in light of the trade channel which sets that a higher misalignment hurts competitiveness, affecting negatively the external position through a deterioration of the trade balance. Several arguments can be put forward to explain the reduction of the relevance of this channel over the euro area period. First of all, the launch of the common currency fosters intra-euro area trade reducing the relevance of this channel for monetary union members. Moreover, as noticed by Gaulier and Vicard (2012), current accounts and exports are very weakly correlated in the euro area. The misalignment effect on external imbalances can also operate through the investment channel. By lowering the profit margins, an overvalued currency discourages domestic investment (Gala, 2008), improving countries' external position, other things being equal.

Figure 1.1: Impulse Response Functions: benchmark





Note: Impulse-responses are represented by solid lines. The dashed lines indicate the 95 percent confidence intervals that are generated by Monte Carlo with 1000 repetitions.

Figure 1.1— Continued.

We also investigate the interaction between the output gap and the exchange rates, useful to understand the short-run dynamic of the REER (see IMF, 2013). The period preceding the inception of the euro displays a positive response of real exchange rate misalignments to an output gap shock. This variable capturing domestic demand shocks (Philips et al., 2013; Adler and Grisse, 2017), a rise in the output gap is followed by an increase in inflation pressures in the domestic economy. Thus, it appreciates the real exchange rates pushing up currency misalignments. The output gap contributes for 10% in explaining the real exchange rate misalignments. The switch to the euro drastically modifies the reaction of the misalignment to a demand shock. Indeed, our IRF shows a significant and negative response of the misalignment to an output gap shock over the euro period. A strong dependence of the REER to demand shocks in the euro period is shown

Table 1.5 Variance decomposition

	OG	CA MIS	MIS BEER
1980-1998			
OG	0.838	0.068	0.094
CA MIS	0.059	0.873	0.074
MIS BEER	0.100	0.125	0.775
1999-2016			
OG	0.934	0.001	0.065
CA MIS	0.110	0.761	0.129
MIS BEER	0.224	0.032	0.744

Note: This table reports the percentage of variation in the variable in row explained by the variable in column. The figures reported are averages over 10, 20 and 30 years.

by our variance decomposition. An acceleration in the output gap contributes to 22.4% of the variation of the misalignment.

The abandonment of the national currencies also affects the dynamic of the external adjustment. Consistent with Freund (2005), over the pre-euro area period, a current account reversal is followed by a currency depreciation. The pre-euro area period being characterized by the use of the nominal exchange rates as a macroeconomic adjustment tool in some euro area countries (Fernàndez-Villaverde et al., 2013; Garcià Solanes et al., 2017), the current account adjustment can occur through a depreciation. Such adjustment is lost since the inception of the euro because of the institution of a fixed exchange rate regime between members, explaining the absence of significant reaction of the misalignment to a current account disequilibrium shock over the 1999-2016 period. The variance decomposition also confirms the disappearance of adjustment through an exchange rate modification. The contribution of current account imbalances to misalignment goes from 12.5% and reduces to 3.2% over the 1999-2016 period.

As noticed by Freund (2005), a current account reversal can also operate through a growth adjustment. The pre-euro period provides no evidence in favor of such adjustment as a shock on the external position does not affect the output gap. Over the post euro period, this absence of slow-growth process is confirmed as the current account misalignment shock to the output gap is insignificant. This finding is also illustrated by the variance decomposition analysis showing a reduction in the current account imbalances' explanation from 6.8% to approximately 0%. Concerning the misalignment effect on the output gap, we find contrasting evidence. The results for the pre-EMU period are consistent with the bulk of literature studying the effect of misalignments on growth, while the post euro period is characterized by different findings. More precisely, over the 1980-1998 period, a misalignment shock lowers the output gap through the reduction of growth (see Rodrik (2008) among others). The switch to the euro reduces the contribution of misalignments to the output gap variation, decreasing from 9.4% to 6.5%.

All in all, our results can be summarized in three key points. First, the inception of the euro has significantly increased current account's vulnerability of euro area members to domestic as well as external shocks. Then, the EMU also hinders the current account adjustment as shown by the disappearance of adjustment through the nominal exchange rate. Finally, demand shocks play an essential role in the REER dynamic within the euro area.

1.5.6 Robustness checks

We investigate the robustness of our findings to the misalignment measure. As detailed previously, we rely on the BEER approach to estimate the equilibrium exchange rates. However, there is still no consensus concerning the methodology to compute exchange rates misalignments, even if

in practice they correspond to the same model applied to different temporal horizons (Bénassy-Quéré et al, 2010). As an alternative to the BEER methodology, we use the Atheoretical Permanent Equilibrium Exchange Rate (APEER) approach (see Bénassy-Quéré et al., 2009) which consists in computing the equilibrium exchange rates using a Hodrick-Prescott filter. The IRFs and the variance decomposition are available in the Appendix (see Figure 1.B.1 and Table 1.B.3). We start to discuss the results concerning the response of the current account misalignment. Considering misalignment shocks, our results are almost identical with those provided with the BEER approach. While the current account response to a misalignment shock was very weak over the pre-euro period, we find no evidence of such an effect in our robustness check. Furthermore, as previously, over the post-euro area period, a misalignment shock reduces current account deficits. On the 1980-1998 period, an output gap shock continues to fuel current account deficits. However, we fail to confirm the lasting effect of a domestic demand boom on the current account disequilibrium. Interestingly, the variance decomposition analysis confirms the increasing vulnerability of euro area members. More specifically, currency misalignments continue to be the main driving force behind current account disequilibria accounting for 18.20% of their variation.

As previously, we do not find evidence of a slow-growth process over our two sub-periods. We thus confirm the absence of current account adjustment through a growth reduction. Moreover, we do not find a significant response of the output gap to a currency misalignment shock. Using the APEER methodology, we confirm the presence of a depreciation following a current account reversal on the 1980-1998 period while such adjustment disappears during the euro period. Finally, we continue to find that a boom in domestic demand reduces currency misalignments after the launch of the euro.

We also check the robustness of the Cholesky decomposition to alternative variables ordering by considering two alternative ordering. Some authors consider that the competitiveness loss of southern eurozone countries is the consequence of the domestic demand booms rather than the cause of their current account imbalances. This view explains why the output gap impacts the misalignment contemporaneously. However, Belke and Dreger (2013) find that the lack of competitiveness is the main explanation for rising European current account imbalances. Hence, it is also relevant to consider that the misalignment affects contemporaneously the current account gap. This alternative ordering is investigated by estimating the following PVAR model:

$$Y_{i,t} = (OG_{i,t}, MIS_{i,t}, CA_{i,t}^D) \quad (1.21)$$

Another variable ordering consists putting first the current account imbalances. Indeed, as shown by Freund (2005), current account reversals occur through a reduction in growth and exchange-rate depreciation. That is why we also examine the robustness of our results to this alternative decomposition by estimating the following PVAR model:

$$Y_{i,t} = (CA_{i,t}^D, MIS_{i,t}, OG_{i,t}) \quad (1.22)$$

Table 1.B.4 in the Appendix provides a summary of the results obtained. The IRF associated to model (1.21) and (1.22) are respectively available in Figures 1.B.2 and 1.B.3 in the Appendix. These additional robustness checks confirm the main results of the benchmark model.

1.6 Conclusion

The adhesion to the EMU involves several sacrifices for its members. It implies the renouncement to an independent monetary policy as well as the impossibility of using an exchange rate stabilization policy. This loss constitutes a challenging issue for the euro area members' stability, especially since it is harder to adjust under a fixed exchange rate regime (Friedman, 1953; Gosh et al., 2013). Falling into this context, our article aims to investigate how the EMU affects the macroeconomic adjustment of the eurozone considering three key macroeconomic imbalances (external imbalances, internal imbalances and exchange rates imbalances).

Our results point out that with the adoption of the single currency, current account vulnerability to demand and exchange rate misalignment shocks increases significantly. Following the launch of the EMU, the contribution of both variables to current account disequilibria variation increases substantially. Thus, our results suggest that macroeconomic stability is substantially affected by the impossibility to use the exchange rate adjustment mechanism and by the absence of an independent monetary policy. The threat of macroeconomic stability is also reinforced by the presence of asymmetric shocks within the euro area. Furthermore, we also show that the advent of the eurozone implies a harder current account adjustment.

In face of these additional difficulties to resorb external imbalances, the evolution of the external position has to be monitored carefully as sizeable current account deficits increase the probability of banking crises through a higher marginal effect of private credit growth (Davis et al., 2016). Our results also suggest that alternative adjustment mechanisms have to be proposed within this monetary union to manage the negative effect of external imbalances.

Our article also contributes to the identification of the roots of the current account imbalances in the euro area. The capital inflows from the Northern to the Southern euro area countries (Hobza and Zeugner, 2014) play a central role in the build-up of current account imbalances as they fuel a private credit boom. Hence, they contribute significantly to house prices dynamic which is now identified as a robust current account driver (see Geerolf and Grjbine 2013; Aizenman and Jinjarak, 2014; Unger, 2017; among others). Thus, a natural extension of our article would be to investigate the interaction and causality between credit boom, house prices and current account imbalances in the eurozone.

Appendix

Appendix 1.A Data appendix

Table 1.A.1 Data sources and definition

Primary	Data sources	Deviation	Comments
Current account balance	OECD	NO	Expressed in % GDP
Demographics			
Ageing speed	Author's calculation	YES	Difference between the dependency ratio in year $t + 20$ and year t
Dependency ratio	WDI	YES	Ratio of people younger than 15 or older than 64 to the working-age population
Young dependency ratio	WDI	YES	Ratio of young people (<15 years) to middle-age (15–64)
Old dependency ratio	WDI	YES	Ratio of older people (>64 years) to middle-age (15–64)

Table 1.A.1 (continued)

Population growth	WDI	YES	Annual growth of total population
Dummies			
Euro area dummies	Author's calculation	NO	1 for northern euro area countries, 0 otherwise
Financial and banking crisis	Laeven and Valencia (2012)	YES	Equal to one in crisis year and during the two following years
Economic development			
Relative income	Author's calculation	YES	GDP PC is GDP divided by midyear population
GDP adjusted PPP	PWT 9.0		Expenditure-side real GDP at chained PPPs (in millions)
Population	PWT 9.0		Population (in millions)
Growth rate of GDP PC	WDI	YES	Real GDP PC growth rate
Relative income squared	WDI	YES	Squared GDP PC series
External financing and international environment			
Long term interest rate	OECD	YES	Long-term interest rates refer to government bonds maturing in ten years
Net Foreign asset	Lane and Milesi-Ferretti (2007)	NO	Expressed in % GDP

Table 1.A.1 (continued)

Financial development			
Capital account openness	Chinn and Ito (2006)	YES	Index that ranges from -1.84 (closed) to 2.48 (open)
Financial integration	Author's calculation	YES	Sum of assets and liabilities in% GDP
Fiscal policy			
Government budget balance	OECD	YES	Expressed in % GDP
Government budget balance's instrument	IMF (2013)	YES	Instrumentation of several macroeconomic variables (see p21)
Institutional quality			
Civil liberties	Freedom House	YES	Coded from 1 (free) to 7 (not free)
Macroeconomic uncertainty			
Volatility of GDP growth	Author's calculation	YES	Fogli and Perri (2015)'s computation
Quarterly real GDP	OECD		
Term Of Trade Volatility	Author's calculation	NO	Estimation using a GARCH(1,1) model
Oil dependency			
Oil balance	Author's calculation	NO	Oil balance is expressed in % GDP
Oil net trade	IEA		Oil net trade is expressed in Mtoe

Table 1.A.1 (continued)

Crude oil prices		BP		Crude oil prices per barrel over the period 1980-2016
GDP series		OECD		logarithm of GDP in millions US dollars
Other variables				
Real Exchange Rate	Effective	EQCHANGE	NO	REER based on 186 trade partners using the 2008-2012 trading weights
Balassa-Samuelson Effect		EQCHANGE	YES	Deviation of countries GDP PC from trading partners. BS based on 186 partners using the 2008-2012 trade trading weights
Output gap		OECD	YES	Deviation of the GDP from its potential level expressed in % potential GDP
Trade integration				
Trade Openness		WDI	YES	Sum of exports and imports in % GDP
Terms Of Trade		OECD	NO	Ratio of export prices to import prices

Note: BP=British Petroleum; CEPII=Centre d'études prospectives et d'informations internationales ; OECD= Organisation for Economic Co-operation and Development; IEA=International Energy Agency; WDI=World Development Indicator (World Bank). GDP= Gross Domestic Product; PC= Per capita; PPP= Purchasing Power Parity.

Appendix 1.B Additional results

Table 1.B.1 Equilibrium exchange rates estimation

Short run dynamic	Coef.	Coef.
ec	-0.350*** (0.0862)	-0.220*** (0.0641)
D.rprod	-0.0664*** (0.0235)	-0.0995 (0.0620)
D.NFAGDP	-0.0258 (0.152)	-0.0590 (0.0375)
Long run dynamic	Coef.	Coef.
rprod	0.0206*** (0.00501)	0.182*** (0.0535)
NFAGDP	-0.205*** (0.0656)	0.0543*** (0.0180)
Constant	1.589*** (0.391)	0.954*** (0.281)
Observations	209	198
Period	1980-1998	1999-2016
Half life	2.30	3.48

Note: Estimation performed with the Pooled mean group estimator. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. ec denotes the error correction term

Table 1.B.2 Panel unit root tests

	LLC With trend and constant	LLC With constant	CIPS IPS With trend and constant	CIPS IPS With constant
CAMIS	-5.16*** (0.000)	-2.37*** (0.008)	-0.63 (0.26)	-1.82** (0.0341)
Period	1980-1998	1980-1998	1980-1998	1980-1998
CAMIS	-3.92*** (0.000)	-2.43*** (0.007)	1.43 (0.92)	-1.791** (0.036)
Period	1999-2016	1999-2016	1999-2016	1999-2016
Output gap	-5.85*** (0.000)	-3.59*** (0.000)	-2.873***	-2.033
Period	1980-1998	1980-1998	1980-1998	1980-1998
Output gap	-5.21*** (0.000)	-4.22*** (0.000)	-1.616	-2.106
Period	1999-2016	1999-2016	1999-2016	1999-2016
D.output gap	-2.70*** (0.003)	-4.87*** (0.000)	-2.315	-2.359**
Period	1999-2016	1999-2016	1999-2016	1999-2016
Output gap	-4.61*** (0.000)	-5.52*** (0.000)	-2.81**	-2.733***
Period	1980-2016	1980-2016	1980-2016	1980-2016
MIS	-4.44*** (0.000)	-2.96*** (0.000)	-2.48*** (0.006)	-2.96*** (0.001)
Period	1980-1998	1980-1998	1980-1998	1980-1998
MIS	-3.20*** (0.000)	-3.54*** (0.000)	-5.56*** (0.000)	-2.29*** (0.001)
Period	1999-2016	1999-2016	1999-2016	1999-2016
MIS HP	-5.60*** (0.000)	-8.19*** (0.000)	-2.832**	-2.917***
Period	1980-1998	1980-1998	1980-1998	1980-1998
MIS HP	-7.34*** (0.000)	-9.44*** (0.000)	-3.268***	-3.422***
Period	1999-2016	1999-2016	1999-2016	1999-2016

Note: CAMIS indicates the current account misalignment variable, MIS is the misalignment exchange rates. MISHP is the currency misalignments computed using the Hodrick Prescott filter. LLC: Levin, Lin and Chin (2002) test. CIPS: CADF test of Pesaran (2007). IPS : Im, Pesaran and Shin (2003). Lags selected using the AIC criterion, max lag authorized for the variable equals 2. IPS test used for CAMIS and MIS. CIPS test used for the output gap and MIS HP. LLC test for Output gap and MIS HP use demean option.

Table 1.B.3 Variance decomposition: robustness check

	OG	CA MIS	MIS HP
1980-1998			
OG	0.887	0.098	0.016
CA MIS	0.046	0.881	0.073
MIS HP	0.008	0.063	0.929
1999-2016			
OG	0.864	0.111	0.025
CA MIS	0.055	0.763	0.182
MIS HP	0.129	0.056	0.814

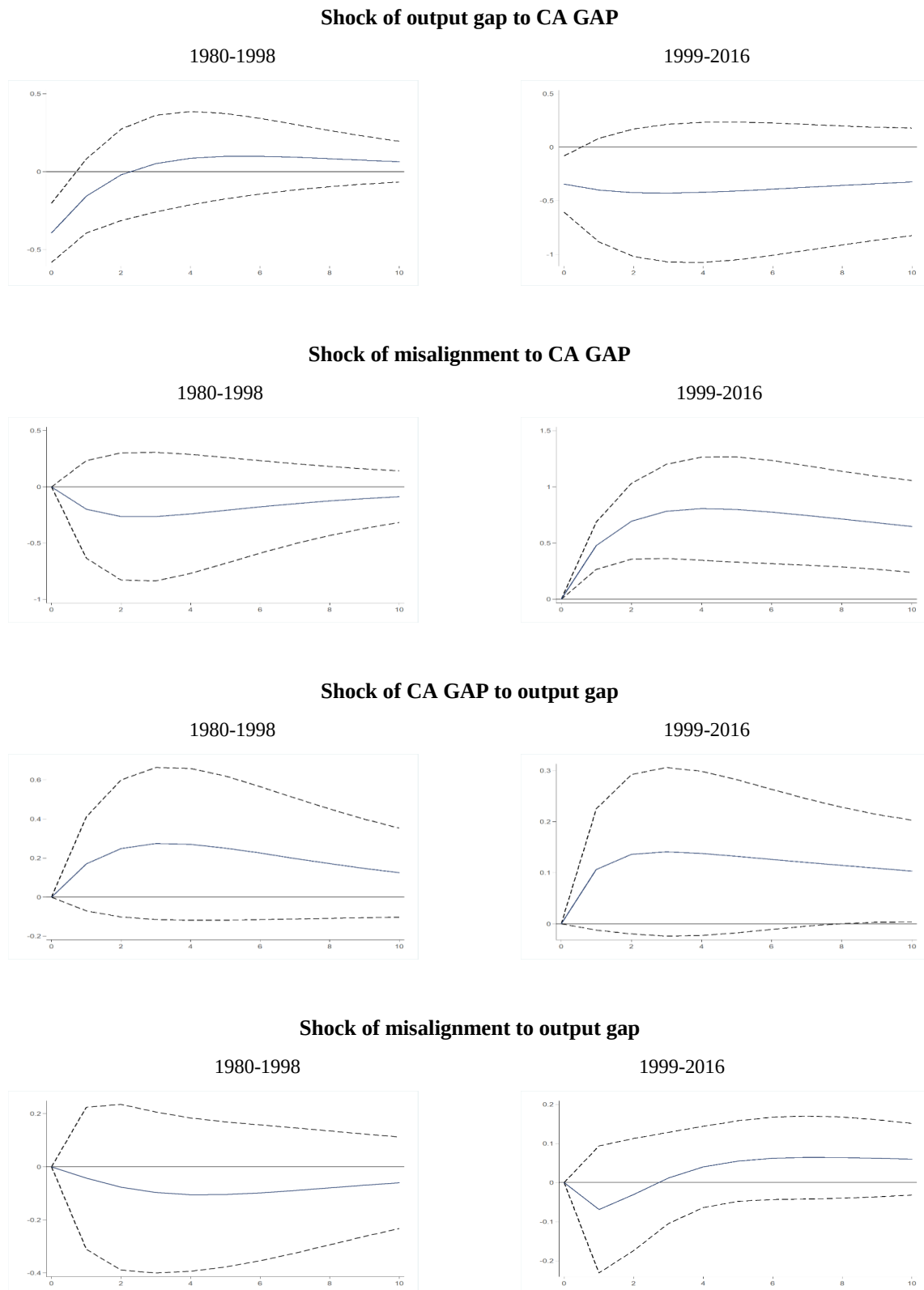
Note: This table reports the percentage of variation in the variable in row explained by the variable in column. The figures reported are averages over 10, 20 and 30 years.

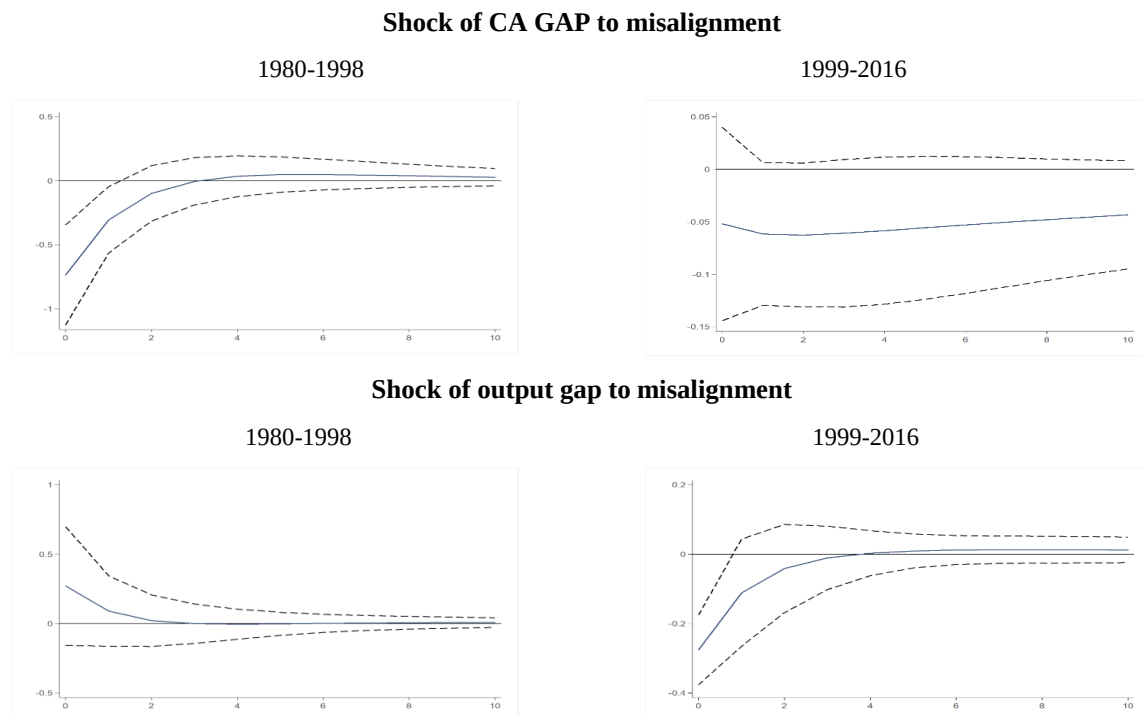
Table 1.B.4 Robustness to the ordering of variables: summary

	Benchmark	(OG, MIS, CA MIS)	(CA MIS, OG, MIS)
1980-1998			
MIS to CA MIS	0	-	-
OG to CA MIS	-	0	0
OG to MIS	+	+	0/+
CA MIS to MIS	-	0	-
MIS to OG	-	-	-
CA MIS to OG	0	-	0
1999-2016			
MIS to CA GAP	+	+	+
OG to CA GAP	-	-	-
OG to MIS	-	-	-
CA GAP to MIS	0	0	0
MIS to OG	+	0	+
CA GAP to OG	0	0	0

Note: MIS to CA MIS indicates the response of the current account imbalances to a misalignment shock. A 0 indicates that the IRF is non significant. - (resp. +) indicates a significant and negative (resp. positive) response to the shock examined. Benchmark model is equation (1.15).

Figure 1.B.1: Impulse Repulse Functions: robustness check

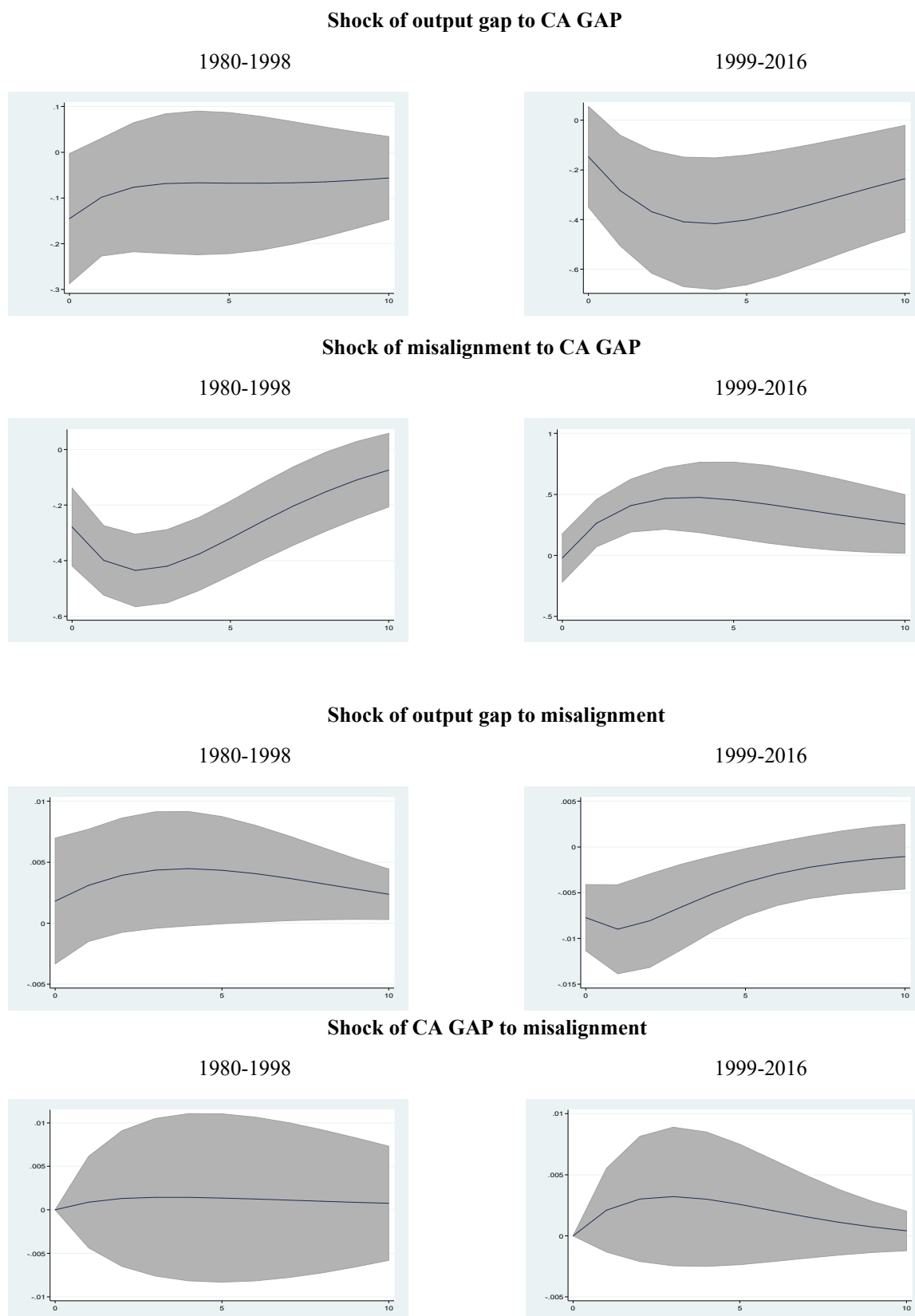


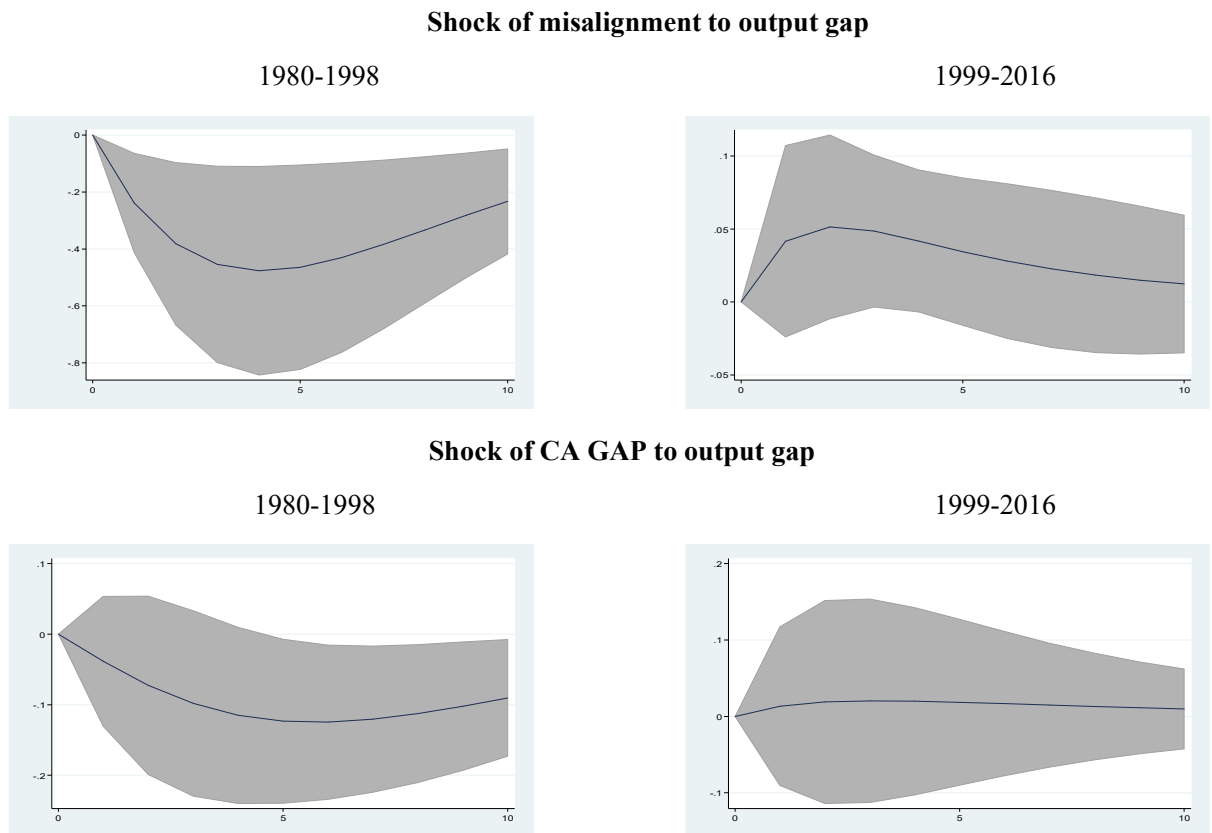


Note: Impulse-responses are represented by solid lines. The dashed lines indicate the 95 percent confidence intervals that are generated by Monte Carlo with 1000 repetitions.

Figure 1.B.1 — Continued.

Figure 1.B.2: Impulse Repulse Functions: robustness check (equation 1.21)

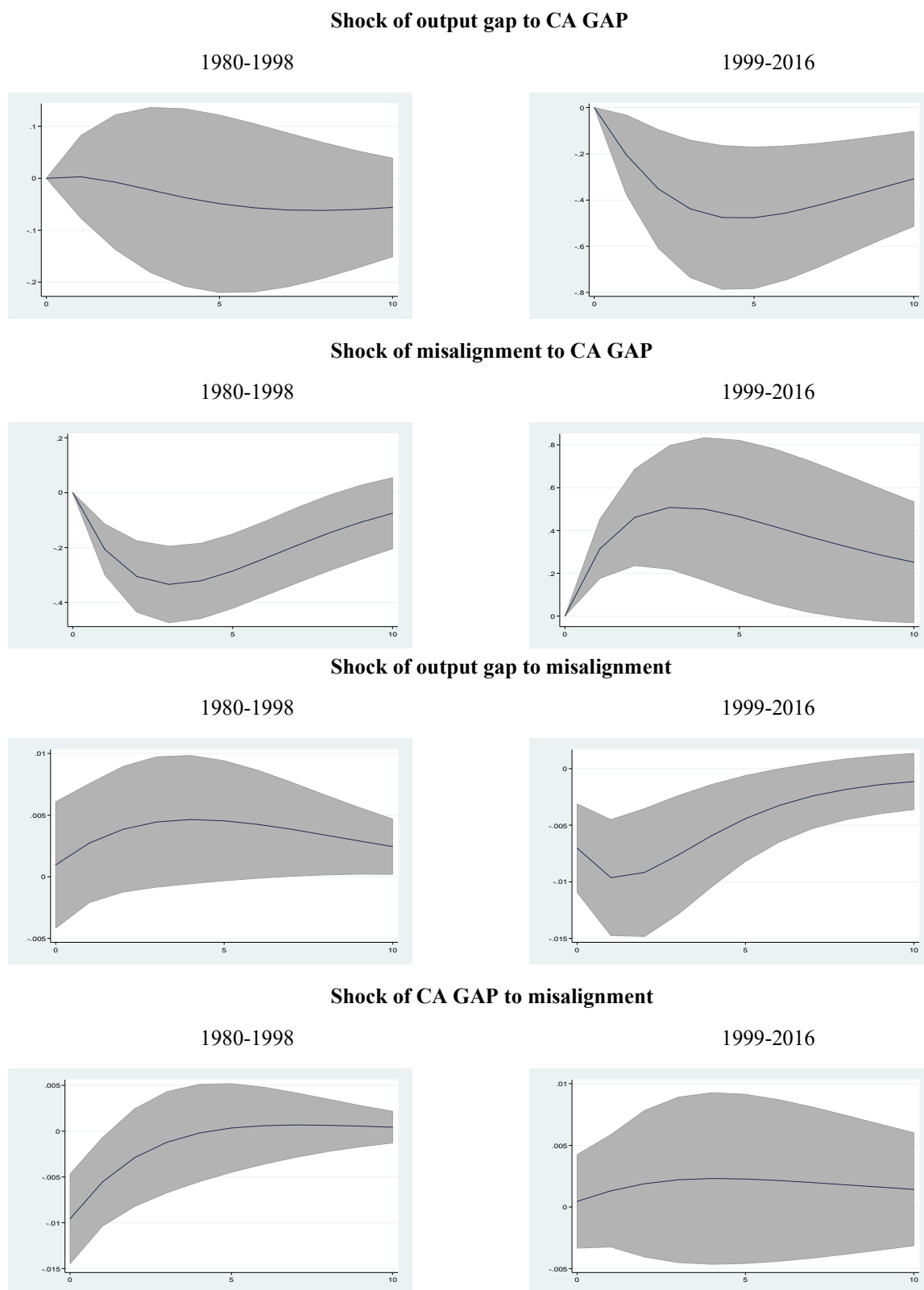


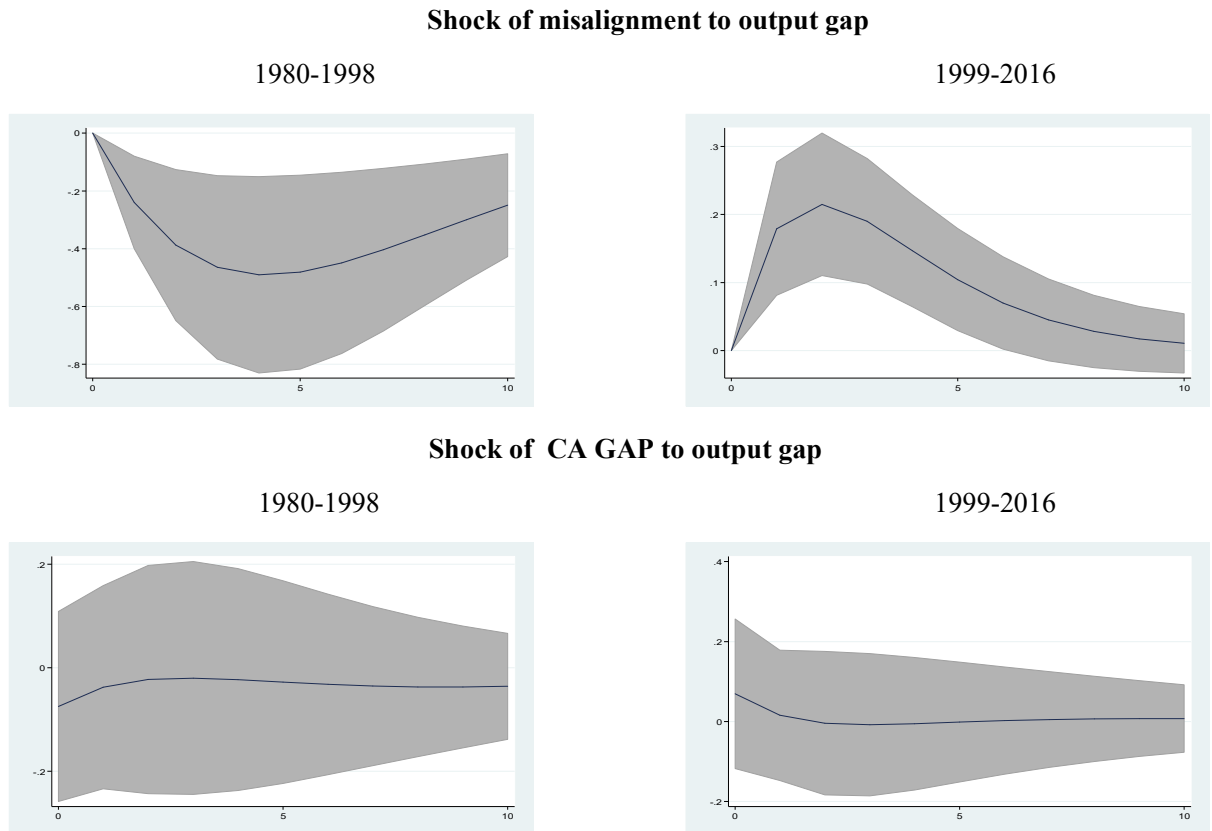


Note: Impulse-responses are represented by solid lines. The gray area indicates the 95 percent confidence intervals that are generated by Monte Carlo with 1000 repetitions. IRF of the following specification: $(OG_{it}, MIS_{it}, CA_{it}^D)$.

Figure 1.B.2 — Continued.

Figure 1.B.3: Impulse Repulse Functions: robustness check (equation 1.22)



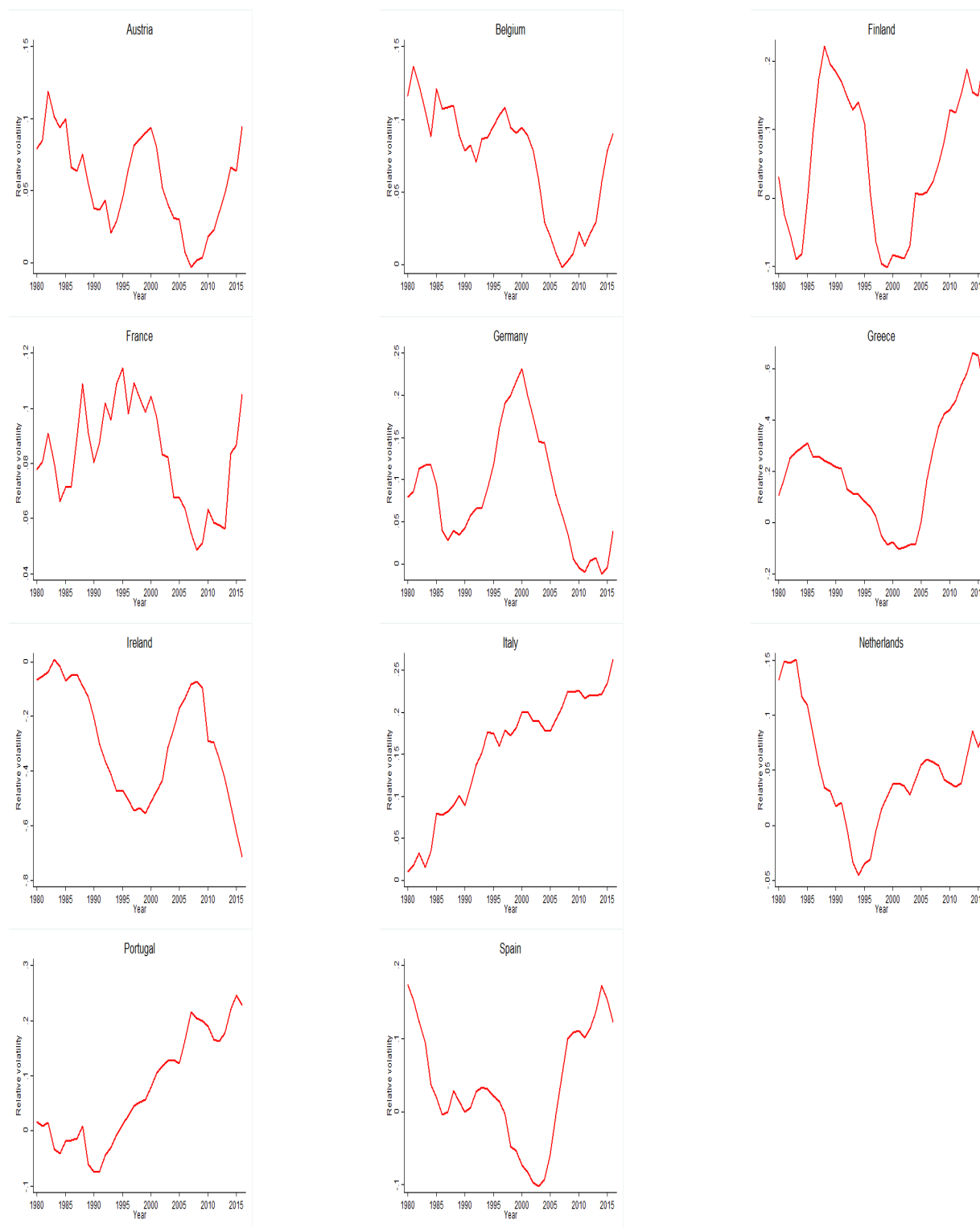


Note: Impulse-responses are represented by solid lines. The gray area indicates the 95 percent confidence intervals that are generated by Monte Carlo with 1000 repetitions. IRF of the following specification: $(CA_{it}^D, MIS_{it}, OG_{it})$.

Figure 1.B.3 — Continued.

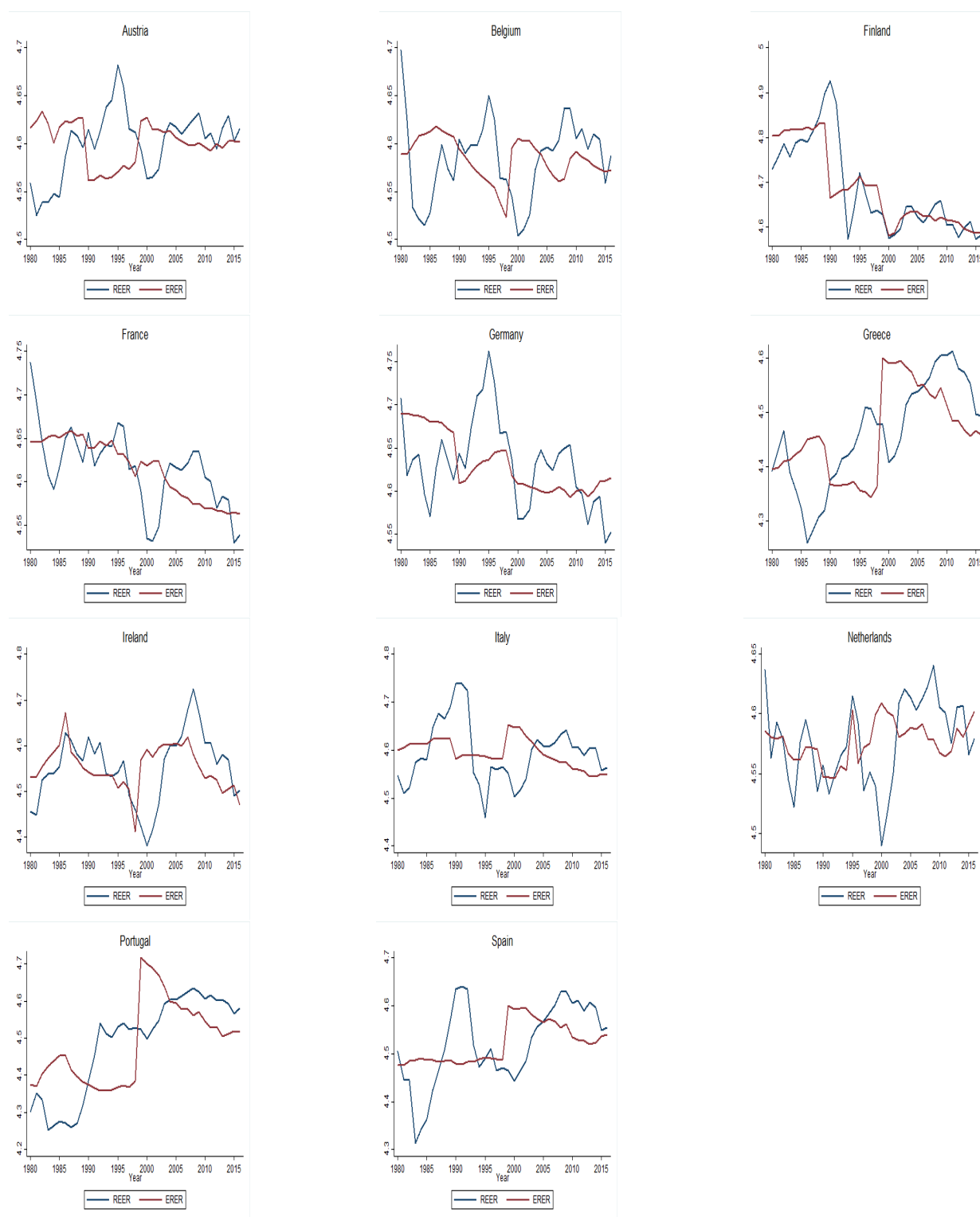
Appendix 1.C Figures

Figure 1.C.1: GDP relative volatility



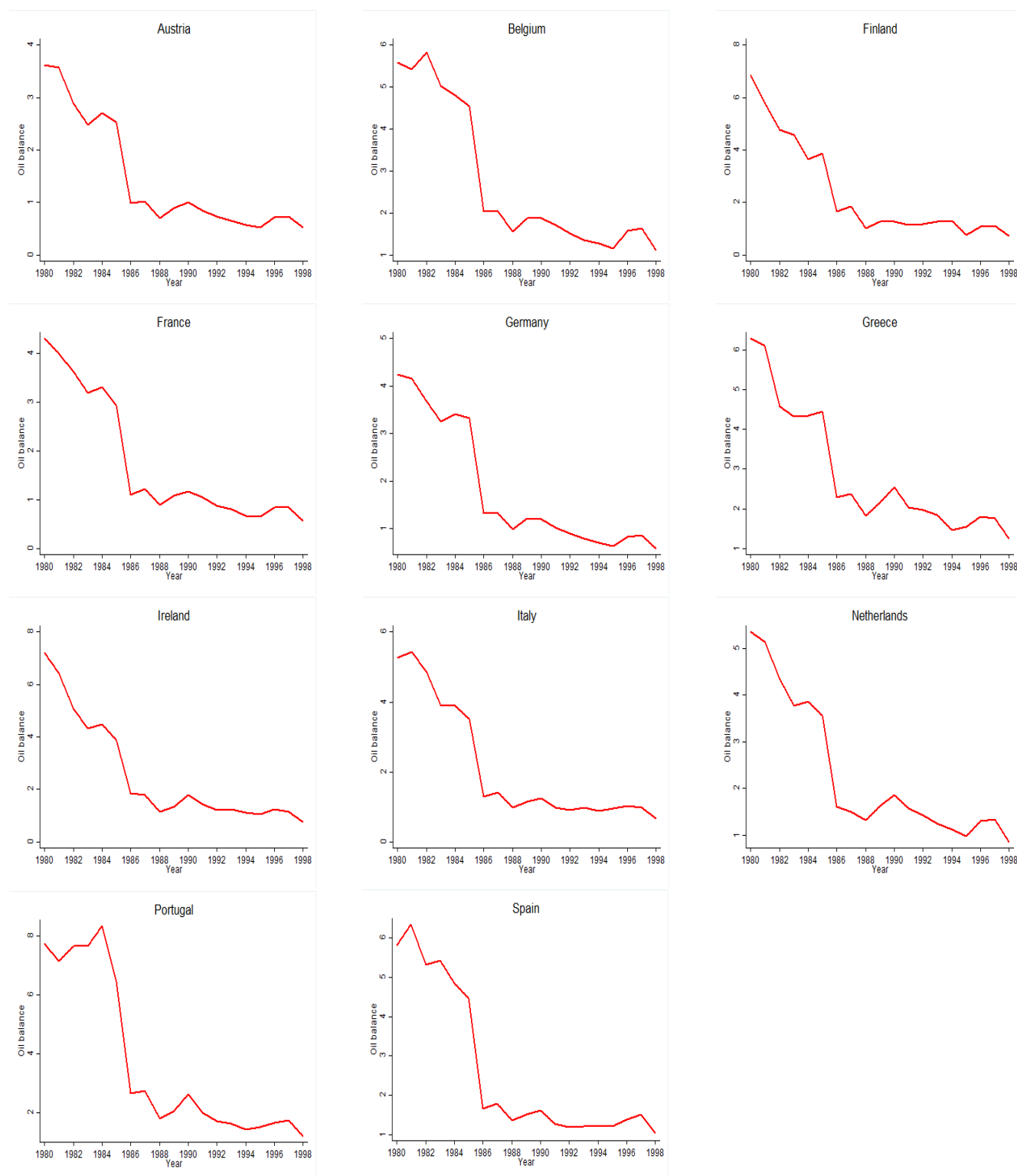
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Figure 1.C.2: REER and ERER



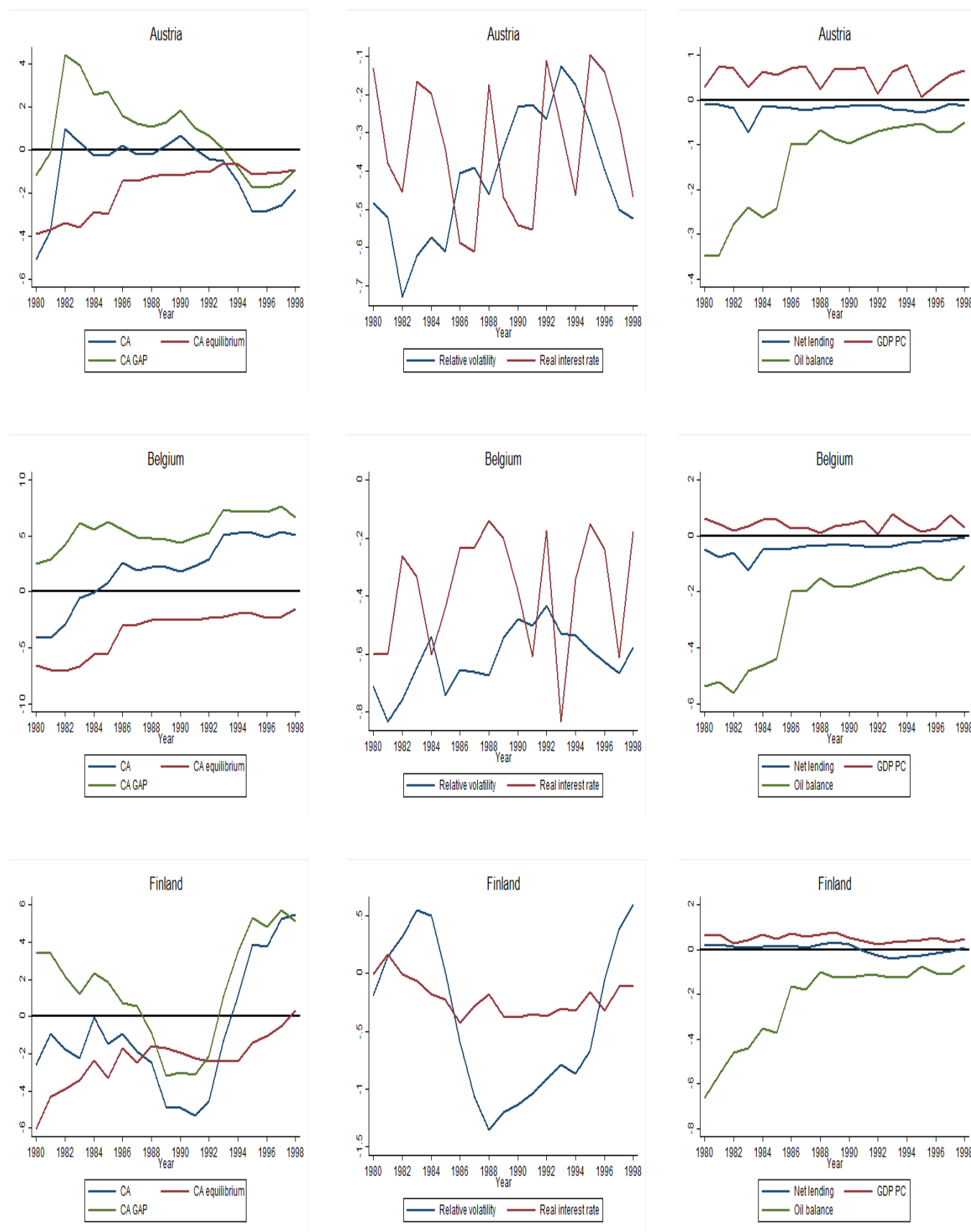
Note: REER (resp. ERER) indicates the logarithm of the Real Effective Exchange Rates (resp. Equilibrium Real Exchange Rate).

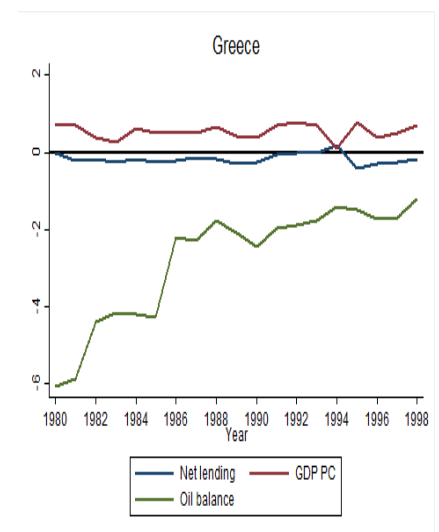
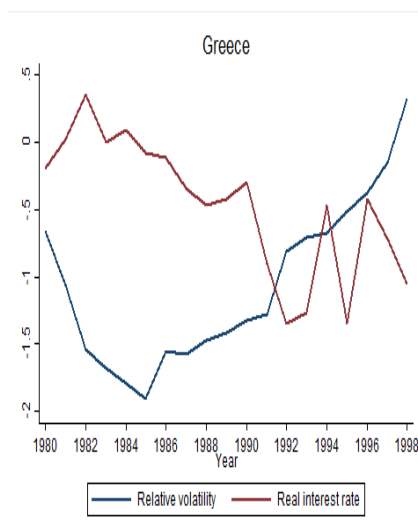
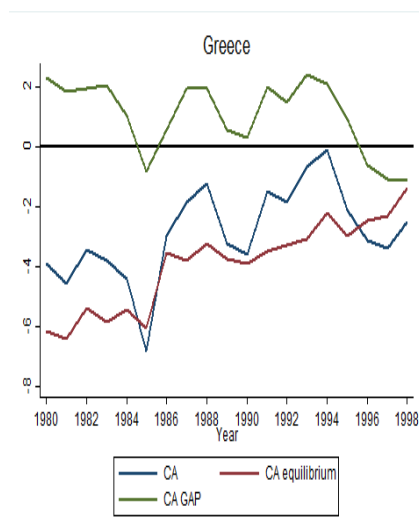
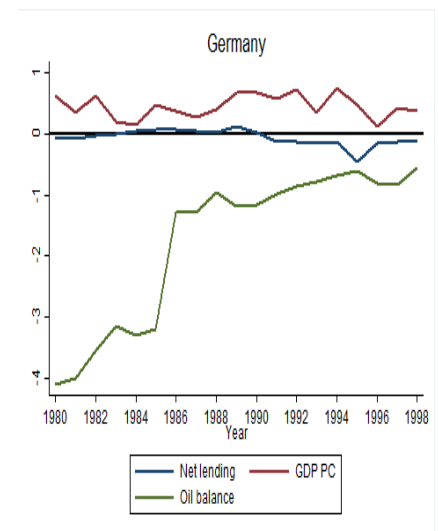
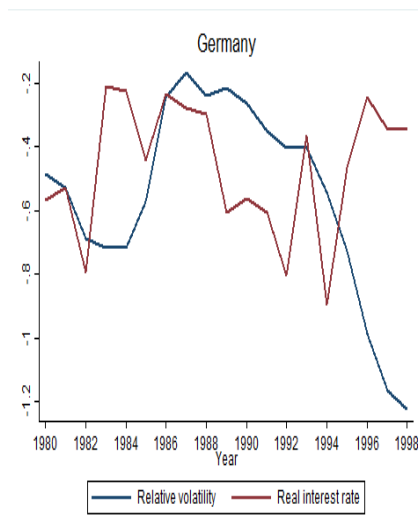
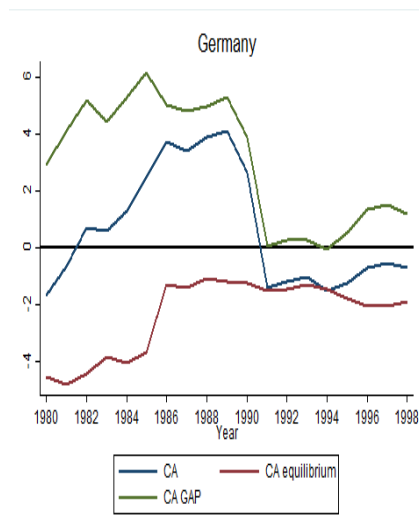
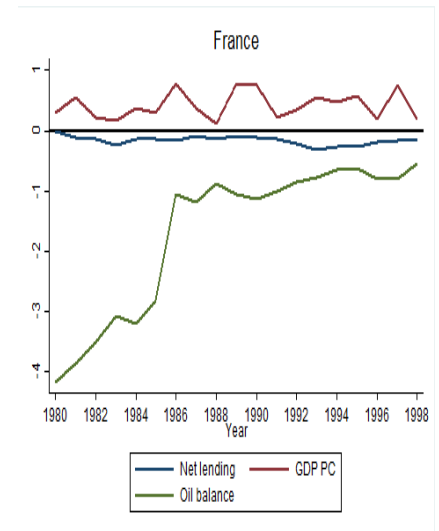
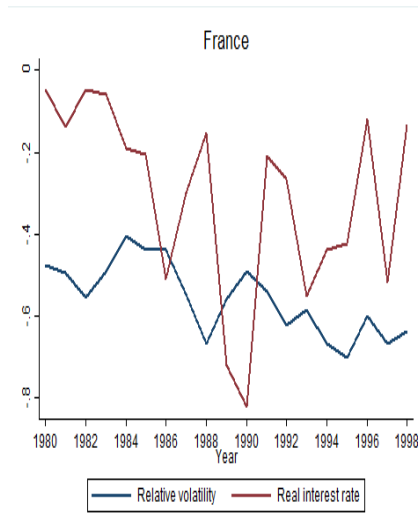
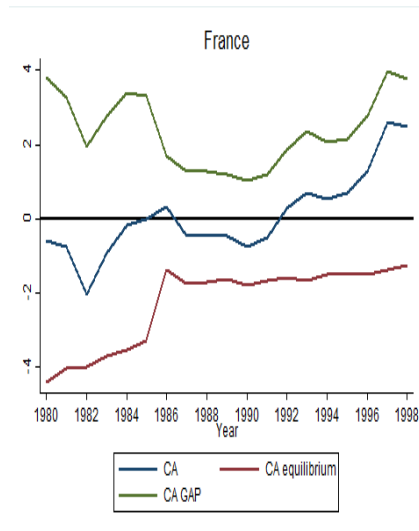
Figure 1.C.3: Oil balance series

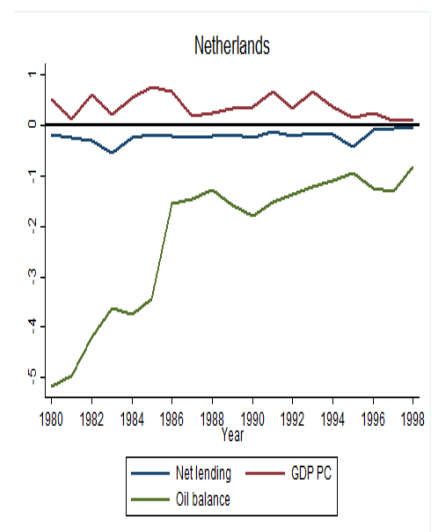
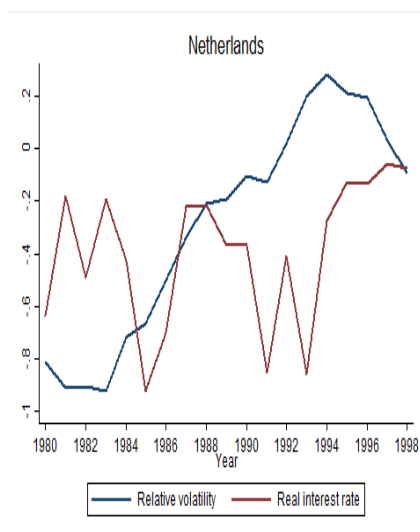
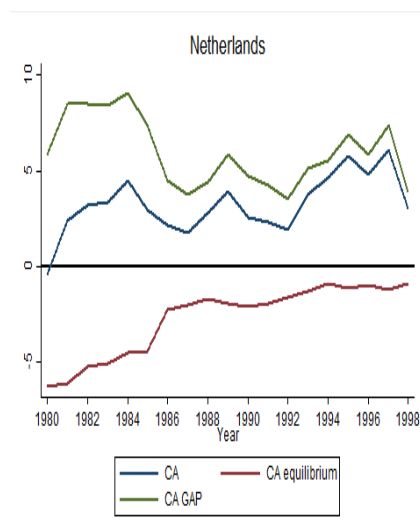
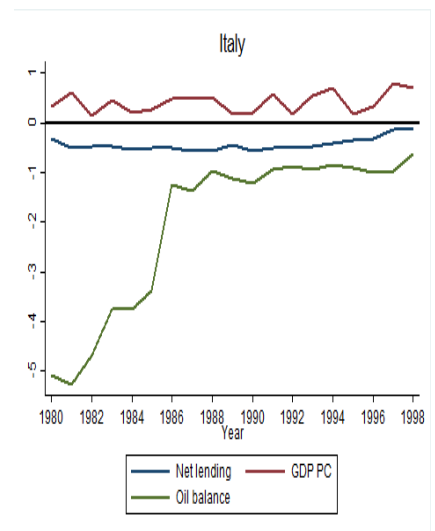
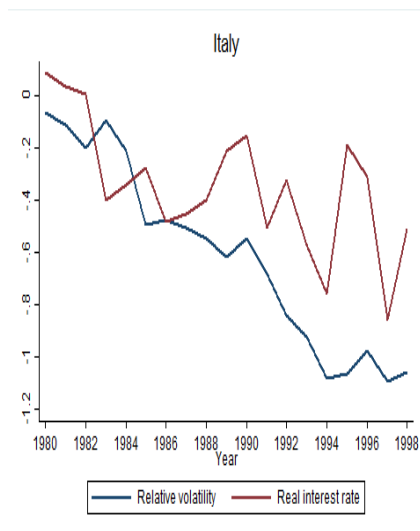
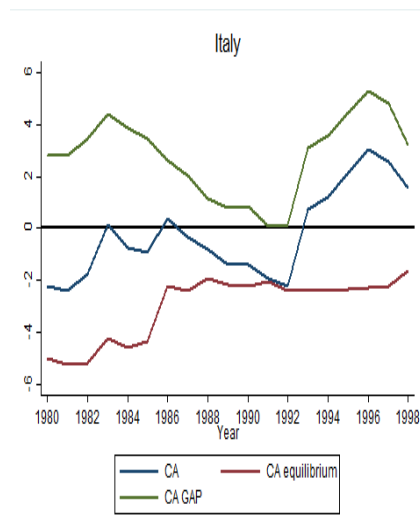
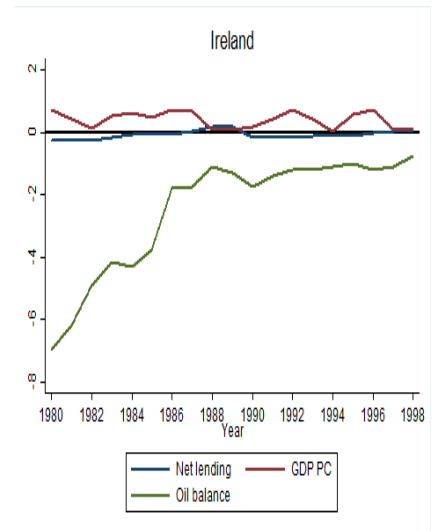
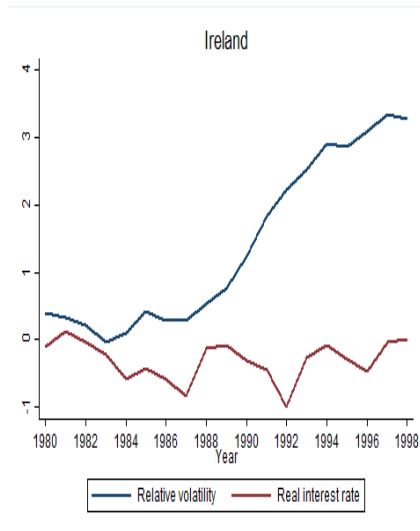
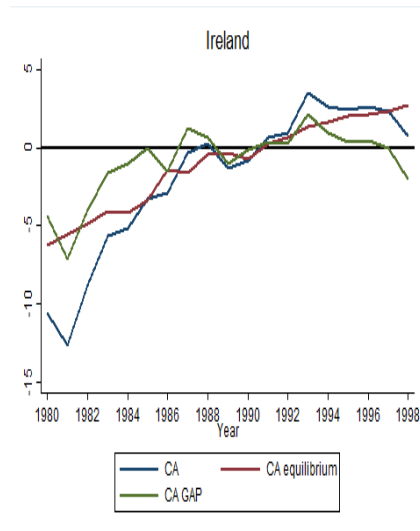


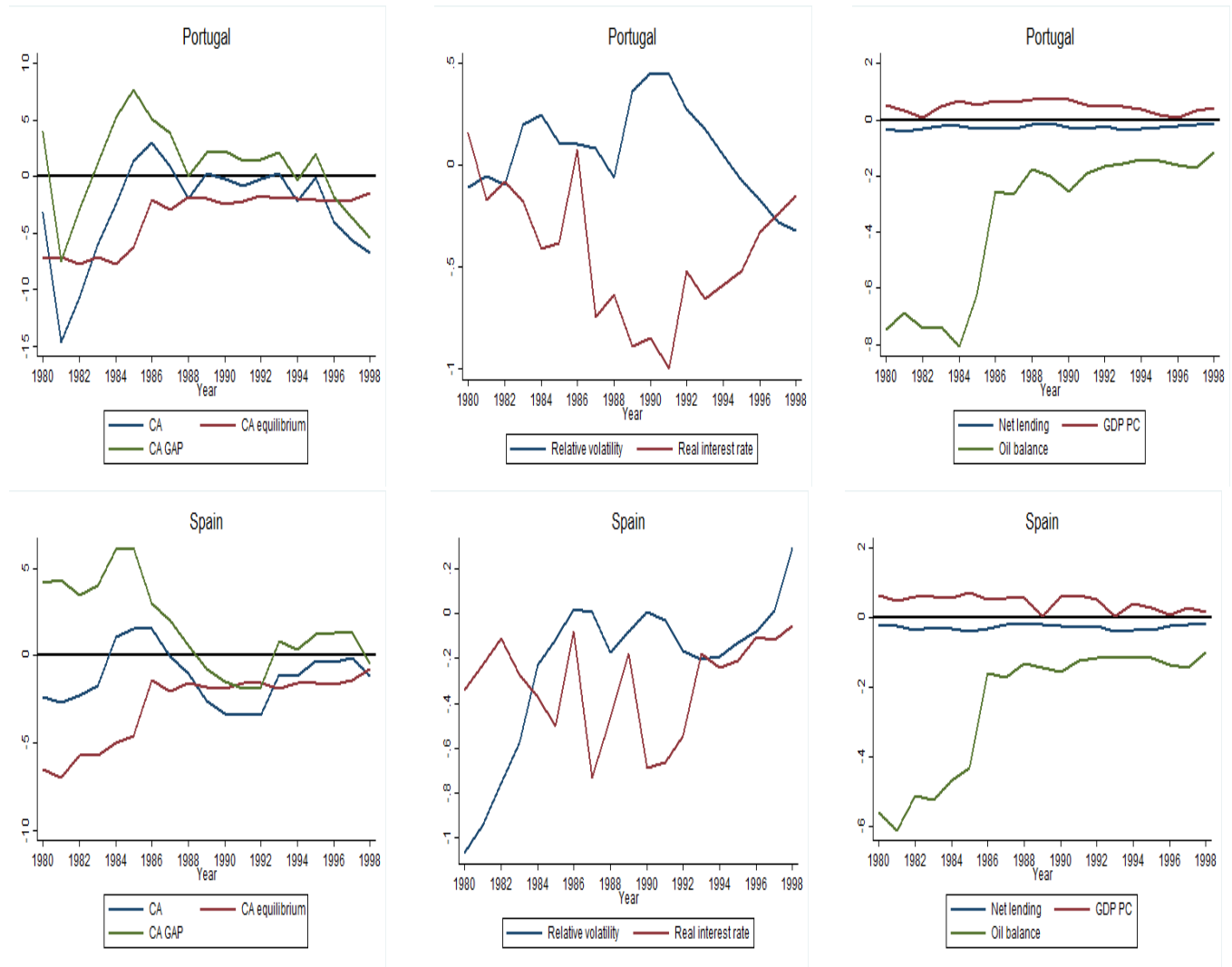
Source: Author's calculations

Figure 1.C.4: CA and fundamentals (1980-1998)



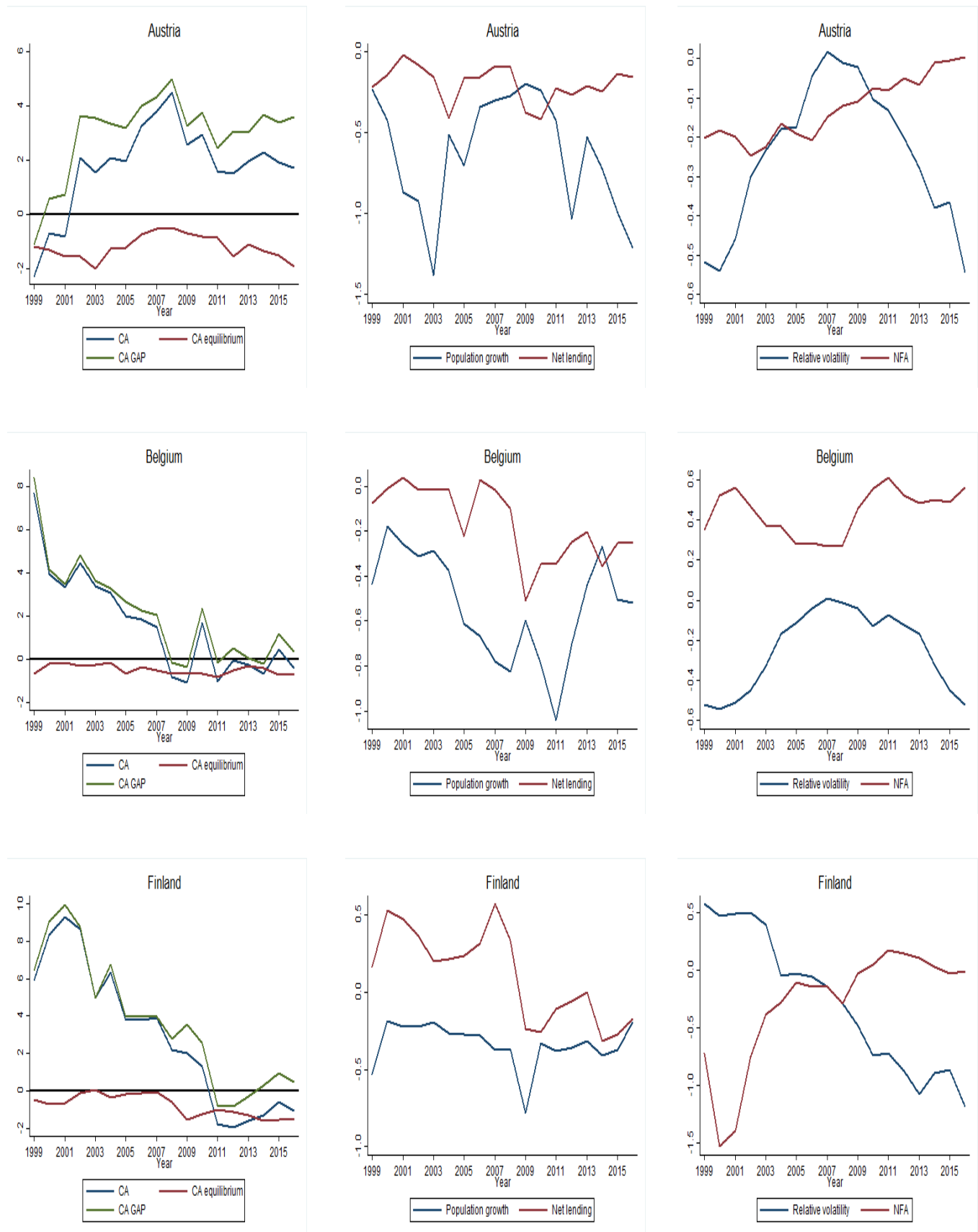


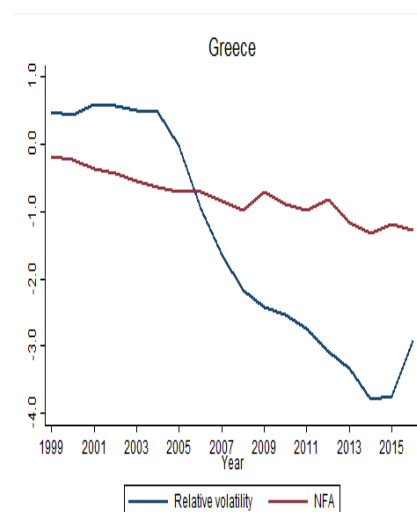
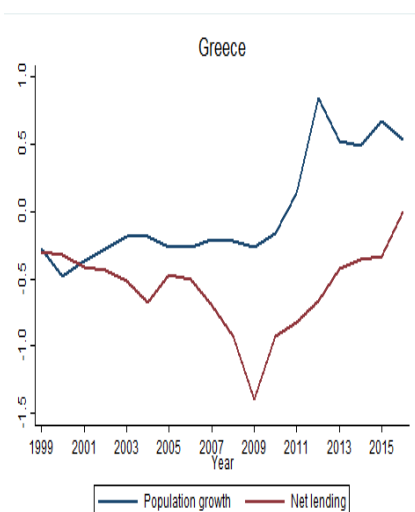
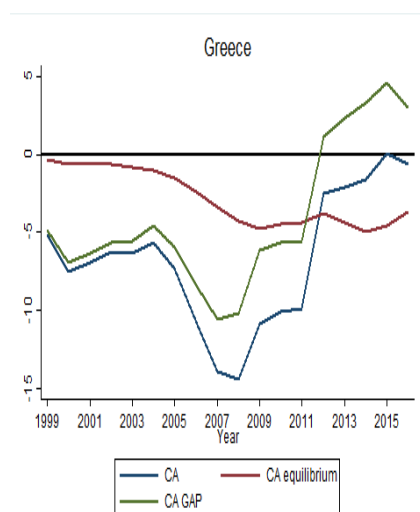
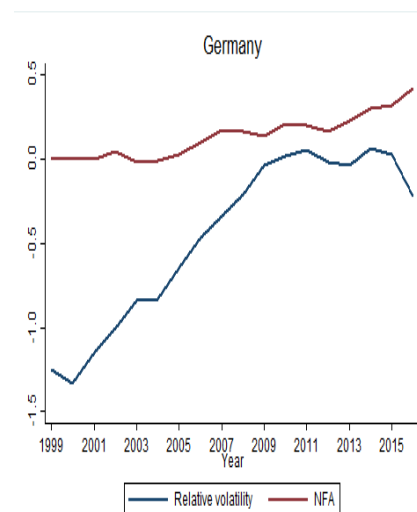
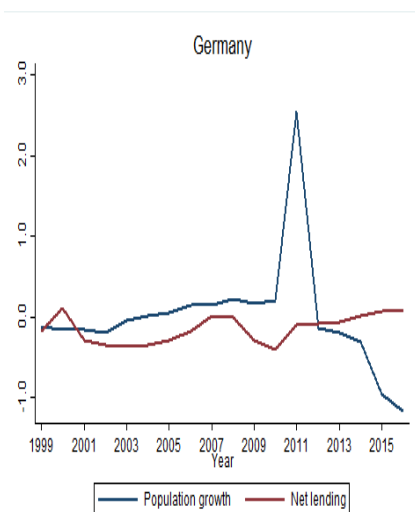
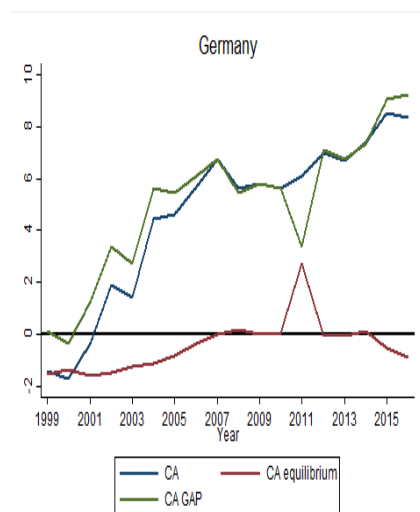
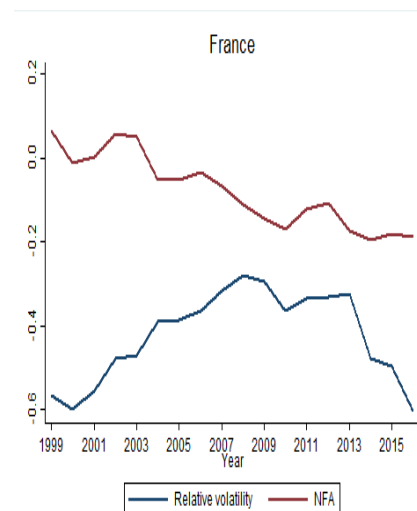
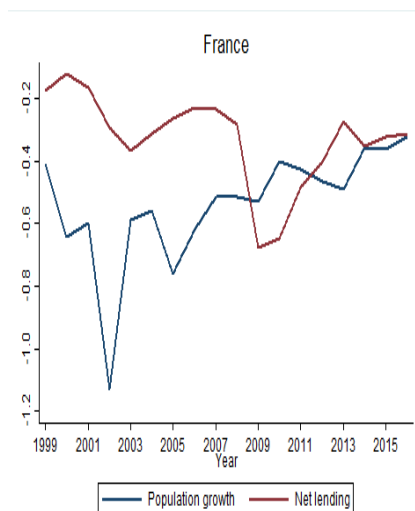
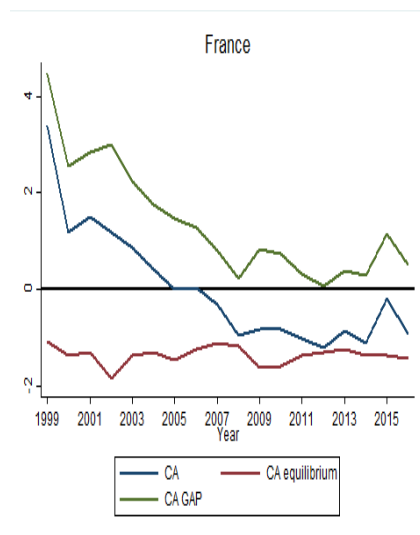


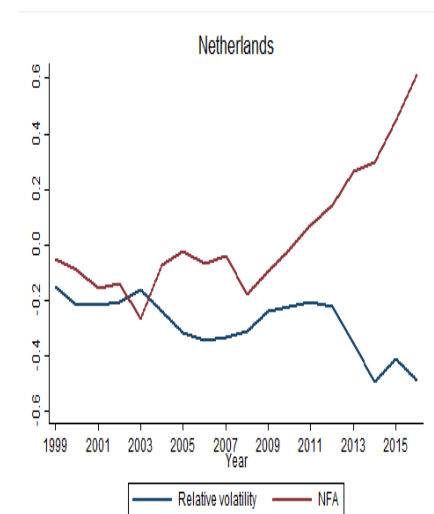
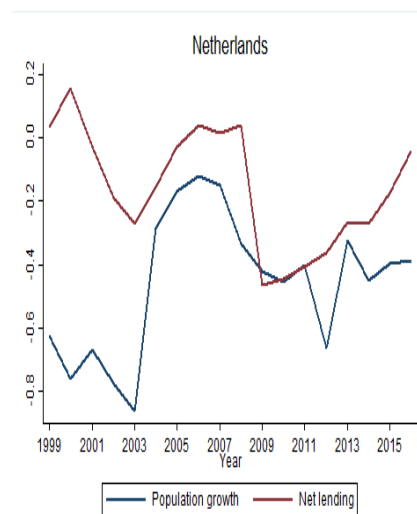
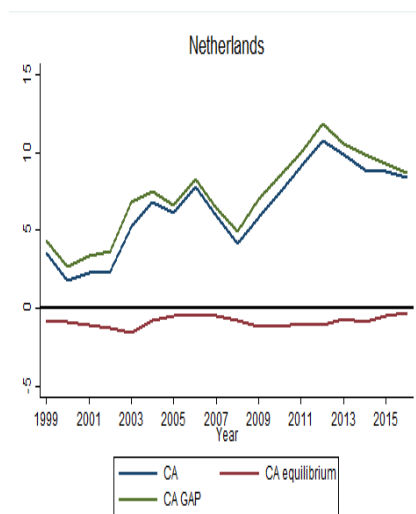
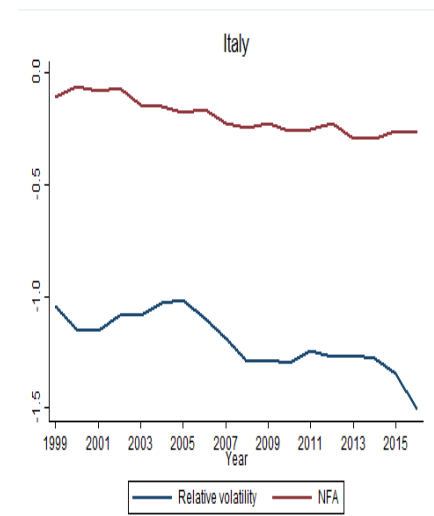
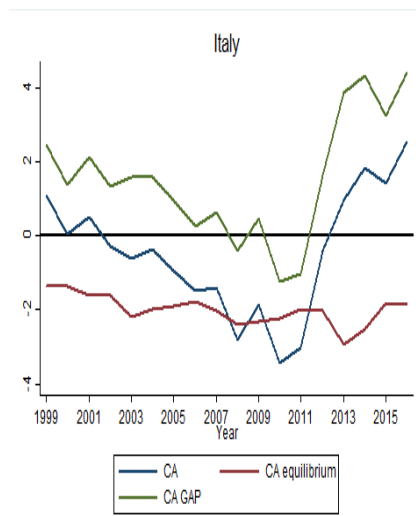
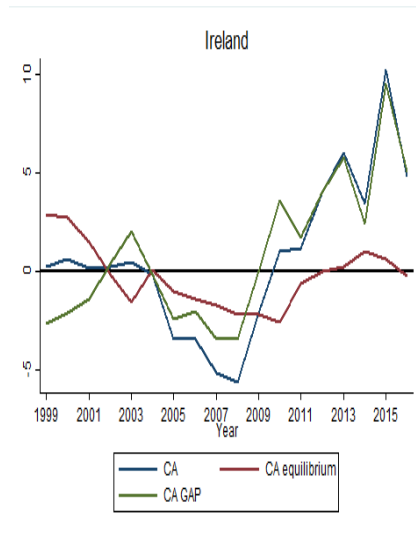


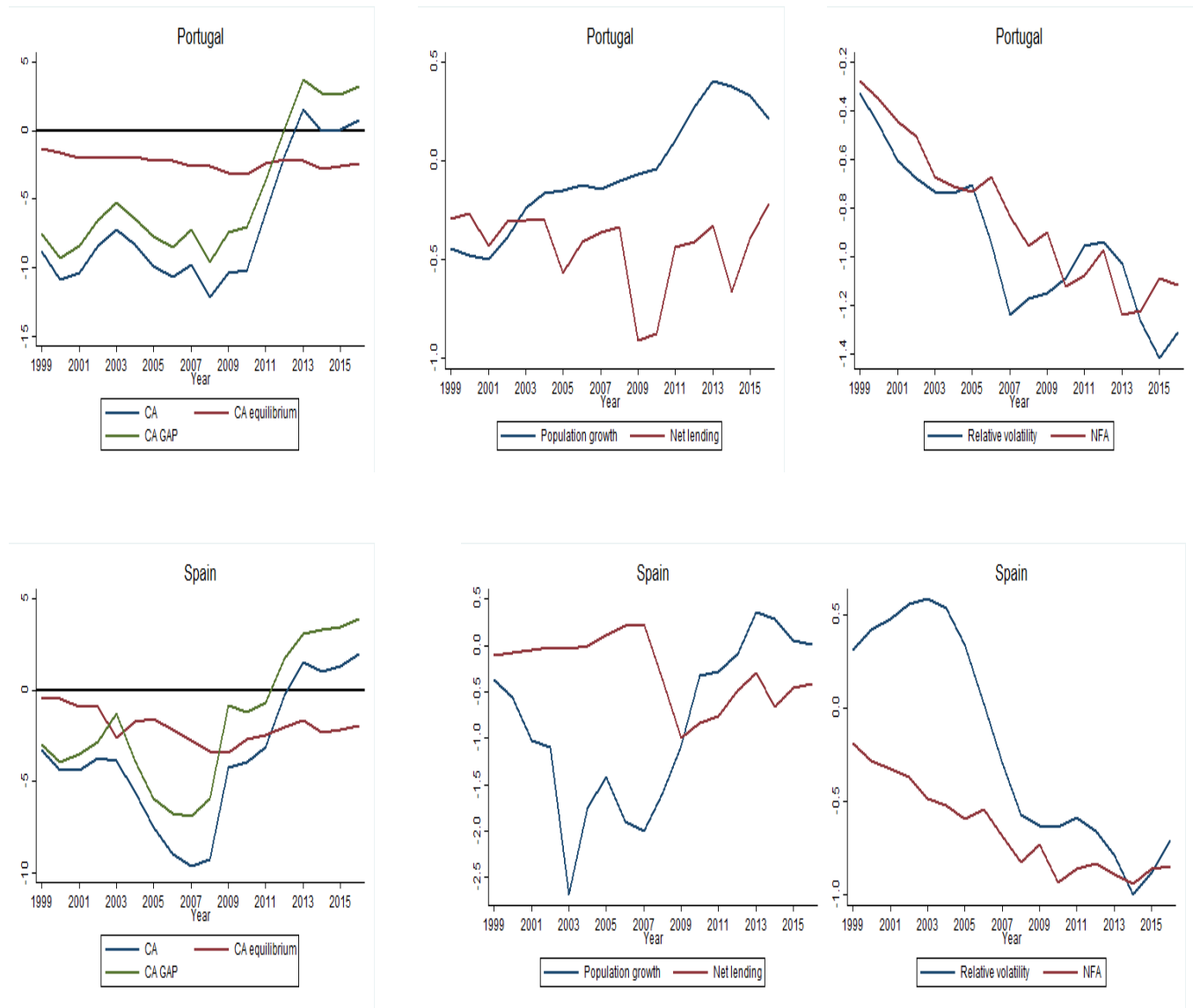
Note: CA (resp. CA equilibrium) is the observed (resp. equilibrium) current account. CA GAP denotes the current account imbalances computed as the difference between the observed and equilibrium current account.

Figure 1.C.5: CA and fundamentals 1999-2016









Note: CA (resp. CA equilibrium) is the observed (resp. equilibrium) current account. CA GAP denotes the current account imbalances computed as the difference between the observed and equilibrium current account.

Chapitre 2

Robustness of the Balassa-Samuelson effect: Evidence from developing and emerging economies[†]

[†]Une première version de ce chapitre est en révision en tant que Document de travail EconomiX. Je suis très reconnaissant envers Valérie Mignon pour ses précieux commentaires et suggestions. Je remercie également Cécile Couharde pour ses remarques très utiles.

2.1 Introduction

Sizeable currency misalignments are shown to be harmful for growth (see Aguire and Calderon, 2005; Gala, 2007). This issue is particularly critical for Emerging Markets and Developing Countries (EMDEs), which can rely on a competitive real exchange rate (RER) policies to promote their economic development. A proper assessment of their equilibrium exchange rates is thus more important as commonly thought as it allows an appropriate monitoring of the evolution of their currency misalignments. Such exercise is, however, affected by significant measurement issues surrounding the consideration of the Balassa-Samuelson (BS, hereafter) effect, the main driving force behind the long-run dynamic of the RER (Couharde et al., 2018). According to the BS effect (Balassa, 1964; Samuelson, 1964) a relatively larger productivity growth in the domestic traded goods compared to the non-traded goods sector causes wage increases in the tradable goods sector. Assuming wage equalization across sectors it leads to a rise in the relative price of non-traded to traded goods, pushing up the general price level and leading therefore to a RER appreciation. In fact, the BS effect relies on two components (Canzoneri et al., 1999): internal and external components (Égert et al., 2003; García-Solanes and Torrejón-Flores, 2009). The internal version is the positive relationship between the productivity differential and the relative price of non-tradables, while according to the external version higher relative price of non-tradables should appreciate the RER. The problem is that the investigations of the BS effect suffer from two main measurement issues. On the one hand, the productivity differential and the relative price of non-tradables to tradables have to be carefully appraised as they are the two key ingredients of the BS effect. On the other hand, an adequate econometric framework is also required to properly estimate the extent of the BS effect, especially in the context of panel data. However, despite their great importance, these different issues have not yet been addressed in the literature examining EMDEs. This chap-

ter aims at filling this gap.

We provide an in-depth investigation of the BS hypothesis for EMDEs by simultaneously addressing the two aforementioned issues on a sample of 38 developing and emerging economies over the period 1980-2016. As the relative price of non-traded to traded goods stands at the heart of the BS effect, we begin our empirical investigation by assessing its determinants. Although some evidence have been provided for advanced economies (see Lane and Milesi-Ferretti, 2002; Galstyan and Lane, 2009; Galstyan and Velic, 2018), to the best of our knowledge, this issue has not yet been addressed for EMDEs. It is however of primary importance as the relative price of non-tradables accounts for a significant amount of the exchange rate variation (Burstein et al., 2006; Ouyang and Rajan, 2013; Cheung et al, 2015). We then assess the internal and external versions using a battery of proxies. Specifically, we address the measurement uncertainty previously discussed by employing two alternative measures for the productivity differential, and three for the relative price of non-tradables. On the one hand, we use the Gross Domestic Product Per Worker (GDP PW) and the labor productivity differential between tradable and non-tradable sectors as a measure of productivity differential. On the other hand, the relative price of non-tradables to tradables is appraised employing three and six sectors' value-added deflators. For the sake of robustness, fixed and time-varying weights are used in the aggregation process of the sectors into non-tradables and tradables. Moreover, for comparison purposes with existing studies, we also examine the relevance of the GDP Per Capita (GDP PC) based-proxy for the external version of the BS hypothesis.

Thus, we go further than previous examinations focusing on EMDEs (Bahmani-Oskooee and Nasir, 2004; Ricci et al., 2013; Wang et al., 2016) as we systematically investigate the robustness

of the internal and external versions of the BS effect to the proxies. Furthermore, from a methodological viewpoint, panel data investigations of the BS hypothesis extensively rely on Dynamic Ordinary Least Square (DOLS) and/or Fully Modified OLS (FMOLS) estimators which assume cross-sectional independence (see Ricci et al., 2013; Wang et al., 2016). This issue is particularly important because the ignorance of the cross-sectional dependence in the data can lead to misleading inference and even inconsistent estimation (see Pesaran, 2015; Reese and Westerlund, 2016; among others). To tackle this issue, we rely on the Cross-Sectionally augmented Distributed Lag (CS-DL) estimator recently developed by Chudik et al. (2016). This estimator is particularly suitable as it allows us to estimate long-run effects in panel data models with cross-sectionally dependent errors and presents good small sample performance. To sum up, we contribute to the existing literature in three ways. First, we provide an original analysis of the relative price of non-tradables to tradables' determinants for EMDEs. Second, we investigate the robustness of the BS effect using a large battery of measures. Finally, we make use of a new methodology allowing us to tackle the issue of cross-sectional dependence.

Our estimations provide evidence that government consumption expenditures are a robust driver of the relative price of non-tradables, which is also affected -but to a lesser extent- by the trade balance. Our results show quite strong support in favor of the internal version of the BS effect if we use the labor productivity differential between the tradable and non-tradable sectors: a 1% increase in the labor productivity differential raises the relative price of non-traded to traded goods by about 0.15% to 0.35%. Furthermore, our findings strongly support the external version of the BS hypothesis. Indeed, no matter the sectoral value-added deflators or the aggregation schemes examined, a significantly positive effect on the Real Effective Exchange Rate (REER) is obtained.

At least, a 1% increase in the price deflator leads to an appreciation of the currency going from 0.18% to a maximum of 0.32%. We also show that GDP PC is clearly inadequate to detect the existence of BS hypothesis for our sample of countries.

Our chapter is organized as follows. In Section 2.2, we discuss the conceptual issues associated with the BS effect. Section 2.3 discusses how to measure the BS effect. Section 2.4 provides an overview of the empirical evidence for the BS effect. Section 2.5 presents the data and methodology. Section 2.6 reports and discusses our empirical results. Finally, Section 2.7 concludes the chapter.

2.2 Conceptual issues

This section is devoted to the presentation of the conceptual issues associated with the Balassa-Samuelson effect. Section 2.2.1 presents the Balassa-Samuelson theoretical framework. Section 2.2.2 discusses the recent theoretical developments of the BS framework.

2.2.1 The Balassa-Samuelson theoretical framework

In this section, we develop the Balassa-Samuelson theoretical framework, which is a useful benchmark for our empirical investigation.

2.2.1.1 The intercountry relative price of non-tradable in terms of tradable goods

One way of giving a very simplified representation of the BS effect is to take the example of two open economies—a catching-up economy and an advanced country—that produce two types of goods: tradable goods (T) and non-tradable goods (NT). If we suppose that the price index (p , expressed in logs) in each economy is a geometric average of traded and non-traded goods prices, log-differentiating the expressions for prices yields:

- In the catching-up economy:

$$\dot{p} = \gamma \dot{p}_{NT} + (1 - \gamma) \dot{p}_T \quad (2.1)$$

- In the more advanced country:

$$\dot{p}^* = \gamma \dot{p}_{NT}^* + (1 - \gamma) \dot{p}_T^* \quad (2.2)$$

where foreign variables (i.e., variables related to the trading partners) are flagged with a star and the $\bullet$ denotes the rate of change. γ is the share of non-tradable goods in the consumption basket, assumed to be the same in the two economies for simplicity.

The real exchange rate (q , expressed in logs) between the two economies is, by definition, the nominal exchange rate adjusted by price levels:

$$\dot{q} = \dot{s} + \dot{p} - \dot{p}^* \quad (2.3)$$

where s is the exchange rate defined in units of the currency of the advanced country per units of the currency of the catching-up economy.

Then, substituting (2.1) and (2.2) into (2.3) gives:

$$\dot{q} = \dot{q}_T + \gamma[(\dot{p}_{NT} - \dot{p}_T) - (\dot{p}_{NT}^* - \dot{p}_T^*)] \quad (2.4)$$

Equation (2.4) indicates that the appreciation of the real exchange rate in the catching-up economy can be explained by two factors: (i) the increase in the relative price of tradable goods, $\dot{q}_T$, and (ii) the increase in the relative price of non-tradable in terms of tradable goods. If Purchasing

Power Parity (PPP) holds only for tradable goods, then the appreciation of the real exchange rate in the catching-up economy will stem from faster rise in the prices of non-tradables relative to tradables compared to the advanced economy.

The faster rise in the relative price of non-tradable in terms of tradable goods may come from a variety of factors. For Balassa (1964) and Samuelson (1964), it results from higher relative productivity gains in the tradable sector in the catching-up economy.

2.2.1.2 The intercountry productivity differential between the tradable and the non-tradable sectors

Assuming that the production functions in the two sectors are of Cobb-Douglas type, as in De Gregorio et al. (1994) and Rogoff (1996), we have:

$$Y_T = A_T L_T^{\alpha_T} K_T^{1-\alpha_T} \quad (2.5)$$

$$Y_{NT} = A_{NT} L_{NT}^{\alpha_{NT}} K_{NT}^{1-\alpha_{NT}} \quad (2.6)$$

where Y designates output, L labor and K capital. α represents the share of labor in the sectors' value-added, and A denotes the total productivity of factors. Under perfect competition, prices in each sector are thus given by:

$$P_T = \frac{1}{A_T} W^{\alpha_T} R^{1-\alpha_T} \alpha_T^{-\alpha_T} (1 - \alpha_T)^{-(1-\alpha_T)} \quad (2.7)$$

$$P_{NT} = \frac{1}{A_{NT}} W^{\alpha_{NT}} R^{1-\alpha_{NT}} \alpha_{NT}^{-\alpha_{NT}} (1 - \alpha_{NT})^{-(1-\alpha_{NT})} \quad (2.8)$$

where W is the unit cost of labor and R the rate of return on capital. If we consider the case of a small open economy with perfect capital mobility and P_T as the numeraire, then PPP in the tradable goods sector ensures that the rate of return in tradables (R) is equal to its world value. Log-differentiating the expressions for prices yields:

$$\dot{p}_{NT} = -\dot{A}_{NT} + \alpha_{NT}\dot{w} \quad (2.9)$$

$$\dot{p}_T = -\dot{A}_T + \alpha_T\dot{w} = 0 \quad (2.10)$$

where variables in lowercase are expressed in logarithmic terms. Solving for the difference, the increase in the relative price of non-tradable in terms of tradable goods can be written in the catching-up economy as:

$$\dot{p}_{NT} - \dot{p}_T = \frac{\alpha_{NT}}{\alpha_T} \dot{A}_T - \dot{A}_{NT} \quad (2.11)$$

Equation (2.11) corresponds to the internal version of the BS hypothesis. A positive productivity differential between the tradable and non-tradable sectors is expected to rise the relative non-tradable price. Assuming for simplicity that $\frac{\alpha_{NT}}{\alpha_T}$ is the same in the two economies, we have:

$$\dot{p}_{NT}^* - \dot{p}_T^* = \frac{\alpha_{NT}}{\alpha_T} \dot{A}_T^* - \dot{A}_{NT}^* \quad (2.12)$$

Substituting equations (2.11) and (2.12) into Equation (2.4) yields to the following expression for the real exchange rate:

$$\dot{q} = \dot{q}_T + \gamma \left[\frac{\alpha_{NT}}{\alpha_T} (\dot{A}_T - \dot{A}_T^*) - (\dot{A}_{NT} - \dot{A}_{NT}^*) \right] \quad (2.13)$$

Then, if PPP holds only for tradable goods, the appreciation of the real exchange rate in the catching-up economy will stem from faster relative productivity growth in the tradable goods sector compared to that of the advanced country.

2.2.2 Theoretical developments

2.2.2.1 BS effect and the new trade theory

One strand of the theoretical literature makes use of the development of the "new trade theory" to enhance the basic BS framework through the endogenization of three key ingredients:

- goods' tradability (Bergin et al., 2006),
- spatial location of firms (Mejean, 2008),
- inclusion of Terms Of Trade (TOT) adjustment (Choudhri and Schembi, 2010).

As shown by Bergin et al. (2006), one possible way to capture the evolving pattern of the BS effect is to endogenize goods' tradability. To do so, they propose an updated BS framework constituted of a continuum of goods differentiated by their productivity. In their model, goods' tradability results from firms' choice which decide to trade a good only if it is sufficiently productive to support the associated trade costs. The time varying pattern of the BS effect is captured by the existence of two additional channels associated with a productivity rise in traded goods. On the one hand, following a productivity rise in the traded sector, wages in the domestic sector increase and some goods become non-traded because they are no longer enough beneficial to be exportable. It reinforces thus the BS effect through the increase of the share of non-traded goods

in the domestic basket pushing upwards the cross-country effect of wage rate. On the other hand, the BS effect is mitigated by the reduction in the traded goods' share which lowers the relative productivity effect. While this model constraints traded goods' producer firms to produce either locally or in the foreign economy, Mejean (2008) builds a framework where the spatial location of these firms is endogenously determined. In her model, a rise in the domestic productivity of the tradable sector affects the RER through three different channels: the BS effect, a "terms-of-labor" effect and an expenditure switching effect. The "terms-of-labor" effect reinforces the BS effect. To take advantage of the productivity improvement in the domestic tradable sector, firms decide to produce locally exerting upward pressures on domestic wages, reinforcing the BS effect. The "expenditure switching effect" acts in opposition with the BS effect. Following the location choice of firms to go in the local market, the share of domestically produced goods in consumption increases, reducing thus the non-tradable price because consumers are able to save on trade costs as there is a higher number of domestic firms. To investigate which effect dominates, Mejean (2008) performs a panel cointegration analysis. She finds that the "terms-of-labor" effect dominates the "expenditure switching effect". Choudhri and Schembi (2010) also consider the role played by firms entries and its potential effect on TOT.¹ Indeed, to understand the failure of the BS effect, a two-country model with differentiated traded and non-traded goods is built where the role of TOT is explicitly modelised. An improvement in traded productivity can either appreciates or depreciates the RER because of the ambiguous effect on TOT. For example, following a rise in the home traded productivity firms entry in this sector, lower the price of the home traded good. Hence, two antagonist effects are at play: (i) the RER appreciates via the relative price of non-traded goods, but (ii) depreciates *via* the TOT channel.

¹In their model, TOT are computed as the ratio between the price of the exported and imported varieties. They also assume that TOT have a positive effect on the RER, meaning that the income effect dominates the substitution effect.

2.2.2.2 BS effect and imperfect competition

The traditional assumption of perfect competition in the BS framework is relaxed by Coto-Martinez and Reboredo (2014). In their amended BS model, the price of non-traded and traded goods is no longer determined only by marginal costs but also by firms' mark-ups. As firms benefit from market power, they are able to fix a price above their marginal costs. Their framework shows that mark-up variations produce changes in prices provided that mark-up movements in one sector are not offset by those prevailing in the other sector. Their model is empirically verified on a sample of 12 OECD countries over the period 1970-2006. Using Mean Group (MG) and Pooled Mean Group (PMG) estimators, they confirm their theoretical prediction as a rise in mark-up differentials between tradable and non-tradable goods positively affects the relative price of non-traded goods. More specifically, a 1% increase in the mark-up differentials leads to a decrease of relative price by about 0.81%. While imperfect competition is assumed for both sectors by Coto-Martinez and Reboredo (2014), Bénassy-Quéré and Coulibaly (2014) assume monopolistic competition only in the non-tradable sector. They investigate the role played by product market regulation on the RER dynamic of some European economies. Consistent with Coto-Martinez and Reboredo's model (2014), they show that market power affects the RER. This theoretical prediction is confirmed by an empirical analysis for 12 European countries over the period 1985-2006, where product market regulation is shown to positively affect the RER.

2.2.2.3 BS effect and the labor market

The transcription of Balassa (1964) and Samuelson (1964) ideas in a modern framework relies on the following assumptions regarding the labor factor: (i) perfect labor mobility across the tradable and non-tradable sectors, (ii) homogeneity of the labor factor and (iii) perfect competition. In front

of the inability of the BS hypothesis to fully explain the RER dynamic, these assumptions have been continuously relaxed through the following ways: inclusion of firing and hiring costs (Shen and Xu, 2011), consideration of heterogeneity in the labor factor (Doan and Gente, 2014), inclusion of imperfect labor mobility across sectors (Cardi and Restout, 2015), labor wedge² (Berka et al., 2018) and sector varying labor market unionization rate (Berka and Steenkamp, 2018). While the costs associated to job search are eluded from the basic BS framework, Sheng and Xu (2011) extend it to an environment with search and unemployment where firms and workers face firing and hiring costs. Hence, obviously the filling up of a vacant job takes time for firms. The traditional BS framework emerges as a special case of their model where hiring and firing costs are equal to zero. Such labor market frictions influence the BS effect as part of the relative productivity rise will be used by firms to cover these frictional costs. Hence, wages increase is lower and the BS effect is mitigated. To examine the empirical relevance of their theoretical framework, Shen and Xu (2011) employ a dummy variable measuring "relative labor market inefficiency"³ which is interacted with GDP PC. They show that economies with high labor market frictions present lower effect for productivity, confirming thus their framework. More recently, Berka et al. (2018) build an amended BS framework where labor market distortions are taken into account. In their new-Keynesian Dynamic Stochastic General Equilibrium (NK DSGE) 2 sectors framework, it is shown that a labor supply shock affects the RER through the TOT channel. Indeed, as a labor supply shock raises the relative wages, export prices increase leading thus to a RER appreciation. In their empirical investigation on the eurozone, they find evidence of a BS effect if and only if they control for labor wedge through Unit Labor Cost (ULC). The positive effect expected for the labor wedge proxy is confirmed by the significantly positive sign for the ULC.⁴ While in the

²Berka et al. (2018) defined the labor wedge as the difference between the marginal product of hours worked in production and the marginal rate of substitution between labor and consumption.

³The labor market inefficiency variable is measured as hiring and firing costs in number of weeks of salary. The dummy is equal to one if a country has higher hiring and firing costs than those of the UK which is 1 by default.

⁴It is worth mentioning that the positive effect of ULC has already been highlighted by Mejean (2008).

previous model, the source of the labor wedge is not explicit, Berka and Steenkamp (2018) amend the specification proposed by Berka et al. (2018) with varying labor market unionization rate. Their amended BS framework is supported by their estimation as an increase in the sectoral wage mark-ups due to labor market institution appreciates the RER.⁵

Cardi and Restout (2015) also relax the hypothesis of perfect labor mobility across sectors in a two sector small open economy model allowing for a limited substitutability in hours worked. Constructing traded and non-traded productivity from the Solow residuals of a production function with capital stock and employment, they provide evidence contrary to the BS effect. These findings are reconciled with this hypothesis showing that countries with higher intersectoral labor reallocation experience higher relative price increase and lower wage decrease. While the assumption of labor homogeneity is common, Doan and Gente (2014) relax this hypothesis in a two-sector specific model where only capital is mobile across sectors. They assume that the traded sector is intensive in skilled workers, while the non-traded sector is unskilled labor intensive. In their model, a rise in traded productivity entails two effects: (i) a decrease in non-tradable goods production, (ii) a rise in the skilled wages and reduction in the unskilled wages since the traded sector is labor intensive. In their model, a reversed BS effect can occur if the share of unskilled workers wage in total wages exceeds the unskilled labor share diminishing the global demand. Thus, countries exporting skilled labor-intensive goods can face a RER appreciation following a traded productivity shock depending on the share of skilled to unskilled workers in the economy. Considering skilled workers as the proportion of persons having completed tertiary education, they can confirm their model prediction through a cointegration analysis.

⁵They use different proxies of structural labor market differences: measures of concentration of unions at aggregate and sectoral levels, union density rate and replacement rate.

2.2.2.4 Introduction of the distribution sector

The tradable and non-tradable sectors obviously constitute an aggregate of different sectors. One of them is the distribution sector which has received a special interest in the literature. Traditionally, the wholesale and retail trade has been considered as a non-tradable sector. Devereux (1999) was the first to endogenize the distribution sector in the BS framework. He shows that an increase in the productivity of the traded sector leads to a rise in consumption; it expands the distribution sector's size and lowers the price for goods distribution. The traded goods price faced by the consumers is thus lower and the RER can depreciate. Shortly after Devereux (1999), MacDonald and Ricci (2005) develop a model where the effects of a rise in productivity in the distribution sector are explicitly modeled. In their framework, two antagonist effects are at play. On the one hand, a rise in productivity in the distribution sector is associated with lower price for consumers, depreciating the RER. On the other hand, the RER appreciates as higher productivity in the distribution sector lowers the price of tradables by lowering the cost of distributing intermediate inputs. Given the absence of clear-cut predictions from their model, they investigate which effect dominates through an empirical analysis. To this aim, they rely on a sample of 9 OECD countries over the period 1970-1991. They show that productivity in the distribution sector relative to the US is positively correlated with the RER. In other words, the use of services from the distribution sector to deliver intermediate goods in the production of tradables has a larger impact on the RER than the use of distribution services to deliver final goods to consumers.

2.2.2.5 BS effect and OverLapping Generation (OLG) model

In the face of the failure of the BS effect for some developing economies, several amendments to the benchmark model have been proposed. One common feature of these studies is to consider how countries' macroeconomic characteristics can affect the effect of the differential productivity on the RER. Examples of characteristics examined are: (i) constraints on capital inflows (Gente, 2006; Christopolous et al., 2012), and (ii) saving rate and population growth (Doan and Gente, 2013). An efficient way to include these different factors is to rely on OverLapping Generation (OLG) models. Building on an OLG model, Gente (2006) highlights the relevance of these different macroeconomic variables for the RER dynamic. Indeed, she shows the dependency of the RER to the following variables: the rate of time preference, the age dependency ratio and external constraints. More precisely, to shed some light on the RER determinants of Asian economies, she develops a two sector small open economy OLG model where the country faces a constraint on capital inflows. If the economy is constrained, the RER is determined by both demand and supply shocks. The theoretical effect of higher traded productivity on the RER is ambiguous. The mechanism proposed by Gente (2006) is the following: higher traded productivity affects the return of each sector and increases the interest rate. Then, we observe a lower aggregate demand leading to a RER depreciation. This capital inflows constraint creates thus a gap between domestic and world returns on capital to explain the mechanism. While capital flows are explicitly constrained, their interaction with the BS effect is not examined in Gente's model. That is why Christopolous et al. (2012) consider this issue. Their results lend support for the theoretical implications of their model: the RER appears to be mainly driven by productivity and NFA in countries that face external constraints and exclusively by productivity in countries with perfect access to international capital markets. Using a sample of 21 countries over the 1974-2004 period,

they find evidence of a positive effect of the productivity gap on the non-traded to traded relative price ratio using the Groningen Growth and Development Center (GGDC) database. Furthermore, Doan and Gente (2013) also develop an OLG semi-small open economy model to investigate the relationship between the RER and countries' savings. They show that in a low-saving country and/or a high-population-growth country, a rise in productivity may appreciate or depreciates the RER.

2.3 How to measure the BS effect?

Section 2.3.1 discusses the concept of tradability. The examination of the internal version of the BS effect requires the specification of the determinants of the relative price of non-traded goods which are reviewed in Section 2.3.2. Finally, Section 2.3.3 surveys the determinants of the RER required in the examination of the external version of the BS effect.

2.3.1 Discussion on tradability

Tradability lies at the heart of the Balassa-Samuelson theory as the latter considers traded and non-traded goods. This concept of tradability receives both empirical and theoretical considerations. From a theoretical point of view, Betts and Kehoe (2001) provide an original definition of tradability. Rather than following the traditional tradable/non-tradable dichotomy, they prefer to rely on the degree of tradability of a good as in Obstfeld and Rogoff (1996). In their approach, tradability is defined by the degree of substitutability in consumption between units of the same good produced in different countries and by the transaction cost that must be incurred to consume goods outside their country of origin. They argue that the traditional dichotomy of goods into purely tradables and non-tradables is empirically inappropriate. Tradability also receives empirical

considerations. De Gregorio et al. (1994) are among the first to propose a sectoral classification between tradable and non-tradable sectors, which is currently the most widely used in empirical studies. Following De Gregorio et al. (1994), a sector is defined as tradable if the ratio of its total exports to total production exceeds a 10% threshold.^{6,7} This approach presents the merit to be simple and easily implementable. However, it has the drawback to impose the same sectoral classification for each country across the whole period examined. Aware of this limitation, Dumrongrittikul (2012) proposes an original approach which is applied to a panel of 33 advanced and emerging economies over the period 1970 to 2008. Contrary to De Gregorio et al. (1994), Dumrongrittikul (2012) computes the tradability ratio for each sector in a given country at a specific year.⁸ He considers three different cases in his analysis. First, as in De Gregorio et al. (1994), if the tradability ratio for a year is below the 10% threshold, the sector examined is classified as non-tradable this year. If the tradability ratio is above 20%, the sector is categorized as tradable over this year. In situations in which the ratio is between 10% and 20%, he implements the Conzalez-Soriano price test to help to assess the sector's tradability. In the first step, the domestic sectoral price is regressed on the world sectoral price. Then, using the residuals from the previous step, two different error correction models are estimated using the domestic and world sectoral prices as endogenous variables. If the null of no cointegration is rejected in at least one specification, the sector is classified as tradable; otherwise the domestic sectoral price is regressed on the world sectoral price. Finally, if the world sectoral price significantly affects the domestic sectoral price, the sector examined is assumed to be tradable; otherwise non-tradable. While "exogenous" thresholds are set by De Gregorio et al. (1994) and Dumrongrittikul (2012), Bems (2008) assumes that the

⁶De Gregorio et al. (1994) consider 14 OECD countries over the period 1970-1985. In their analysis, the following sectors are considered: agriculture, mining, manufacturing, transportation and other services.

⁷In the following, we refer to this ratio as the tradability ratio.

⁸Dumrongrittikul (2012) considers the following sectors in his empirical analysis: agriculture, hunting, forestry and fishing; mining, utilities; manufacturing; construction; wholesale and retail trade, hotels, restaurants; transport, storage, communication and other activities.

wholesale and retail trade sector is the benchmark as this sector is known to produce non-tradable outputs.⁹ According to Bems (2008), a sector is classified as non-tradable (resp. tradable) if its tradability ratio is lower (resp. higher) than the one of the wholesale and retail trade sector in the same country. Using the same approach as Bems (2008) and a 10% critical threshold, Lombardo and Ravena (2012) find substantial variation in the effective threshold, introducing thus important cross-country variability in sectors' tradability.¹⁰

2.3.2 Determinants of the relative price of non-traded goods

2.3.2.1 Government consumption expenditures

In traditional macroeconomic frameworks, government consumption expenditures are assumed to be biased towards non-tradable goods (Froot and Rogoff, 1991). A rise in government consumption expenditures is thus associated with an increase in the non-traded goods' demand pushing-up the relative price of non-traded to traded (see Froot and Rogoff, 1991; among others). This determinant received strong empirical support in the literature, as notably shown by Galstyan and Lane (2009) and Galstyan and Velic (2018).

2.3.2.2 Government public debt

The public debt has been recently proposed as a new determinant of the relative price of non-tradables to tradables by Galstyan and Velic (2018). They build a theoretical framework where higher public debt can be financed through two instruments: borrowing and labor taxation. They show that if higher level of public debt is issued through the second instrument, it can affect the relative price of non-traded goods. Indeed, following a rise in labor taxation, labor supplies in the

⁹Its interest lies in the tradable content of investment.

¹⁰It is worth noting that the sensitivity of the classification to a specific threshold has been investigated by Piton (2019) on a sample of advanced economies. She shows that a threshold of 15% would exclude financial and insurance activities and information and communication from the tradable sector. Using a threshold of 20% would also exclude professional, scientific and technical activities from the tradable sector as well as information and communication.

tradable and non-tradable sectors are contracted. The effect of public debt is thus ambiguous and depends on the relative factor intensity. In the case where the non-tradable sector's output is more labor intensive, we expect a positive effect of the public debt on the relative price of non-traded goods as the decrease in labor supply is higher in the non-tradable sector than in the tradable one. On the contrary, if the tradable sector is more intensive, the public debt effect is negative. Disentangling the two effects is thus an empirical issue that is investigated by Galstyan and Velic (2018). To this aim, controlling for the traditional determinants of the relative prices of non-tradables, they examine the effects of government public debt and labor taxation.¹¹ Considering 15 advanced economies over the period 1980–2007, they find a positive effect of labor taxation and general government gross debt on the relative price of non-tradables. Their results are consistent with a non-tradable sector exhibiting higher labor share than the traded sector.

2.3.2.3 Government investment

By its effects on productivity, larger stock of public capital can influence the relative price of non-tradable to tradable goods. To formalize the underlying mechanisms, Galstyan and Lane (2009) build a two-sector small open-economy model including the stock of public capital in the production functions of the tradable and non-tradable sectors. Due to its heterogeneous effects across sectors, government investment has an ambiguous impact on the non-tradable relative price. In their theoretical framework, different situations emerge depending on which sectors benefit the more from higher public capital stock. In the case where government investment mainly rises productivity in the non-tradable sector, it leads to an increase in the relative supply of non-traded goods causing a decrease in the relative price. On the contrary, if productivity gains are more

¹¹Following Eurostat methodology, labor taxation is measured as the implicit tax rate on labor. It is calculated as the "sum of all direct and indirect taxes and social contributions, divided by the total economic remuneration of employees working in the economic territory".

concentrated in the tradable sector, the relative supply of tradable goods increases pushing up the relative price of non-traded goods. This theoretical indetermination is addressed by an empirical investigation, where a panel of 19 advanced countries is examined over the period 1980-2004. Galstyan and Lane (2009) confirm the existence of an ambiguous effect of government investment (expressed as share of GDP) as they obtain significant coefficients ranging from -3.63 to 8.47 on different sub-samples. Galstyan and Velic (2018) also consider this determinant in their empirical analysis. Instead of government investment, they use the public capital stock and provide evidence of a positive effect for this variable.

2.3.2.4 Trade balance

The trade balance is expected to influence the relative price of non-traded to traded goods dynamic through three mechanisms (Lane and Milesi-Ferretti, 2002). First of all, as a trade balance surplus is associated with an absorption level below domestic production, the demand for non-traded goods is lower. Furthermore, an improvement in the trade balance also leads to a negative wealth effect. We thus expect an increase in labor supply in both sectors, decreasing the production costs for the non-tradable sector; contributing to the decrease of the relative price. Moreover, as argued by Lane and Milesi-Ferretti (2002), the necessity to sustain a trade balance surplus also works through labor force movements from the non-tradable sector to the tradable one. From an empirical perspective, different outcomes are proposed by the literature. Lane and Milesi-Ferretti (2002) successfully confirm their predictions as higher trade balance surplus decreases the relative price of non-tradables to tradables. More recently, Galstyan and Lane (2009) fail to find support for this variable while Galstyan and Velic (2018) provide evidence of a negative effect.

2.3.2.5 Relative income

The level of GDP PC of a country is expected to influence the relative price of non-traded goods through the Penn-effect i.e. the positive association between per capita income and price level. Evidence in favor of this hypothesis is provided by Lane and Milesi-Ferretti (2002) showing a positive effect of relative income on the relative price of non-tradables. The impact is expected to be positive as it occurs through a positive wealth effect which increases demand for non-traded goods. The relationship between both variables can also be subject to non-linearity as shown by Hassan (2016). Indeed, the price-income relationship turns out to be significantly negative in poor countries, while it is positive for richer economies.

2.3.3 Determinants of the RER

This section is devoted to a quick overview of the main RER determinants for EMDEs. Our determinants selection builds extensively on the seminal paper from Edwards (1988).¹² He proposes a three-goods sector economy to apprehend real exchange rate determination for developing economies. In the long run, he shows that only real variables affect the RER dynamic of the 12 developing economies examined. His theoretical framework provides thus a list of variables useful to investigate the behaviour of the RER (import tariffs, terms of trade, the composition of government consumption and capital flows).

2.3.3.1 Trade openness

Countries' trade openness has been examined as a RER determinant because it proxies for trade liberalization (IMF, 2013). As further trade liberalization is expected to lower the domestic price level, trade openness should be negatively signed. For EMDEs experiencing significant variation

¹²Theoretical frameworks applicable for developing and emerging market economies are also proposed by Elbadawi (1994) and Elbadawi and Soto (2004).

in their trade openness degrees, this variable seems to be particularly relevant (Elbadawi, 1994; Dufrénot and Yehoue, 2005). Dufrénot and Yehoue (2005) obtain an elasticity equals to -0.30 for middle-income countries, while a lower effect is evidenced for low-income countries.

2.3.3.2 Terms Of Trade

The impact of TOT on the RER is ambiguous as two antagonists effects are at play, an income and a substitution effect (Couharde et al., 2018). The income effect leads to a positive wealth effect and increases non-traded goods' demand. In order to ensure internal balance, a real depreciation is needed. In the case of the substitution effect, producers are expected to move their production towards the tradable sector which leads to a wage increase in this sector. Assuming wage equalization across both sectors, we expect an increase in the overall price level, leading thus to an appreciation of the domestic currency.¹³ Although ambiguous, the appreciating effect of higher terms of trade on the RER is a standard result (Elbadawi, 2004). For example, empirical evidence provided by Dufrénot and Yehoue (2005) show that the income effect dominates the substitution effect on a sample of low and middle income countries.

2.3.3.3 Government consumption expenditures

The government consumption expenditures are expected to affect the RER through the well-known Froot-Rogoff effect (Froot and Rogoff, 1991). As government consumption expenditures are biased towards non-traded goods, a positive effect is expected for this determinant. This variable has been investigated through several studies (see Edwards, 1988; De Gregorio and Wolf, 1994; Chinn, 1997). Examining 73 developing countries over the 1970-2004 period, Elbadawi (2004) finds that a lower fraction of government expenditures on traded goods leads to RER appreciation.

¹³In line with the TOT effect, is worth mentioning that part of the literature investigates the existence of commodity currencies (see Cashin et al. (2004) among others).

2.3.3.4 Fertility rate

The fertility rate is expected to influence the RER through the savings channel. A higher fertility rate is associated with lower savings due to the increase in the young dependency ratio. At the same time, it also increases domestic investment due to the decline in the future equilibrium capital stock. The current account is then deteriorated and the domestic currency appreciates (see Higgings, 1998; Rose et al., 2009; Hassan et al., 2011). Moreover, as the young's consumption is biased towards non-traded goods (Rose et al., 2009), a higher fertility rate is thus again expected to be positively signed. Examining a panel of 87 countries over the period 1975–2005, Rose et al. (2009) provide robust evidence of a positive sign for this determinant.

2.3.3.5 Government investment

In addition to investigate the effect of government investment on the non-traded to traded relative price, Galstyan and Lane (2009) also examine how relative government investment affects the RER. They failed to find a significant effect of relative government investment on the RER of advanced economies over the period 1980-2004.

2.3.3.6 Foreign Direct Investment

The theoretical effect of the Foreign Direct Investment (FDI) on the RER is ambiguous. Following Kosteletou and Liargovas (2000), we assume a trade integrated model in the presence of a small open economy, which is a price taker. Within this framework, the FDI effect depends on the way capital inflows are used in the domestic economy. These effects are likely to work through two main transmission channels. On the one hand, if capital inflows are used for a spending finance purpose, it raises the traded and non-traded goods' demand. As the traded goods' price is fixed in the world economy, higher FDI appreciates the RER. On the other hand, FDI also affects capital

accumulation in the non-tradable and tradable sectors which raises productivity in both sectors. The net effect of this channel thus depends on which sector benefits the more from the productivity increase.

2.3.3.7 Net Foreign Asset position

The connection between real exchange rates and net foreign assets derives from the intertemporal budget constraint which links external assets, real exchange rate and trade balance together, as documented by Lane and Milesi-Ferretti (2002). When a country runs a current account deficit, it is building up liabilities to the rest of the world. Solvency requires that the country be willing and able to (eventually) generate sufficient current account surpluses to repay what it has borrowed to finance the current account deficits. Therefore, a country running a current account deficit (borrowing more) may have an overvalued currency. Indeed, it should register a more depreciated real exchange rate in order to restore external equilibrium. Conversely, net creditor countries may have an undervalued currency and experience real exchange rate appreciations: their trade deficit will be indeed offset by investment income on their net foreign asset position.

2.3.3.8 Investment

The relevance of domestic investment (as GDP share) as a RER determinant has been proposed by Edwards (1989). The effect of this variable depends on the composition of investment terms of tradable and non-tradable goods. If higher investment rate raises the relative share of tradable goods, an exchange rate depreciation is expected. A currency appreciation is possible if an increasing investment rate is associated with a rise in the relative non-tradable share. Edwards (1989) finds that a higher investment rate depreciates the RER.

2.4 Overview of the evidence

The end of the 1990s and the beginning of the 2000s gave birth to a growing literature investigating the BS effect. At the heart of these studies are either heterogeneous groups of countries, or specific geographical areas. For example, Drine and Rault (2003) and Iyke and Odhiambo (2017) investigate the existence of the BS effect in Africa. The first ones consider a sample of 16 Middle East and North Africa (MENA) countries over the period 1960-1999. They use GDP PC to measure the productivity differential. While they failed to find evidence in favor of the productivity bias hypothesis for 11 of the 16 economies examined, their panel cointegration analysis provides support for the BS effect. Considering a smaller sample of countries over a longer period of time, Iyke and Odhiambo (2017) confirm Drine and Rault (2003)'s findings in a panel framework.

Besides the scarce studies existing for the African continent, the Asia-Pacific region has been, on the contrary, a source of great interest in the literature. This enthusiasm is explained by the sustained growth experienced by South-East Asian economies over the last decades of the previous century, making these countries ideal candidates for the investigation of the BS effect. The very influential study of Chinn (2000) is among the first to document the main determinants of the RER dynamic in this region. He examines 9 Asian countries over the period 1970-1992. The relative productivity between the tradable and non-tradable sectors is measured using the difference in the value-added per worker in both sectors.¹⁴ His time-series analysis validates the existence of the BS effect for 5 of the 9 Asian economies examined (Indonesia, Japan, Korea, Malaysia and the Philippines). Similar results are provided by Bahmani-Oskooee and Ree (1996) for the Korean won, and by Ito et al. (1996) for the yen and the Taiwan dollar. Updating the dataset from Chinn

¹⁴The tradable sector consists of manufacturing, while the non-tradable one is composed of services, construction, mining, and transportation.

(2000) to a most recent period, King and Thomas (2008) show that his findings continue to be valid. While previous authors only consider an external version of the BS hypothesis, Drine and Rault (2004) propose a more in-depth investigation for a panel of 9 Asian economies. They test the three following hypotheses: the positive relationship between productivity differential and relative price of tradables, the positive relationship between relative prices of tradables and REER and the verification of the PPP. All in all, they confirm the last two hypotheses, while the first one is rejected. While Chinn (2000) and King and Thomas (2008) do not assess the contribution of each determinant to the RER's variation, Tsen (2011) performs a generalized forecast error variance decomposition to analyse the relative importance of the terms of trade, productivity differential,¹⁵ real oil price and reserve differential for Hong Kong, Japan and Korea. His results show that productivity differential accounts for about 1%, 2% and 8% of the RER variation respectively for Japan, Hong Kong and Korea. To circumvent the potential drawbacks associated with the use of labor productivity measures, Kakkar and Yan (2012) prefer to rely on Total Factor Productivity (TFP) measures. To this aim, TFP series for the tradable and non-tradable sectors are constructed for 6 Asian economies¹⁶ as the Solow residuals (1957) from a Cobb-Douglas production function. Their results provide support for both the internal and external versions of the BS hypothesis.

Given their recent history, the Central Eastern European Countries (CEECs) constitute a relevant research laboratory for who seeks to investigate the BS hypothesis.^{17,18} Indeed, during the initial transition period,¹⁹ the apparition of three key elements makes these economies a particularly

¹⁵Tsen (2011) approximates the productivity differential by the ratio of GDP in volume to manufacturing employment relative to the US.

¹⁶Hong Kong, Indonesia, Korea, Malaysia, Singapore and Thailand.

¹⁷According to the Organisation for Economic Co-operation and Development's (OECD) definition, CEECs includes: Albania, Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, the Slovak Republic, Slovenia, and the three Baltic States: Estonia, Latvia and Lithuania. Following the literature dealing with the BS effect for these countries, the use of CEECs term rather refers to the following countries: Czech Republic, Hungary, Poland, Slovakia and Slovenia.

¹⁸In the following, we only review the main papers investigating this issue, see the survey by Egert et al. (2006) for more details.

¹⁹According to De Broeck and Šlók (2006), the transition period spans from 1991 to 1998.

relevant case of study: the establishment of free-market economies, the creation of new currencies and the productivity rebound. It is thus quite naturally that the BS effect has been proposed as the prime explanation for CEECs' RER movements during the transition period. Defining relative productivity as the ratio between industrial and services productivity, De Broeck and Sløk (2006) confirm the existence of the BS effect for the European Union (EU) acceding countries. Using time-series and panel econometric techniques, Egert (2002) also finds that the BS effect works well for transition economies. However, although explaining part of their exchange rate variation, this effect fails to fully explain its dynamic (Egert, 2002; Klau and Mihaljek, 2004; Egert et al., 2006). Thereupon, Egert et al. (2006) argue that: "at best, half of this appreciation can be ascribed to the B-S effect". That is why alternative explanations have been proposed, notably by Fischer (2004). He builds an amended BS framework which consists of three sectors and four inputs, where investment demand is explicitly taken into account. In his framework, a productivity shock affects both the supply and demand sides of the economy.²⁰ He shows that a productivity shock in any sector raises the equilibrium stock of physical capital, increasing investment demand which, in turn, rises the relative price of non-tradables.

Because of the role of currency misalignments as an Early Warning Indicator of currency crises, the BS effect has been examined as a long term driver of the equilibrium exchange rate in Latin American Countries (LAC). Over comparable samples of countries and over more or less long-time spans, panel estimations provide evidence in favor of the BS hypothesis within this area (Alberola et al., 2003; Drine and Rault, 2003; Garcìa-Solanes and Torrejon-Flores, 2009; Iyke, 2017). These different investigations rely on various proxies: Consumer Price Index (CPI)-to-Producer Price Index (PPI) ratio (Alberola et al., 2003), GDP PC (Drine and Rault, 2003) and average labor

²⁰It is obvious that this transmission mechanism is in contradiction with the traditional BS effect as the demand side is also affected.

productivity (García-Solanes and Torrejon-Flores, 2009; Iyke, 2017).

Probably guided by data availability motivations, the first attempts of the BS investigations focused on OECD economies.²¹ Earlier studies by Chinn and Johnston (1996) and Chinn (1997) make use of industry specific TFP series for these countries. Considering 14 OECD economies over the period 1970-1991, they established that TFP differential is a driver of the long-run RER movements. More recently, Ricci et al. (2013) fail to find evidence for this effect for 20 advanced economies over the period 1980-2004.²² Using respectively TFP differential and productivity in the tradable sector, Lee and Tang (2007) and Gubler and Sax (2019) obtain results in contradiction with the traditional view, as a higher productivity depreciates the RER. Contrary to the previous authors who use a static classification of tradability, Dumrongritikul (2012) implements a new approach allowing for country-specific and time varying tradability over each industry. With this new methodology, he finds results inconsistent with the BS effect as the traded productivity growth depreciates the REER. More recently, applying a new panel cointegration test, Wang et al. (2016) confirm the existence of a cointegrating relationship between GDP PC and REER for 20 advanced economies. Using the group mean estimator, they find an elasticity equals to 0.76 confirming thus the BS effect. The numerous studies previously discussed rely on various proxies, creating thus uncertainty on the robustness of this effect to the measures. This essential issue has been considered by Bénassy-Quéré et al. (2009) for the G20 countries over the period 1980-2005 through the use of four different proxies: the CPI-to-PPI ratio, three-sectors' value-added deflator, GDP PC and GDP PW. Estimated coefficients for the first two variables are shown to be close to unity, while the last two proxies present lower marginal effects. Besides these panel analyses, time-series

²¹For example, the STructural ANalysis (STAN) database from OECD has been widely used at the end of the 1990s and the beginning of the 2000s to investigate the effect of productivity differential on the exchange rate.

²²In their empirical investigation, Ricci et al. (2013) rely on six-sectors' value-added deflator.

investigations have also been performed for advanced economies. However, at best only mixed results are obtained (see Faria and Ledesma, 2003; Bahmani-Oskooee and Nasir, 2004; Drine and Rault, 2005; among others).

Concerning EMDEs, only scarce evidence is provided regarding the BS effect. Choudhri and Kahn (2007) propose a stimulating empirical investigation of the BS hypothesis for a sample of 16 developing economies over the 1976-1994 period. They find evidence of a positive effect of the relative price of non-traded to traded goods on the RER. Finally, they also confirm the internal version as a rise in the productivity differential is associated with higher relative price of non-tradables. Ricci et al. (2013) confirm these previous findings. They show a significant impact of relative productivity on the RER for emerging markets. While previous studies find support for the productivity bias hypothesis with sectoral measures, aggregate proxies seem to be clearly inadequate to corroborate the BS hypothesis. For example, using GDP PW, Bahmani-Oskooee and Nasir (2004) find that the major fail of the productivity bias hypothesis is due to the emerging economies in their time-series analysis of 44 advanced and emerging economies. Relying on a panel cointegration analysis, Wang et al. (2016) confirm the previous result. Indeed, the null hypothesis of no cointegration between GDP PC and RER is not rejected for a sample of 20 developing economies.

2.5 Data and methodology

2.5.1 Which proxies to measure the Balassa-Samuelson effect?

As we aim to investigate the internal and external versions of the BS effect, two "ingredients" are required. As a reminder, the internal version is a positive relationship between the productivity differential and the non-traded to traded relative price. Hence, a proper measurement of both variables is required.²³ To achieve this purpose, some of the existing databases can be useful. For example, the EU KLEMS database is of interest for who investigates the BS hypothesis in the European Union (EU). This database allows the construction of quite precise measures because of the availability of the following variables: sectoral value-added (at current and constant prices) and sectoral employment over the 1995-2015 period for 28 member states of the EU. A very narrow classification is also available: 34 industries and 8 aggregates. Consideration of a larger countries sample is possible if the World Input Output (WIO) database is used.²⁴ Although having the appealing feature to present 56 sectors, its time-series span is more limited covering the period 2000-2014. Furthermore, given our interest in EMDEs, the most interesting database for our purpose would be the GGDC database. Unfortunately, although being available from almost the year 1950, the end date is too early for us and only a few number of EMDEs are covered. Finally, we can also mention the database from Mano and Castillo (2015) which makes available real labor productivity in the non-traded and traded sectors for 56 countries.²⁵ All in all, although presenting very appealing features, these different databases are hardly compatible with our purposes. As we need to measure the relative price of non-tradables, we rely on sectoral value-added deflators. The use of relative prices can be difficult as an accurate separation between the tradable and non-tradable

²³Obviously the investigation of the external version of the BS hypothesis also requires a measure of non-traded to traded relative price.

²⁴In addition to the 28 previous EU countries, 15 other major countries are available.

²⁵Their database contains advanced and some emerging economies over the period 1989-2013.

sectors is required.²⁶ We thus use three-sectors' value-added deflators to track the evolution of the relative price of non-tradables to tradables.²⁷ The three-sectors' value-added deflator is based on (i) agricultural, (ii) industrial, and (iii) services sectors.²⁸ Total services are used to represent the non-tradable sector, whereas manufacturing and agriculture are taken together to represent the tradable sector (Choudhri and Kahn, 2005; Bénassy-Quéré et al., 2009). This decomposition is usually considered as broadly consistent with the tradability measure (Betts and Kehoe, 2001).

For a country i , the price index of value-added at time t for each sector k ($PVA_{i,t}^k$) is calculated by dividing value-added at current prices by value-added at constant prices in the accounting period and the considered sector, using 2010 as base year. As the tradable sector is composed of 2 sectors, the latter have to be aggregated together to form a composite tradable sector. To this aim, country-specific weights for each sector have been used which are measured by the value-added share of the sector in total output (i.e the sum of the values added of agriculture and manufacturing sectors). Although commonly employed in the literature, it can be viewed as a rather strong assumption as it does not take into account the evolution of the productive base. However, it ensures that the only source behind the relative price of non-tradables' dynamic is variations in non-tradable or tradable goods' price. It is thus not driven by any variation in sectoral weights. As an alternative to fixed country-specific weights, we also compute time-varying country-specific weights for each industry. We get for a country i at time t :

²⁶This issue is also widely discussed in the literature focusing on the role of the relative price of non-tradable goods in accounting for real exchange rate fluctuations (see the seminal and most cited paper of Engel (1999)).

²⁷It is possible to rely on the CPI-to-PPI ratio to track the evolution of the relative price of non-tradables to tradables. In this configuration, PPI mainly concerns tradables' prices, whereas CPI covers essentially non-tradables' prices. However, PPI is unfortunately unavailable for most countries of our sample over a long time span.

²⁸Agriculture corresponds to International Standard Industrial Classification (ISIC) divisions 1-5, and includes forestry, hunting, and fishing, cultivation of crops and livestock production. Industry corresponds to ISIC divisions 10-45, and services to ISIC divisions 50-99.

$$pva_{i,t,f} = pva_{i,t}^{serv} - \beta pva_{i,t}^{agr} - (1 - \beta)pva_{i,t}^{ind} \quad (2.1)$$

$$pva_{i,t,tv} = pva_{i,t}^{serv} - \beta_t pva_{i,t}^{agr} - (1 - \beta_t)pva_{i,t}^{ind} \quad (2.2)$$

where β and β_t for a country i are computed as follows:

$$\beta = \frac{\sum_{t=1}^T VA_t^{agr}}{\sum_{t=1}^T VA_t^{agr} + \sum_{t=1}^T VA_t^{ind}} \quad (2.3)$$

$$\beta_t = \frac{VA_t^{agr}}{VA_t^{agr} + VA_t^{ind}} \quad (2.4)$$

Computing the value-added deflators as the deviation from the main trading partners, we get:

$$def3_fr_{i,t} = pva_{i,t,f} - \sum_{j=1}^N (w_{i,j,t} \times pva_{j,t,f}) \quad (2.5)$$

$$def3_tvr_{i,t} = pva_{i,t,tv} - \sum_{j=1}^N (w_{i,j,t} \times pva_{j,t,tv}) \quad (2.6)$$

where $pva_{i,t,f}$ and $pva_{i,t,tv}$ are respectively the values added deflator based on fixed and time-varying weights, for country i expressed in logarithms. *serv*, *agr* and *ind* respectively denote services, agriculture and industry. $w_{i,j,t}$ is country i 's trade-based weights for all its partners j , N denoting the number of trading partners. $def3_fr_{i,t}$ and $def3_tvr_{i,t}$ are respectively three-sectors value-added deflators computed with fixed and time-varying weights as a deviation from trading partners.

We also consider a six-sectors' value added deflator. In the six-sector disaggregation, the following sectors are distinguished: (i) agriculture, hunting, forestry, fishing; (ii) mining, manufacturing; (iii) construction; (iv) wholesale, retail trade, restaurants and hotels; (v) transport, storage and communications; and (vi) other activities.²⁹ Following De Gregorio and al.'s (1994) classification, construction, wholesale, retail trade, restaurants and hotels, and other services are classified in the non-tradable sector, while agriculture, manufacturing, mining, utilities and transport are treated as tradable goods.

To derive the six-sectors' deflator, we follow Lee and Tang (2007) and compute country-specific weights for each sector ($\omega_{i,k}$), measured by its value-added share in total output:

$$\omega_{i,k} = \frac{\sum_{t=1}^T VA_{i,k,t}}{\sum_{k \in h} (\sum_{t=1}^T VA_{i,k,t})} \quad (2.7)$$

where h denotes the nature of the sector k under consideration, i.e., tradable (T) or non-tradable (NT) sector. We also compute time-varying country-specific weights for each sector k ($\omega_{i,k,t}$), measured by its value-added share in total output at a year t :

$$\omega_{i,k,t} = \frac{VA_{i,k,t}}{\sum_{k \in h} (VA_{i,k,t})} \quad (2.8)$$

For each country i , the aggregated value added deflator of the non-tradable ($pva_{i,t}^{NT}$) and tradable ($pva_{i,t}^T$) sectors is then calculated as a weighting average of value-added deflators for respectively all non-tradable sectors and all tradable sectors:

$$pva_{i,t,f}^{NT} = \sum_{k \in NT} (\omega_{i,k} \times pva_{i,t}^k) \quad (2.9)$$

²⁹The description of the divisions associated with each of these sectors is available in Table 2.B.7 in the Appendix.

$$pva_{i,t,f}^T = \sum_{k \in T} (\omega_{i,k} \times pva_{i,t}^k) \quad (2.10)$$

$$pva_{i,t,tv}^{NT} = \sum_{k \in NT} (\omega_{i,k,t} \times pva_{i,t}^k) \quad (2.11)$$

$$pva_{i,t,tv}^T = \sum_{k \in T} (\omega_{i,k,t} \times pva_{i,t}^k) \quad (2.12)$$

where $pva_{i,t,f}^{NT}$, $pva_{i,t,f}^T$, $pva_{i,t,tv}^{NT}$ and $pva_{i,t,tv}^T$ are expressed in logarithmic terms. Denoting $def6$ the BS measure based on six-sectors' value-added deflators, we get for a country i at time t :

$$def6_f_{i,t} = (pva_{i,t,f}^{NT} - pva_{i,t,f}^T) \quad (2.13)$$

$$def6_tv_{i,t} = (pva_{i,t,tv}^{NT} - pva_{i,t,tv}^T) \quad (2.14)$$

As previously, variables are also expressed as a deviation from the main trading partners:

$$def6_fr_{i,t} = def6_f_{i,t} - \sum_{j=1}^N w_{i,j,t} (pva_{j,t,f}^{NT} - pva_{j,t,f}^T) \quad (2.15)$$

$$def6_tvr_{i,t} = def6_tv_{i,t} - \sum_{j=1}^N w_{i,j,t} (pva_{j,t,tv}^{NT} - pva_{j,t,tv}^T) \quad (2.16)$$

The internal version of the BS hypothesis also requires to measure the productivity differential between tradable and non-tradable sectors. To this aim, we rely on the sectoral value-added

per worker of three sectors: agriculture, industry and services.³⁰ As previously, we assume that agriculture and industry are tradable sectors, and services are assumed to cover non-tradable goods. The productivity differential (in logarithm) is computed as follows:

$$prod_diff_tv_{i,t} = a_{i,t,tv}^T - a_{i,t}^{NT} \quad (2.17)$$

$$prod_diff_fixed_{i,t} = a_{i,t,f}^T - a_{i,t}^{NT} \quad (2.18)$$

where $a_{i,t,f}^T = \beta vapw_{i,t}^{agr} + (1 - \beta) vapw_{i,t}^{ind}$, $a_{i,t,tv}^T = \beta_t vapw_{i,t}^{agr} + (1 - \beta_t) vapw_{i,t}^{ind}$ and $a_{i,t}^{NT} = vapw_{i,t}^{serv}$. $vapw_{i,t}$ is the value-added per worker of country i expressed in logarithms. $prod_diff_tv$ and $prod_diff_fixed$ stand respectively for the productivity differential between the tradable and the non-tradable sectors computed with time-varying and fixed weights.

Another way to assess relative productivity is to rely on GDP PW. Investigations of the BS hypothesis have also frequently been carried out relying on relative labor productivity to capture total-economy productivity differentials (see Hsieh, 1982; Marston, 1986; Canzoneri et al., 1999; Schnatz, 2004; Bénassy-Quéré et al., 2009; among others). In this respect, we measure labor productivity as GDP per worker in constant 2011 PPP U.S. dollars.

2.5.2 Empirical strategy

In the following, we briefly outline our empirical strategy. The first step consists to select the RER determinants used in the examination of the external version of the BS effect. To tackle the uncertainty surrounding the selection of RER determinants, we rely on the Bayesian Model

³⁰Our first best will be to rely on a six sectoral values added per worker. However, due to data availability issues, this was impossible.

Averaging (BMA) methodology to have a parsimonious specification. The potential RER drivers examined are those reviewed in Section 2.3.3: trade openness, TOT, government consumption expenditures, fertility rate, government investment, FDI, NFA and investment. Specifically, the external version is apprehended through the following equation:

$$reer_{i,t} = \alpha_i + \beta_1 X_{i,t} + \gamma Z_{i,t} + \epsilon_{i,t} \quad (2.19)$$

where $reer$ is the logarithm of the REER. $Z_{i,t}$ stands for the REER determinants obtained using the BMA approach. $X_{i,t}$ refers to the different measures used to proxy the relative price of non-tradables to tradables in deviation from the main trading partners ($def6_tvr_{i,t}$, $def6_fr_{i,t}$, $def3_tvr_{i,t}$ and $def3_fr_{i,t}$).

In a second step, we test the null hypothesis of cross-sectional dependence (CSD) to apply the appropriate panel unit root tests. To this aim, we rely on the Pesaran (2004)'s test (see Section 2.C.1 in Appendix). In the next step of our empirical strategy, we implement the CIPS (Pesaran, 2007) and the Bai and Carrion-I-Silvestre (BCIS hereafter, 2009) panel unit root tests to assess the integration order of our series (see Section 2.C.2 in the Appendix). The CIPS and BCIS tests allow us to control for the presence of CSD. It is worth noting that the BCIS test is also robust to the existence of structural breaks in the series. Finally, our estimations are performed using the CS-DL approach proposed by Chudik et al.(2016) (see Section 2.C.3 in Appendix). This approach allows us to assess long-run effects in a panel where CSD is present, regardless if the regressors are $I(0)$ or $I(1)$, even if the common factors contain unit roots (Chudik et al., 2016). This estimator is interesting for our investigation as it presents better small sample performance compared to the CS-ARDL approach, for moderately large time-series ($30 \leq T \leq 50$) as shown by Monte

Carlo simulations (Chudik et al., 2016). To check the robustness of our results, we follow the suggestion formulated by Chudik et al.(2017) which is to test different lags of the first-differenced regressors. We start our empirical investigation by documenting the non-traded to traded relative price determinants for EMDEs. To this aim, the two following equations are estimated:

$$\text{def6_tv}_{i,t} = \alpha_i + \beta_1 \text{gov cons}_{i,t} + \beta_2 \text{public debt}_{i,t} + \beta_3 \text{tb}_{i,t} + \beta_4 \text{yc}_{i,t} + \beta_5 \text{public capital}_{i,t} + \epsilon_{i,t} \quad (2.20)$$

$$\text{def6_tv}_{i,t} = \alpha_i + \beta_1 \text{gov cons}_{i,t} + \beta_2 \text{public debt}_{i,t} + \beta_3 \text{tb}_{i,t} + \beta_4 \text{yc}_{i,t} + \beta_5 \text{gov inves}_{i,t} + \epsilon_{i,t} \quad (2.21)$$

Where $i=1,\dots,N$ and $t=1,\dots,T$ respectively denote the cross-sectional and time-series dimensions of the panel. *gov cons* stands for the government consumption expenditures. *public debt* is the gross government public debt. *tb* is the trade balance, *yc* the logarithm of the GDP PC in constant PPP terms, *public capital* is the public capital stock and *gov inves* is the government investment. $\epsilon_{i,t}$ stands for a serially uncorrelated error term that, potentially, could be dependent across countries due to the presence of unobserved common factors. As can be seen from equations (2.20) and (2.21), two different specifications are examined. The first one considers the public capital stock, while the second one analyses the effect of government investment. As there is no consensus on the more adequate variable, we thus examine these two measures. Furthermore, we also investigate if the lagged values of both variables can help to explain the dynamic of the non-traded to traded relative price. It can be interesting as the productivity effect of these variables is likely to take time. Furthermore, we check the robustness of our results to the aggregation method. To do so,

we also estimate equations (2.20) and (2.21) using the six-sectors value-added deflators with fixed weights as the dependent variable.

Our investigation of the robustness of the BS hypothesis begins with the consideration of its internal version. As suggested by the simple theoretical framework presented earlier, a rise in the productivity differential should be associated with a higher domestic relative price of non-tradables. To investigate this hypothesis, we examine two different measures of productivity: GDP PW and the productivity differential between the tradable and non-tradable sectors. For each proxy, we consider two different specifications. The first one excludes government investment from the regressors to properly disentangle the productivity's effect. This goal is difficult to achieve if government investment is also included as it is expected to affect the relative price of non-tradables through a BS effect (Galstyan and Lane, 2009). To see how government investment affects our previous findings, our second regression augments the previous one with the government investment.³¹ All in all, our different specifications are the following:

$$\text{def6_tv}_{i,t} = \alpha_i + \beta_1 \text{prod_diff}_{i,t} + \beta_2 \text{gov cons}_{i,t} + \beta_3 \text{public debt}_{i,t} + \beta_4 \text{tb}_{i,t} + \beta_5 \text{yc}_{i,t} + \epsilon_{i,t} \quad (2.22)$$

$$\text{def6_tv}_{i,t} = \alpha_i + \beta_1 \text{gdp pw}_{i,t} + \beta_2 \text{gov cons}_{i,t} + \beta_3 \text{public debt}_{i,t} + \beta_4 \text{tb}_{i,t} + \epsilon_{i,t} \quad (2.23)$$

$$\begin{aligned} \text{def6_tv}_{i,t} = \alpha_i + \beta_1 \text{gdp pw}_{i,t} + \beta_2 \text{gov cons}_{i,t} + \beta_3 \text{public debt}_{i,t} + \beta_4 \text{tb}_{i,t} + \beta_5 \text{yc}_{i,t} \\ + \beta_6 \text{gov inves}_{i,t} + \epsilon_{i,t} \end{aligned} \quad (2.24)$$

³¹As in the seminal paper of Galstyan and Lane (2009), we use government investment as share of GDP.

$$\text{def6_tv}_{i,t} = \alpha_i + \beta_1 \text{gdp pw}_{i,t} + \beta_2 \text{gov cons}_{i,t} + \beta_3 \text{public debt}_{i,t} + \beta_4 \text{tb}_{i,t} + \beta_5 \text{gov inves}_{i,t} + \epsilon_{i,t} \quad (2.25)$$

gdp pw stands for the logarithm of the gross domestic product per worker. *prod_diff* is the logarithm of the productivity differential between the tradable and non-tradable sectors. We use the *prod_diff_fixed* and *prod_diff_tv* variables. Unfortunately, the productivity differential only starts in 1991 while GDP PW begins in 1980. A comparison between the two proxies is hard because of the shorter span for the productivity differential. Moreover, due to collinearity between GDP PW and GDP PC, equations (2.23) and (2.25) do not include *yc*. As previously, we check the robustness of our results to the aggregation method using also the six-sectors value-added deflators with fixed weights as the dependent variable for equations (2.22) to (2.25).

2.5.3 Data sources

Our sample is composed of 38 developing and emerging economies, equally divided between both groups.³² Our sample is representative of the EMDEs world as shown by the diversity of its geographical coverage: Central and South America, South-Eastern Asia and different regions of Africa (see Table 2.A.1 in the Appendix). Our dataset spans from 1980 to 2016. A detailed description of the sources, as well as additional information on the variables, are available in Table 2.A.2 in the Appendix. The trade balance and government consumption expenditures, expressed as a share of GDP, come from the World Development Indicators (WDI) database of the World Bank. General government final consumption expenditures include all government current expenditures for purchases of goods and services (including compensation of employees). The general government (i.e., central plus subnational governments) investment (gross fixed capital formation) is extracted

³²The choice of our sample is guided by data availability issues to obtain a balanced panel.

from the International Monetary Fund (IMF, fiscal affairs department). The general government capital stock arises from the same source and is computed using the perpetual inventory method. Moreover, Central government debt (as a share of GDP) series are extracted from WDI. For the sake of comparison with previous studies, we express these three variables as a percent of GDP. GDP PC, expressed in constant PPP, and the majority of the REER's determinants (terms of trade, trade openness, fertility rate, investment and FDI) are extracted from WDI. The NFA position comes from the Lane and Milesi-Ferretti database (2007). The REER and the weights used in the computation of the variables expressed in relative terms (i.e. relatively to trading partners) are extracted from the EQCHANGE database (CEPII, Couharde et al., 2018). The GDP PC expressed as a deviation from the trading partners comes from the same source. The data used in the computation of the non-traded to traded goods' price arise from various sources. Current and constant values added for agriculture, industry and services are extracted from the WDI database. The current and constant values added required for the six-sectors' value-added deflators are taken from United Nations Conference on Trade and Development (UNCTAD). The value-added per worker series for the agriculture, industry and services sectors are extracted from the International Labour Organization (ILOSTAT) database. They are available only from 1991 to 2016. The GDP PW expressed in PPP is calculated using the Penn World Table 9.0 for the 1980-2014 period. The 2015 and 2016 years are filled up using the ILOSTAT database.

2.6 Econometric results

2.6.1 Selection of REER determinants: BMA results

Table 2.1 below displays the BMA results. Among the eight potential determinants, three of them present decisive evidence of having an effect as illustrated by their PIPs over 0.99. Indeed, in all

specifications considered, the PIP is equal to one for TOT and the fertility rate. Our result for TOT is conform to previous findings (see Grekou, 2019). Moreover, the openness ratio and government consumption expenditures belong to the robust REER determinants. The BMA analysis confirms thus the crucial role attributed to the openness ratio for developing economies by earlier studies. The four other potential determinants can not be considered as robust variables as shown by their PIPs below 0.50.

Table 2.1 BMA results: REER determinants

	Model prior	Random	Random	Fixed	Fixed	Uniform
	Parameter prior	UIP	RIC	UIP	RIC	UIP
tot		1.000^a	1.000^a	1.000^a	1.000^a	1.000^a
fertility		1.000^a	1.000^a	1.000^a	1.000^a	1.000^a
open		0.996^a	0.997^a	0.994^a	0.994^a	0.997^a
gov cons		0.983^a	0.987^a	0.972^a	0.971^a	0.984^a
fdi		0.480	0.479	0.255	0.266	0.478
gov inves		0.313	0.309	0.136	0.134	0.308
investment		0.248	0.248	0.094	0.095	0.245
nfa		0.246	0.247	0.093	0.091	0.244

Note: The results are based on 100.000 burn-ins and 200.000 draws. Simulations are made using birth-death MCMC sampler. "^a" denotes a PIP over 0.99 and decisive evidence of a regressor. Numbers in bold denote PIP over 0.50 and evidence of robustness. RIC=Risk Inflation Criterion. UIP= Unit Information Prior.

2.6.2 CSD and panel unit root tests results

Once the REER determinants have been selected, we test for the presence of CSD in our series. Table 2.B.1 in the Appendix displays the results of the Pesaran (2004)'s test. We conclude to the presence of CSD as the null hypothesis of cross-sectionally uncorrelated errors is strongly rejected for all the variables examined. Table 2.B.2 in the Appendix displays the results of these panel unit root tests, a summary being provided in Table 2.2 below. For the CIPS test, two different

specifications are examined. The first one includes a trend and a constant, while the second only assumes a constant in the regression. The BCIS test considers level shift as well as trend level shift. The majority of the test statistics points in favor of stationarity for the trade balance, government investment and public capital stock as the null hypothesis is almost unanimously rejected. Moreover, the last two determinants of the non-traded to traded relative price (i.e. government consumption expenditures and GDP PC) are integrated of order one as their first difference is stationary.

Our results provide mixed evidence regarding the presence of unit root for the two six-sectors' value-added deflators, particularly depending on the specification. Moving to the three and six sectors' value-added deflators in relative terms, we find that these series are integrated of order one as shown by the results of the CIPS and BCIS on their first differences. Moving to REER, the usual evidence of unit root is confirmed for this variable. A quite similar conclusion is shared by trade openness and TOT which are integrated of order 1. Examining the fertility rate, the conclusions are less clear-cut as some evidence of unit root is provided. Finally, our different productivity proxies (*gdp pw*, *prod_diff_tv*, *prod_diff_fixed* and *yc_r*) are first difference stationary.

2.6.3 Relative non-traded to traded price determinants: empirical results

Table 2.3 below displays the results regarding the relative non-traded to traded price determinants.

Columns (1) to (4) display the results for the six-sectors' value-added deflator based on a time-varying weights aggregation scheme, while columns (5) to (8) present the findings associated with the six-sectors' deflator with fixed weights. Our results show that whatever the specification examined, the government consumption expenditures variable is significant. This variable is thus an essential driver of the relative price of non-tradables for EMDEs. As expected, this determinant is positively signed as higher government consumption expenditures are associated with a rise in the

Table 2.2 Panel unit root tests: summary

Variable	Abbreviation	Integration order
PNT_PT determinants		
External balance	tb	I(0)
Gross net debt	public debt	I(0)/I(1)
Government consumption expenditures	gov cons	I(1)
Government investment	gov inves	I(0)
Public capital stock	public capital	I(0)
GDP PC	yc	I(1)
Price deflators		
Deflator 6 sectors (TV weights)	def6_tv	I(0)/I(1)
Deflator 6 sectors (Fixed weights)	def6_f	I(0)/I(1)
Deflator 6 sectors relative (TV weights)	def6_tvr	I(1)
Deflator 6 sectors relative (Fixed weights)	def6_fr	I(1)
Deflator 3 sectors relative (TV weights)	def3_tvr	I(0)/I(1)
Deflator 3 sectors relative (Fixed weights)	def3_fr	I(1)
REER determinants		
Real Effective Exchange Rates	reer	I(1)
Openness	open	I(0)/I(1)
Fertility rate	fertility	I(1)
Terms Of Trade	tot	I(1)
Productivity proxies		
GDP PC relative	ycr	I(1)
Productivity differential (TV weights)	prod_diff_tv	I(1)
Productivity differential (Fixed weights)	prod_diff_fixed	I(1)
Gross Domestic Product Per Worker	gdp pw	I(1)

Source: Author's calculations

Table 2.3 Relative non-tradable price determinants: whole sample

	def6_tv	def6_tv	def6_tv	def6_tv	def6_f	def6_f	def6_f	def6_f
	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
gov cons	1.48**	2.11**	1.93***	2.15***	1.70**	2.44*	2.33**	2.53**
	(2)	(2.18)	(2.57)	(2.62)	(2.05)	(1.94)	(2.53)	(2.53)
public debt	-0.07	-0.07	-0.09	-0.07	-0.11	-0.09	-0.13	-0.08
	(-0.88)	(-0.78)	(-0.90)	(-0.50)	(-1.57)	(-1.00)	(-1.30)	(-0.67)
tb	-0.38***	-0.55***	-0.3	-0.14	-0.49***	-0.62***	-0.32	-0.17
	(-2.71)	(-3.24)	(-1.43)	(-0.50)	(-2.88)	(-3.26)	(-1.33)	(-0.59)
yc	-0.23	-0.25	-0.16	-0.15	-0.24	-0.23	-0.16	-0.07
	(-1.23)	(-0.92)	(-1.13)	(-0.70)	(-1.28)	(-0.81)	(-1.15)	(-0.39)
public capital	-0.10	-0.15			-0.11	-0.10		
	(-0.62)	(-0.64)			(-0.57)	(-0.38)		
gov inves			-1.02	-0.97			-1.53*	-1.53
			(-1.39)	(-0.87)			(-1.77)	(-1.37)
Observations	1406	1406	1406	1406	1406	1406	1406	1406
No of countries	38	38	38	38	38	38	38	38

Note: CS-DL(1) and CS-DL(2) indicate cross-sectionally distributed lag model with respectively one year and two years lags of the first-differenced regressors and contemporaneous cross-sectional mean value of the dependent variable and regressors (in level). Each regression includes country-specific fixed effects. ***, **, and * denote the levels of statistical significance at 1, 5, and 10%, respectively. t-stat are reported in parentheses.

non-traded goods' demand. Hence, it pushes up the non-traded price, increasing the relative price of non-traded to traded goods. The marginal effect of government consumption expenditures also seems to be higher if the sectors are aggregated with fixed weights, as shown by the comparison between columns (5) to (8) with columns (1) to (4). Although being a crucial determinant of the relative price of non-tradables for EMDEs, its marginal effect remains quite low with an average coefficient of about 2.083. However, it is four times higher than the average coefficient obtained by Galstyan and Velic (2018). All in all, a 10% increase in government consumption expenditures is associated with a rise of about 0.21% for the non-tradable relative price (in mean).

Examining the gross public debt, we fail to find a significant effect on the relative price of non-traded to traded. Our findings are in contradiction with Galstyan and Velic (2018) who obtain a positive effect for this variable over a sample of advanced economies. In their theoretical

framework, public debt influences the relative non-traded to traded goods price through a rise in labor taxation, which affects both the non-traded and traded labor supplies. Structural macroeconomic differences between industrialized and EMDEs help to explain our results. Indeed, the transmission channel is likely to be not working for EMDEs. The main financing source for higher debt for the least advanced economies is probably not labor taxation because of the existence of high costs associated with tax collections. Government budget deficits in these economies are more likely to be financed through money creation for some economies rather than higher labor taxation, explaining probably our findings.

Moving to the trade balance, this variable is significant at the 1% level in half of our specifications. Once government investment is not included in our specifications, we display the significant negative sign expected by the study from Lane and Milesi-Ferretti (2002). Our estimated coefficients range from a low of 0.38 to a high of 0.62. Moreover, our estimates are lower than the estimations provided by Lane and Milesi-Ferretti (2002) who obtain a coefficient equals to -1.17.

Although government consumption expenditures play a key role in the non-traded to traded goods price's dynamic, the contemporaneous government investment is not significant. This result is robust to the variable considered as both the public capital stock and government investment are not correlated with our endogenous variables. In the best case, government investment is significant at the 10% level (columns (7)) with a negative sign. Our results illustrate thus the ambiguous sign of this variable. Following Galstyan and Lane (2009), our findings correspond to the case in which the productivity rises in tradable and non-tradable sectors are equal. Due to this equality, we have a neutral effect on the relative price of non-tradables. As previously argued,

we also examine the effect of the lagged values of government investment and public capital stock. The results are available in Table 2.B.3 in the Appendix. Even if lagged values are included as regressors, we continue to fail to find evidence for these determinants. These results may arise from the fact that monetary measures can be inappropriate to catch the trends in public capital stock (Calderón et al., 2015) as the link between spending and physical capital can depend on inefficiency and corruption surrounding the projects.

Higher GDP PC is expected to positively influence the relative price of non-tradables to tradables through a positive wealth effect. It should rise the demand for non-traded goods, pushing thus upwards the relative price of non-traded goods. Over the whole sample, we do not find evidence of a positive effect of this determinant across our 8 specifications. Two elements can help to understand such results: (i) the existence of a non-linear relationship between income and relative price of non-tradables, (ii) the inclusion of economies setting at different economic development stages. In fact, our two explanations are very closely linked one to each other. Indeed, the existence of this non-linear relationship can arise from the pooling of countries setting at different development stages. This intuition is confirmed by Hassan (2016). He shows that the Penn-effect depends on countries' income: low-income countries exhibit a negative price-income relationship while middle and high income countries display a positive one. One way to address this non-linearity is to include the squared GDP PC in our regressions. However, it is at the cost of high multicollinearity between our regressors. To overcome this drawback, we control for such heterogeneity in the development stage, by performing sub-sample regressions by splitting our sample into developing and emerging economies.

Tables 2.4 and 2.5 respectively display the estimation results for developing and emerging economies. Our sub-sample regressions exhibit some striking differences between the two group of countries. We continue to find evidence of a robust effect of government consumption expenditures on the non-traded to traded relative price. Examining developing economies (Table 2.4), this determinant is significant across all the specifications, while it turns out to be non significant in our last two specifications (columns (7.2) and (8.2) of Table 2.5) for emerging economies. The average marginal effect for this driver is "virtually" higher for developing countries than for emerging ones. Overall, for both groups of countries, the effect is larger than for advanced economies, perhaps due to the increasing trend in the government consumption expenditures in these economies.

Table 2.4 Relative non-tradable price determinants: developing economies

	def6_tv	def6_tv	def6_tv	def6_tv	def6_f	def6_f	def6_f	def6_f
	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)
	(1.1)	(2.1)	(3.1)	(4.1)	(5.1)	(6.1)	(7.1)	(8.1)
gov cons	1.65**	2.43**	1.77***	2.20**	1.79*	2.65**	1.81**	2.13*
	(2.26)	(2.29)	(2.81)	(1.96)	(1.95)	(2.15)	(2.41)	(1.92)
public debt	0.02	0.03	0.03	0.06	-0.01	0.02	0.01	0.02
	(0.25)	(0.30)	(0.33)	(0.43)	(-0.13)	(0.20)	(0.11)	(0.17)
tb	0.01	-0.06	-0.01	0.01	-0.15	-0.18	-0.23	-0.24
	(0.04)	(-0.21)	(-0.04)	(0.03)	(-0.58)	(-0.62)	(-0.77)	(-0.56)
yc	-0.28	-0.23	-0.21	-0.28	-0.27	-0.21	-0.17	-0.24
	(-1.56)	(-0.89)	(-1.19)	(-1.18)	(-1.47)	(-0.83)	(-0.97)	(-1)
public capital	-0.14	-0.16			-0.12	-0.12		
	(-0.58)	(-0.52)			(-0.52)	(-0.49)		
gov inves			-0.71	-0.52			-1.00	-0.92
			(-0.92)	(-0.35)			(-0.99)	(-0.55)
Observations	703	703	703	703	703	703	703	703
No of countries	19	19	19	19	19	19	19	19

Note: CS-DL(1) and CS-DL(2) indicate cross-sectionally distributed lag model with respectively one year and two years lags of the first-differenced regressors and contemporaneous cross-sectional mean value of the dependent variable and regressors (in level). Each regression includes country-specific fixed effects. ***, **, and * denote the levels of statistical significance at 1, 5, and 10%, respectively. t-stat are reported in parentheses.

Furthermore, the results obtained for developing countries are quite in line with those of the whole sample, except the trade balance which has no effect. All in all, our results show that the great majority of determinants evidenced for advanced economies are clearly inadequate for devel-

Table 2.5 Relative non-tradable prices determinants: emerging economies

	def6_tv	def6_tv	def6_tv	def6_tv	def6_f	def6_f	def6_f	def6_f
	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)
	(1.2)	(2.2)	(3.2)	(4.2)	(5.2)	(6.2)	(7.2)	(8.2)
gov cons	1.55** (2.35)	1.86** (2.33)	1.81** (2.01)	2.07* (1.85)	1.62** (2.13)	1.71** (2.06)	1.68 (1.62)	1.95 (1.50)
public debt	-0.22* (-1.83)	-0.18 (-1.13)	-0.32** (-2.13)	-0.28 (-1.27)	-0.25* (-1.79)	-0.27* (-1.93)	-0.36** (-2.12)	-0.35 (-1.52)
tb	-0.35 (-1.59)	-0.19 (-0.61)	-0.5*** (-2.63)	-0.34 (-1.21)	-0.37 (-1.42)	-0.12 (-0.33)	-0.45** (-2.05)	-0.24 (-0.96)
yc	0.21** (2.13)	0.32 (1.57)	0.30** (2.20)	0.32 (1.55)	0.16 (1.51)	0.31 (1.45)	0.300** (2.04)	0.29 (1.45)
public capital	-0.22 (-1.17)	-0.16 (-0.44)			-0.28 (-1.33)	-0.14 (-0.34)		
gov inves			-0.61 (-0.57)	-0.96 (-0.52)			-0.49 (-0.46)	-0.92 (-0.49)
Observations	703	703	703	703	703	703	703	703
No of countries	19	19	19	19	19	19	19	19

Note: CS-DL(1) and CS-DL(2) indicate cross-sectionally distributed lag model with respectively one year and two years lags of the first-differenced regressors and contemporaneous cross-sectional mean value of the dependent variable and regressors (in level). Each regression includes country-specific fixed effects. ***, **, and * denote the levels of statistical significance at 1, 5, and 10%, respectively. t-stat are reported in parentheses.

opening market economies. The analysis of emerging markets economies displays findings contrasting with the whole sample results. In more than half of our specifications more or less strong support is provided for the gross government public debt. Contrary to advanced economies where a rise in gross public debt is associated with higher non-traded to traded relative price (Galstyan and Velic, 2018), we observe opposite results. Indeed, columns (1.2), (3.2), (5.2), (6.2) and (7.2) display a negative coefficient for this determinant. Such results would be consistent with the verification of the assumption of a tradable sector output more labor intensive than the non-tradable one. Thus a rise in gross public debt leads to a reduction of labor supply higher in the tradable sector than in the non-tradable.³³ Hence, as non-tradable price decrease is lower than the one experienced by the tradable sector, the relative price of the non-traded to traded sector shrinks. The estimated coefficients range from a low of 0.22 to a high of 0.36. Our estimated marginal effects are quite

³³This assumption is hardly falsifiable because of data availability. Indeed, sectoral labor decomposition statistics start in 1991, while our panel begins in 1980.

higher than the ones obtained by Galstyan and Velic (2018). Furthermore, we get weakly significant negative coefficients for the trade balance across our different specifications. Moving to GDP PC, some evidence of a positive effect is provided by Table 2.5 (see columns (1.2), (3.2) and (7.2)). Considering columns (3.2) and (7.2), a 1% increase in GDP PC is associated with a rise in the relative price of non-tradables of about 0.30%. This elasticity is consistent with non-linearity in the price-income relationship as higher elasticity is obtained for advanced economies. Indeed, Lane and Milesi-Ferretti (2002) and Galstyan and Lane (2009) respectively obtain elasticities of 0.56 and 0.83. Finally, the potential sample heterogeneity does not affect the government investment and public capital stock effects. Indeed, Tables 2.4 and 2.5 show no significant effect of both the public capital stock and government investment. As previously, we address the absence of potential simultaneous effect of these variables by using their lagged values. Tables 2.B.4 and 2.B.5 in the Appendix display our estimation results. Even if we consider this issue, we continue to fail to find evidence of significant impact of government investment and public capital stock.

2.6.4 Internal and external versions of the BS hypothesis: empirical results

Table 2.6 displays the estimation results for the investigation of the internal version of the BS hypothesis, using GDP PW as a proxy for the productivity differential. As a reminder, following this hypothesis, a higher productivity differential between the traded and non-traded sector is expected to rise the relative price of non-traded to traded. Columns (5.3) to (8.3) show that GDP PW does not affect the dynamic of the relative price of non-traded to traded. We can expect this finding is due to the inclusion of government investment in the specification. Indeed, as discussed previously this variable is expected to work through a productivity channel, leading to difficulty in disentangling the "pure" productivity differential effect. However, the non inclusion of

this variable does not affect our previous results as illustrated by columns (1.3) to (4.3). All in all, GDP PW does not allow us to conclude to the existence of an internal version of the BS hypothesis.

Table 2.6 Internal version of the bs hypothesis: gdp pw

	def6_tv	def6_tv	def6_f	def6_f	def6_tv	def6_tv	def6_f	def6_f
	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)
	(1.3)	(2.3)	(3.3)	(4.3)	(5.3)	(6.3)	(7.3)	(8.3)
gdp pw	-0.18 (-1.30)	-0.17 (-0.90)	-0.20 (-1.33)	-0.17 (-0.97)	-0.14 (-0.90)	-0.07 (-0.28)	-0.12 (-0.85)	0.01 (0.06)
gov cons	1.91*** (2.81)	2.04** (2.49)	2.35*** (2.68)	2.38** (2.36)	1.98*** (2.79)	2.16*** (3.01)	2.36*** (2.78)	2.48*** (2.89)
public debt	-0.04 (-0.80)	-0.06 (-0.46)	-0.12 (-1.20)	-0.09 (-0.75)	-0.08 (-0.73)	-0.06 (-0.4)	-0.13 (-1.30)	-0.08 (-0.57)
tb	-0.30* (-1.66)	-0.31 (-1.63)	-0.31 (-1.19)	-0.38 (-1.65)	-0.31 (-1.48)	-0.20 (-0.87)	-0.33 (-1.44)	-0.30 (-1.15)
gov inves					-1.03 (-1.40)	-0.90 (-0.84)	-1.59* (-1.90)	-1.60 (-1.57)
Observations	1406	1406	1406	1406	1406	1406	1406	1406
No of countries	38	38	38	38	38	38	38	38

Note: CS-DL(1) and CS-DL(2) indicate cross-sectionally distributed lag model with respectively one year and two years lags of the first-differenced regressors and contemporaneous cross-sectional mean value of the dependent variable and regressors (in level). Each regression includes country-specific fixed effects. ***, **, and * denote the levels of statistical significance at 1, 5, and 10%, respectively. t-stat are reported in parentheses.

The consideration of the labor productivity differential between the traded and non-traded sectors is maybe more adequate to investigate this hypothesis. The results for the investigation of the internal version of the BS hypothesis performed with the labor productivity differential between tradable and non-tradable sector is available in Table 2.7 below.

Columns (1.4) to (4.4) display the results for the productivity differential with time-varying weights, while fixed weights' findings are available in columns (5.4) to (8.4). Contrasting with the results displayed in Table 2.6, our measure of productivity differential is significant across 6 of our 8 specifications. It is also robust to the aggregation scheme used to regroup the sectors between tradable and non-tradable, even if the elasticities exhibit some variations. Examining columns (1.4) to (4.4), our results show that a 1% rise in the productivity differential is associated with an

Table 2.7 Internal version: productivity differential

	def6_tv	def6_tv	def6_f	def6_f	def6_tv	def6_tv	def6_f	def6_f
	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)
	(1.4)	(2.4)	(3.4)	(4.4)	(5.4)	(6.4)	(7.4)	(8.4)
prod_diff_tv	0.16** (1.98)	0.21 (1.41)	0.15* (1.65)	0.26** (2.21)				
prod_diff_fixed					0.32*** (3.15)	0.17 (1.28)	0.35*** (2.84)	0.23* (1.87)
gov cons	0.94 (1.52)	1.58 (1.10)	1.14 (1.63)	2.35* (1.68)	0.95 (1.30)	1.16 (0.60)	1.22 (1.34)	1.40 (0.80)
public debt	-0.02 (-0.03)	-0.02 (-0.04)	-0.01 (-0.05)	-0.05 (-0.12)	0.03 (0.37)	0.23 (1.00)	0.05 (0.21)	0.09 (0.53)
tb	-0.59 (-1.55)	-0.99 (-1.25)	-0.54 (-1.54)	-0.60 (-1.30)	0.76** (-2.30)	-0.51 (-1.09)	-0.75* (-1.83)	-0.48 (-1.04)
yc	0.08 (0.30)	0.06 (0.06)	0.13 (0.46)	-0.27 (-0.22)	-0.03 (-0.09)	-0.03 (-0.09)	0.02 (0.06)	-0.32 (-0.91)
Observations	988	988	988	988	988	988	988	988
No of countries	38	38	38	38	38	38	38	38

Note: CS-DL(1) and CS-DL(2) indicate cross-sectionally distributed lag model with respectively one year and two years lags of the first-differenced regressors and contemporaneous cross-sectional mean value of the dependent variable and regressors (in level). Each regression includes country-specific fixed effects. ***, **, and * denote the levels of statistical significance at 1, 5, and 10%, respectively. t-stat are reported in parentheses.

increase of 0.15 to 0.26% of the relative price of the non-traded to traded goods. Columns (5.4) to (8.4) confirm the previous findings. However, the elasticities obtained are much higher if we consider specifications (5.4) and (7.4). They range from a low of 0.23 to a high of 0.35. Hence, a higher effect of productivity differential is evidenced with a fixed weighting scheme. Using time-varying weights mitigates thus the productivity effect as another source of variation is included in our productivity differential variable. Furthermore, the inclusion of government investment in the specification seems to be a clearly inadequate choice to study the internal version of the BS hypothesis. Indeed, once this variable is included, the productivity differential significance vanishes (see Table 2.B.6). It is in line with Galstyan and Lane's (2009) findings as they show that government investment significantly affects the relative sectoral productivity either positively or negatively. Hence, once this variable is controlled for, the effect of productivity differential is no longer detectable. To sum up, our empirical investigation shows some support in favor of the

internal version of the BS hypothesis. Examining GDP PW does not allow us to conclude to the existence of a positive relationship between productivity and the relative price of non-traded to traded goods for EMDEs. The use of the labor productivity differential allows us to confirm this internal version although it is sensitive to the specification. Investigation of this hypothesis for EMDEs is a hard task suffering from two major caveats. Although productivity differential between the traded and non-traded sector is available, it is perhaps difficult to detect a long-run relationship because of rather short time-series span (26 years, here) and availability of few sectors.

Our empirical investigation also aims to examine the robustness of the external version of the BS effect to the proxies. Table 2.8 below displays the corresponding estimation results. Examining the REER determinants, we find a significantly negative effect of the trade openness ratio on the REER in the majority of our specifications. The estimated marginal effect ranges from -0.27 to -0.43. As expected, higher trade openness is associated with a more depreciated REER as it lowers the domestic price level. The relevance of this determinant for the REER dynamic of EMDEs is thus confirmed by our results. Examining the Terms Of Trade, we fail to find evidence of a robust effect for this determinant. It is only weakly significant in one of our ten specifications (column (3.5)). The positive sign for this specification suggests that the income effect dominates the substitution effect. From a theoretical perspective, the non-significance of TOT can be explained by the non-dominance of either the income or substitution effects. Our estimations confirm the relevance of government consumption expenditures for EMDEs. Once the six-sector value-added is not examined, we find evidence of a significant effect of the government consumption expenditures (columns (5.5) to (10.5)), confirming the Froot-Rogoff effect. Considering column (5.5), a 10% increase in government consumption expenditures raises the REER by 0.145%. Our estimated

marginal effects are lower than the ones obtained by Ricci et al. (2013). Indeed, for a sample of 27 emerging markets economies, they get a marginal effect of about 0.386%. Finally, we observe strong significance and a positive sign for the fertility rate, in line with Rose et al. (2009) who show that lower fertility rate depreciates the exchange rate as the young consumption is biased towards non-traded goods.

According to the external version of the BS hypothesis, higher relative price of the non-traded to traded goods should appreciate the REER. To investigate this hypothesis, we rely on three and six sectors' value-added deflators. As can be seen from Table 2.8, the external version of the BS hypothesis is strongly verified for EMDEs as illustrated by columns (1.5) to (8.5). This finding is not affected by the difference in the price deflator and by the weighting system used as our proxies are always significant. At least a 1% increase in this proxy appreciates the REER of about 0.18% to 0.32%. Moreover, the marginal effects of the relative price of non-traded to traded goods are lower for the three-sectors' value-added deflators. Indeed, the estimated coefficients for these variables range from 0.180 to 0.257 (columns (5.5) to (8.5)), while the elasticities go from 0.275 to 0.319 for the six-sectors' value-added deflators. Another interesting result is that our findings are not affected by the weighting system considered for the computation. For the sake of comparison, we also examine the effect of GDP PC. Our results show no significant effect of this variable on the REER. We thus confirm previous findings, even if CSD is taken into account, GDP PC appears to be a misleading proxy for the BS effect in EMDEs. All in all, our results provide very strong support for the BS hypothesis. We show that this finding is robust to measurement issues using four alternative proxies for the relative price of non-traded to traded goods.

Table 2.8 External version of the BS hypothesis

	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)	CS-DL(1)	CS-DL(2)
	(1.5)	(2.5)	(3.5)	(4.5)	(5.5)	(6.5)	(7.5)	(8.5)	(9.5)	(10.5)
def6_tvr	0.298*** (2.886)	0.296* (1.895)								
def6_fr			0.275** (2.274)	0.319*** (2.698)						
def3_tvr					0.248*** (3.604)	0.180* (1.761)				
def3_fr							0.257*** (3.891)	0.199** (1.973)		
yc_r									0.086 (0.549)	0.411 (0.873)
open	-0.42*** (-5.25)	-0.30*** (-2.73)	-0.42*** (-4.67)	-0.30*** (-3.75)	-0.17 (-1.31)	-0.14 (-0.82)	-0.16 (-1.23)	-0.11 (-0.61)	-0.43*** (-4.30)	-0.27** (-1.93)
tot	0.08 (1.61)	0.08 (0.97)	0.09*** (1.82)	0.07 (0.98)	-0.02 (-0.31)	-0.08 (-1.59)	-0.01 (-0.16)	-0.08 (-1.53)	0.06 (1.10)	-0.02 (-0.16)
gov cons	0.57 (1.43)	0.89 (1.39)	0.57 (1.19)	0.88 (1.35)	1.45*** (4.53)	2.37*** (5.04)	1.52*** (4.61)	2.33*** (5.18)	1.32*** (3.22)	2.18*** (2.73)
fertility	0.31** (2.47)	0.34* (1.89)	0.33** (2.10)	0.36** (2.02)	0.36* (1.91)	0.49*** (2.07)	0.36* (1.93)	0.54** (2.11)	0.34** (2.19)	0.21 (0.88)
Observations	1406	1406	1406	1406	1406	1406	1406	1406	1406	1406
Number of countries	38	38	38	38	38	38	38	38	38	38

Note: CS-DL(1) and CS-DL(2) indicate cross-sectionally distributed lag model with respectively one year and two years lags of the first-differenced regressors and contemporaneous cross-sectional mean value of the dependent variable and regressors (in level). Each regression includes country-specific fixed effects. ***, **, and * denote the levels of statistical significance at 1, 5, and 10%, respectively. t-stat are reported in parentheses.

2.7 Conclusion

This chapter has investigated the robustness of the BS effect on a sample of 38 EMDEs over the period 1980-2016 using five alternative measures. We address two crucial issues that have not been examined so far in the existing literature: (i) the measurement issues associated with the productivity differential and the relative price of non-traded to traded goods, (ii) accounting for the first time for CSD, using the CS-DL approach (Chudik et al., 2016).

We start by identifying the determinants of the relative price of non-tradables for EMDEs. Our findings strongly support the key role played by government consumption expenditures in the dynamic of the relative price of non-traded goods for both developing and emerging market economies over the period 1980-2016: higher government consumption expenditures are indeed associated with a rise in the relative price of non-tradables to tradables. The trade balance exerts a significant effect, but to a lesser extent. Finally, we show that higher wealth positively affects the non-traded to traded price for emerging market economies.

Investigating both the internal and external versions of the BS hypothesis, we show that while the internal version is not confirmed if we use GDP PW as a proxy for productivity differential, quite strong support is obtained with the labor productivity differential. A rise in this latter is associated with an increase in the relative price of non-traded to traded goods of 0.15% to 0.35%. The verification of the internal version thus depends crucially on the proxy chosen. Moving to the external version, we find strong support for the BS effect. An increase in the non-traded to traded price is associated with an appreciation of the REER. Although the estimated elasticity is more or less affected by the proxies, we find evidence of a significant positive effect if three-sectors or

six-sectors deflators are used. An increase in the relative price of the non-tradables to tradables is associated with a REER appreciation of 0.180% to 0.319%. We also show that GDP PC is not relevant to test for the external version of the BS hypothesis.

As illustrated by our findings, the Balassa-Samuelson effect works through the productivity differential between the traded and non-traded sectors. However, identifying the potential source of this increase has not yet been a concern in the literature. Although Du et al. (2013) constitute a first attempt in this direction by considering the impact of transport infrastructure on the RER, transport infrastructure represents only one dimension of an economy network. Accounting for the multidimensional characteristic (including transportation, communication, and energy and utilities dimension) of economies' infrastructure would be a promising extension of the present chapter. Another interesting avenue for future research would be to examine the transmission channel of infrastructure on the RER through productivity in the traded and non-traded sectors.

Appendix

Appendix 2.A Sample and data sources

Table 2.A.1 Sample of countries

Emerging	Geographical zone	Developing	Geographical zone
Chile	South America	Bangladesh	Southern Asia
Colombia	South America	Benin	Western Africa
Costa Rica	Central America	Bolivia	South America
Dominican republic	Caribbean	Botswana	Southern Africa
Ecuador	South America	Burkina Faso	Western Africa
El Salvador	Central America	Cameroon	Middle Africa
Guatemala	Central America	Central african republic	Middle Africa
India	Southern Asia	Comoros	Middle Africa
Korea republic	Eastern Asia	Congo	Middle Africa
Malaysia	South-Eastern Asia	Gabon	Middle Africa
Mexico	Central America	Honduras	Central America
Morocco	Northern Africa	Kenya	Middle Africa
Pakistan	Southern Asia	Malawi	Eastern Africa
Panama	Central America	Mali	Western Africa
Philippines	South-Eastern Asia	Mauritius	Eastern Africa
South Africa	Southern Africa	Rwanda	Eastern Africa
Sri Lanka	Southern Asia	Senegal	Western Africa
Thailand	South-Eastern Asia	Togo	Western Africa
Uruguay	South America	Uganda	Eastern Africa

Table 2.A.2 Data sources

Primary	Abbreviation	Data sources	Comments
External balance on goods and services	tb	WDI	Expressed as share of GDP
Gross public debt	public debt		Expressed as share of GDP
Government consumption expenditures	gov cons	WDI	Expressed as share of GDP
Public capital stock	public capital	IMF, fiscal affair department	Expressed as share of GDP
Government investment	gov inves	IMF, fiscal affair department	Expressed as share of GDP
Gross Domestic Product per Capita	yc	WDI	Expressed in constant PPP
Terms of Trade	tot	WDI	Ratio of export prices to import prices
Net Foreign asset	nfa	Lane and Milesi-Ferretti (2007)	Expressed as share of GDP
Trade openness	open	WDI	Sum of exports and imports as share of GDP
Fertility rate	fertility	WDI	Births per woman
Investment	investment	WDI	Expressed as share of GDP
Foreign Direct Investment	fdi	WDI	Net inflows, Expressed as share of GDP
Real Effective Exchange Rate	reer	EQCHANGE	REER based on 186 trade partners using the 2008-2012 trading weights
GDP per workers		PWT 9.0, ILOSTAT	GDP in constant 2011 PPP U.S divided by total employment (number of engaged people)
Value added per worker (agriculture)	vw_agr	ILOSTAT	Value added per unit of input measured in constant 2010 us dollars
Value added per worker (industry)	vw_indus	ILOSTAT	Value added per unit of input measured in constant 2010 us dollars
Value added per worker (services)	vw_serv	ILOSTAT	Value added per unit of input measured in constant 2010 us dollars
Values added (agriculture)		WDI	Value added of agriculture input measured in constant/current 2010 us dollars
Values added (industry)		WDI	Value added of industry input measured in constant/current 2010 us dollars
Values added (services)		WDI	Value added of services measured in constant/current 2010 us dollars
Values added of division 01-05		UNCTAD	Value added of the sector 01-05 in constant/current 2010 us dollars
Values added of division 10-41		UNCTAD	Value added of of the sector 10-41 measured in constant/current 2010 us dollars
Values added of division 45		UNCTAD	Value added of the sector 45 measured in constant/current 2010 us dollars
Values added of division 50-55		UNCTAD	Value added of the sector 50-55 measured in constant/current 2010 us dollars
Values added of division 60-64		UNCTAD	Value added of the sector 60-64 measured in constant/current 2010 us dollars
Values added of division 65-99		UNCTAD	Value added of the sector 65-99 measured in constant/current 2010 us dollars
GDP PC F1	yc_r	CEPII EQCHANGE	Deviation of countries GDP PC from trading partners.
Commercial weights	w_ijt	CEPII EQCHANGE	Time-invariant weighting scheme representative of foreign trade between 2008-2012

Note: CEPII=Centre d'études prospectives et d'informations internationales; WDI=World Development Indicator (World Bank); PWT=Penn World Table; ILOSTAT=International Labour Organization Statistics; UNCTAD=United Nations Conference on Trade and Development; IMF=International Monetary Fund; GDP= Gross Domestic Product; PC= Per capita; PPP= Purchasing Power Parity.

Appendix 2.B Additional results

Table 2.B.1 Cross section dependence tests: results

def6_tv	def6_f	tb	public debt	gov cons	gov inves
29.100	29.346	32.044	27.990	35.530	26.176
(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
public capital	yc	prod_diff_fixed	prod_diff_tv	reer	def6_fr
18.860	5.391	16.598	18.046	32.550	8.009
(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
def6_tvr	def3_fr	def3_tvr	open	fertility	ycr
19.048	19.717	19.048	14.155	7.686	18.571
(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
tot	gdp pw				
16.757	10.308				
(0.00)	(0.00)				

Note: Pesaran (2004)'s test of cross-section independence. Null hypothesis of cross-section independence. P-values are given in parentheses.

Table 2.B.2 Panel unit root tests: supplementary results

Specification	Test	Stat	tb	public	Δ public	gov	Δ gov	gov
				debt	debt	cons	cons	inves
<i>Trend and constant</i>	CIPS		-2.975***	-2.554*	-4.964***	-2.609**		-3.521***
<i>Constant</i>	CIPS		-2.607***	-2.002	-4.929***	-2.119**		-2.54***
<i>Level mean shift</i>	BCIS	Z	-2.036**	-2.515***	-4.35***	-0.396	-4.61***	-1.066
	BCIS	Pm	4.074***	3.293***	24.22***	-0.746	31.243***	2.637***
	BCIS	P	126.23***	116.602***	374.664***	66.794	461.196***	108.516***
<i>Trend level shift</i>	BCIS	Z	-1.39	0.414	-3.79***	2.009**	-4.938***	5.446***
	BCIS	Pm	2.364**	0.969	16.45***	-0.96	23.383***	0.447
	BCIS	P	105.149**	87.949	278.84***	64.044	364.296***	81.511
			public	GDP	Δ GDP	def6_tv	Δ	
			capital	PC	PC		def6_tv	
<i>Trend and constant</i>	CIPS		-2.600*	-2.306	-5.282***	-2.556*		
<i>Constant</i>	CIPS		-2.239***	-1.813	-5.021***	-2.362***		
<i>Level mean shift</i>	BCIS	Z	1.972**	4.44***	-4.963***	2.618***	-4.586***	
	BCIS	Pm	-2.276**	-2.407***	20.080***	-1.866***	28.511***	
	BCIS	P	47.928	46.319	323.574***	52.99	427.18***	
<i>Trend level shift</i>	BCIS	Z	2.528***	2.34	-4.381***	-1.319	-4.938***	
	BCIS	Pm	-1.674**	0.284	20.038***	-1.478	23.383***	
	BCIS	P	55.361	79.503	323.057***	57.773	364.296***	
			def6_f	Δ	def6_tvr	Δ	def6_fr	Δ
				def6_f		def6_tvr		def6_fr
<i>Trend and constant</i>	CIPS		-2.766***		-2.488	-5.373***	-2.288	-5.531***
<i>Constant</i>	CIPS		-2.490***		-2.011	-5.292***	-2.226	-5.534***
	BCIS	Z	4.709***	-4.631***	2.700***	2.062**	1.101	-4.667***

Table 2.B.2 (continued)

<i>Level mean shift</i>	BCIS	Pm	-2.530***	29.472***	0.322	-0.365	-0.819	29.813***
	BCIS	P	44.799	439.364***	79.975	71.498	65.898	443.561***
<i>Trend level shift</i>	BCIS	Z	-1.035	-4.886***	-0.606	-5.032***	0.159	-5.241***
	BCIS	Pm	0.21	24.47***	0.7.2	24.274***	-0.918	23.995***
	BCIS	P	78.6	377.695***	85.036	375.272***	64.678	371.831***
<i>Trend and constant</i>			def3_tvr	Δdef3_tvr	def3_fr	Δdef3_fr	reer	Δreer
	CIPS		-2.488		-2.499	-5.308***	-2.467	-5.416***
<i>Constant</i>	CIPS		-2.228***		-2.154**	-5.265***	-2.037	-5.192***
<i>Level mean shift</i>	BCIS	Z	2.062**	-4.686***	1.148	-4.631	5.242***	-4.486***
	BCIS	Pm	-0.365	27.633***	0.519	29.517***	-1.649	25.28***
	BCIS	P	71.498	416.687***	82.406	439.916***	55.66	387.682***
<i>Trend level shift</i>	BCIS	Z	4.069***	-5.346***	-0.698	-5.354***	1.699	-5.191***
	BCIS	Pm	-2.052**	24.872***	-1.602	25.703***	-0.811	24.825***
	BCIS	P	50.699	382.654***	56.238	392.9***	65.99	382.063***
<i>Trend and constant</i>			open	Δopen	fertility	Δfertility	tot	Δtot
	CIPS		-2.101	-5.603***	-2.473	-3.494***	-2.21	-5.670***
<i>Constant</i>	CIPS		-1.982	-5.495***	-2.183**	-3.553***	-1.725	-5.497***
<i>Level mean shift</i>	BCIS	Z	-1.452	-4.408***	-2.933***	29***	-2.236**	-4.397***
	BCIS	Pm	2.442***	26.713***	0.112	-2.89***	-1.906**	23.718***
	BCIS	P	106.110**	405.351***	77.39	15.7	52.49	368.420***
<i>Trend level shift</i>	BCIS	Z	-1.033	-4.858***	43.5***	68.13***	-0.332	-5.046***
	BCIS	Pm	1.338	22.865***	-6.022***	-5.575***	-1.572	23.410***
	BCIS	P	92.496	357.898***	1.753	7.261	95.386	364.627***
			prod	Δprod	prod	Δprod	gdp pw	Δ
			diff_tv	diff_tv	diff_fixed	diff_fixed		gdp pw

Table 2.B.2 (continued)

<i>Trend and constant</i>	CIPS		-2.67**	-4.483***	-2.498	-4.768***	-2.341	-5.162***
<i>Constant</i>	CIPS		-1.922	-4.338***	-1.865	-4.616***	-1.841	-5.087***
<i>Level mean shift</i>	BCIS	Z	5.191***	-4.467***	6.07***	-4.49***	3.950***	-4.581***
	BCIS	Pm	-2.191**	15.919***	-1.45	20.77***	-0.589	25.34***
	BCIS	P	48.982	272.270***	58.06	332.15***	68.736	388.418***
<i>Trend level shift</i>	BCIS	Z	1.634	-4.650***	1.32	-4.62***	3.314***	-5.260***
	BCIS	Pm	-1.362	12.179***	-1.44	14.84***	1.268	24.826***
	BCIS	P	59.199	226.155***	58.2	258.911***	91.637	382.086***
<i>Trend and constant</i>			yc_r	Δ				
				yc_r				
	CIPS		-2.438	-5.013***				
<i>Constant</i>	CIPS		-1.652	-4.783***				
<i>Level mean shift</i>	BCIS	Z	2.447***	-4.710***				
	BCIS	Pm	-1.781**	28.275***				
	BCIS	P	54.034	424.601***				
<i>Trend level shift</i>	BCIS	Z	10.042	-1.441				
	BCIS	Pm	-0.611	19.210***				
	BCIS	P	68.458	312.846***				

Note: Critical values for the trend and constant (resp. constant) model at 10%, 5% and 1% are respectively -2,55, -2,60 and -2,72 (resp. -2,05, -2,11 and -2,23). Critical values for the Z and Pm statistics at the 1% and 5% level are respectively 2,33 and 1.645. Critical values for P at the 1% level and 5% level are 97.35 and 107.58. Maximum number of factors allowed equals to 5. Bayesian information criterion in Bai and Ng (2002) used to estimate the number of factors.

Table 2.B.3 Whole sample: alternative specifications

	def6_tv CS-DL(1)	def6_tv CS-DL(2)	def6_tv CS-DL(1)	def6_tv CS-DL(2)	def6_f CS-DL(1)	def6_f CS-DL(2)	def6_f CS-DL(1)	def6_f CS-DL(2)
gov cons	0.95 (0.84)	1.38 (1.33)	1.78** (2.34)	1.63 (1.60)	1.44** (2.03)	1.52 (1.49)	2.19** (2.46)	2.12* (1.74)
public debt	-0.23 (-1.35)	-0.09 (-0.75)	-0.09 (-0.90)	-0.03 (-0.20)	-0.11 (-1.22)	-0.10 (-0.71)	-0.11 (-1.10)	-0.03 (-0.20)
tb	-0.47 (-0.65)	-0.3* (-1.77)	-0.31 (-1.48)	-0.27 (-1.13)	-0.41*** (-2.56)	-0.41** (-2.05)	-0.26 (-0.96)	-0.29 (-1.04)
yc	-0.24 (-0.48)	-0.24 (-0.66)	-0.16 (-1.05)	-0.15 (-0.60)	-0.18 (-1.05)	-0.23 (-0.65)	-0.15 (-0.99)	-0.09 (-0.42)
lagged public capital	0.12 (0.24)	-0.007 (-0.02)			-0.10 (-0.61)	0.03 (0.12)		
lagged gov inves			-0.44 (-0.89)	0.04 (0.04)			-0.78 (-1.51)	-0.22 (-0.29)
<i>Observations</i>	1370	1370	1370	1370	1370	1370	1370	1370
<i>Number of countries</i>	38	38	38	38	38	38	38	38

Note: CS-DL(1) and CS-DL(2) indicate cross-sectionally distributed lag model with respectively one year and two years lags of the first-differenced regressors and contemporaneous cross-sectional mean value of the dependent variable and regressors (in level). Each regression includes country-specific fixed effects ***, **, and * denote the levels of statistical significance at 1, 5, and 10%, respectively. t-stat are reported in parentheses.

Table 2.B.4 Developing economies: alternative specifications

	def6_tv CS-DL(1)	def6_tv CS-DL(2)	def6_tv CS-DL(1)	def6_tv CS-DL(2)	def6_f CS-DL(1)	def6_f CS-DL(2)	def6_f CS-DL(1)	def6_f CS-DL(2)
gov cons	1.46** (2.25)	2.45** (2.01)	1.68** (2.51)	2.12** (2.04)	1.7** (1.98)	2.52** (2.05)	1.91** (2.42)	2.3** (2.32)
public debt	-0.03 (-0.33)	-0.03 (-0.33)	0.01 (0.11)	0.04 (0.24)	-0.03 (-0.33)	-0.01 (-0.13)	-0.01 (-0.13)	0.04 (0.24)
tb	-0.19 (-0.66)	0.13 (0.45)	-0.10 (-0.40)	0.10 (0.24)	-0.34 (-1.10)	-0.08 (-0.17)	-0.24 (-0.86)	-0.15 (-0.27)
yc	-0.27 (-1.43)	-0.26 (-0.77)	-0.25 (-1.38)	-0.31 (-1.25)	-0.25 (-0.09)	-0.25 (-0.75)	-0.18 (-1.10)	-0.24 (-1.01)
lagged public capital	-0.08 (-0.28)	-0.12 (-0.20)			-0.32 (-1.33)	-0.13 (-0.27)		
lagged gov inves			-0.35 (-0.416)	0.24 (0.150)			-0.56 (-0.60)	0.24 (0.15)
<i>Observations</i>	684	684	684	684	684	684	684	684
<i>Number of countries</i>	19	19	19	19	19	19	19	19

Note: CS-DL(1) and CS-DL(2) indicate cross-sectionally distributed lag model with respectively one year and two years lags of the first-differenced regressors and contemporaneous cross-sectional mean value of the dependent variable and regressors (in level). Each regression includes country-specific fixed effects ***, **, and * denote the levels of statistical significance at 1, 5, and 10%, respectively. t-stat are reported in parentheses.

Table 2.B.5 Emerging economies: alternative specifications

	def6_tv CS-DL(1)	def6_tv CS-DL(2)	def6_tv CS-DL(1)	def6_tv CS-DL(2)	def6_f CS-DL(1)	def6_f CS-DL(2)	def6_f CS-DL(1)	def6_f CS-DL(2)
gov cons	1.65* (1.81)	2.03* (1.74)	1.43* (1.64)	2.02*** (2.66)	1.00 (0.75)	0.48 (0.29)	0.84 (0.64)	-0.07 (-0.04)
public debt	-0.36** (-2.12)	-0.31 (-1.63)	-0.24* (-1.71)	-0.19 (-1.36)	-0.19 (-1.58)	-0.26 (-1.63)	-0.19 (-1.36)	-0.29 (-1.32)
tb	-0.48** (-2.18)	-0.44 (-1.16)	-0.27 (-1.13)	-0.29 (-1.16)	-0.60 (-1.94)	-0.07 (-0.16)	-0.31 (-0.94)	-0.08 (-0.14)
yc	0.29* (1.87)	0.33 (1.55)	0.18 (1.30)	0.35*** (3.06)	0.18*** (3.11)	0.11 (1.37)	0.25*** (4.54)	0.26*** (3.47)
lagged public capital	-0.10 (-0.36)	-0.10 (-0.29)			-0.03 (-0.10)	-0.02 (-0.05)		
lagged gov inves			-1.06 (-0.79)	-1.73 (-0.75)			0.23 (0.31)	-0.13 (-0.09)
<i>Observations</i>	684	684	684	684	684	684	684	684
<i>Number of countries</i>	19	19	19	19	19	19	19	19

Note: CS-DL(1) and CS-DL(2) indicate cross-sectionally distributed lag model with respectively one year and two years lags of the first-differenced regressors and contemporaneous cross-sectional mean value of the dependent variable and regressors (in level). Each regression includes country-specific fixed effects. ***, **, and * denote the levels of statistical significance at 1, 5, and 10%, respectively. t-stat are reported in parentheses.

Table 2.B.6 Internal version of the BS hypothesis: alternative specification

	def6_tv CS-DL(1)	def6_tv CS-DL(2)	def6_tv CS-DL(1)	def6_tv CS-DL(2)	def6_f CS-DL(1)	def6_f CS-DL(2)	def6_f CS-DL(1)	def6_f CS-DL(2)
gov cons	0.60 (0.43)	1.09 (0.01)	1.22 (0.97)	-1.46 (-0.10)	1.69 (0.85)	2.20 (0.14)	1.02 (0.52)	0.83 (0.01)
gross debt	-0.06 (-0.46)	0.20 (0.02)	0.03 (0.04)	-0.03 (-0.01)	0.04 (0.15)	0.13 (0.06)	-0.06 (-0.20)	0.05 (0.13)
tb	-0.59 (-1.59)	0.28 (0.01)	-0.78 (-1.56)	-1.59 (-0.30)	-0.70 (-1.01)	0.72 (0.11)	-0.41 (-0.55)	-0.21 (-0.01)
yc	-0.03 (-0.09)	-0.03 (-0.01)	-0.13 (-0.64)	0.03 (0.10)	-0.07 (-0.25)	-0.04 (-0.12)	0.06 (0.03)	-0.02 (-0.01)
gov inves	-1.25 (-0.58)	-1.00 (-0.01)	-1.13 (-0.73)	-1.30 (-0.03)	-1.89 (-0.66)	-1.85 (-0.05)	-1.71 (-0.47)	-1.41 (-0.01)
prod_diff_fixed			0.08 (0.67)	0.17 (0.13)	0.06 (0.31)	0.05 (0.03)		
prod_diff_tv	0.11 (0.65)	0.09 (0.02)					0.05 (0.15)	0.12 (0.03)
<i>Observations</i>	1408	1408	1408	1408	1408	1408	1408	1408
<i>Number of countries</i>	38	38	38	38	38	38	38	38

Note: CS-DL(1) and CS-DL(2) indicate cross-sectionally distributed lag model with respectively one year and two years lags of the first-differenced regressors and contemporaneous cross-sectional mean value of the dependent variable and regressors (in level). Each regression includes country-specific fixed effects. ***, **, and * denote the levels of statistical significance at 1, 5, and 10%, respectively. t-stat are reported in parentheses.

Table 2.B.7 Six sectors' classification

Sector	Divisions
Agriculture, hunting, forestry, fishing	01-05
Mining, manufacturing, utilities	10-41
Construction	45
Wholesale, retail trade, restaurants and hotels	50-55
Transport, storage and communications	60-64
Other activities	65-99

Source: International Standard Industrial Classification of All Economic Activities (ISIC), Revision 3.1, United Nations.

Appendix 2.C Methodology

2.C.1 Cross-sectional dependence in panel data: issues and modelisation

Pesaran (2015) argues that: "ignoring cross-sectional dependence of errors can have serious consequences, and the presence of some form of cross-section correlation of errors in panel data applications in economics is likely to be the rule rather than the exception". This cross-sectional correlation of errors arises from omitted common effects such as aggregate demand and/or supply shocks. In our case, the existence of CSD is particularly important from the estimation and unit root testing perspectives. Indeed, if conventional estimators are employed, misleading inference³⁴ and even inconsistent estimations are likely to occur if the presence of CSD is not taken into account (Pesaran, 2015; Reese and Westerlund, 2016). In the context of panel unit root tests, the first generation of test is no longer suitable as they assume cross-sectionally uncorrelated errors.³⁵ Indeed, Chang (2002) points out that in the case where such a hypothesis does not hold, the test distributions are no longer valid. To test for the presence of CSD,³⁶ Pesaran (2004) has proposed a simple test based on average of pairwise correlation of the residuals. We consider the following panel data model:

$$y_{i,t} = a_i + \beta_i' x_{i,t} + u_{i,t} \quad (2.C.1)$$

where $x_{i,t}$ is a k -dimensional vector of regressors, and a_i and β_i' are assumed to be fixed unknown coefficients. The null of cross-sectionally uncorrelated errors is defined by:

$$H_0 : E(u_{i,t}u_{j,t}) = 0, \text{ for all } t \text{ and } i \neq j \quad (2.C.2)$$

³⁴One way to get ride of this problem is to rely on standard errors robust to CSD, as the one proposed by Driscoll and Kraay (1998).

³⁵The first generation of panel unit root tests encompasses the following tests: Im et al. (2003); Choi (2001) and Maddala and Wu (1999). See Hurlin and Mignon (2005) for a survey on the panel unit root tests.

³⁶To test for the presence of CSD in the context of ordered individuals, the Moran test (1948) is applicable.

Consider the panel model described by equation (2.C.1), and let $\widehat{u}_{it}$ be the OLS estimator of u_{it} defined by:

$$\widehat{u}_{i,t} = y_{i,t} - \hat{a}_i - \hat{\beta}'_i x_{i,t} \quad (2.C.3)$$

$\hat{a}_i$ and $\hat{\beta}'_i$ being the OLS estimates of a_i and β'_i , based on the T sample observations. Using the previous results, we estimate the pair wise correlation of the residuals, $\widehat{u}_{i,t}$ and $\widehat{u}_{j,t}$, for $i \neq j$:

$$\widehat{\rho}_{i,j} = \widehat{\rho}_{j,i} = \frac{\sum_{t=1}^T \widehat{u}_{i,t} \widehat{u}_{j,t}}{(\sum_{t=1}^T \widehat{u}_{i,t}^2)^{1/2} (\sum_{t=1}^T \widehat{u}_{j,t}^2)^{1/2}} \quad (2.C.4)$$

Denoting CD_p the cross-sectional dependence test statistics, computed as the average of the pairwise correlation of the residuals:

$$CD_p = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^N \widehat{\rho}_{ij} \right) \quad (2.C.5)$$

Under the null of cross-sectionally uncorrelated errors, we get:

$$CD_p \rightarrow \mathcal{N}(0, 1) \quad (2.C.6)$$

Once the presence of CSD has been tested for, it has to be control for. To provide a better understanding of the tests implemented in this chapter, we present a convenient way used to modelise the CSD. To this aim, we set up a common factor models:

$$y_{i,t} = \gamma_{i,1} f_{1,t} + \gamma_{i,2} f_{2,t} + \dots + \gamma_{i,k} f_{m,t} + e_{i,t} \quad (2.C.7)$$

which can also be written:

$$y_t = \Gamma f_t + e_t \quad (2.C.8)$$

where $f_t = (f_{1,t}, f_{2,t}, \dots, f_{m,t})'$, $e_t = (e_{1,t}, e_{2,t}, \dots, e_{N,t})'$, and $\Gamma = (\gamma_{i,j})$, for $i=1,2,\dots,N$, $j=1,2,\dots,m$ is an $N \times m$ matrix of factor loadings. $k=1,2,\dots,K$.

The observed variable $y_{i,t}$ is thus explained in terms of m unobserved common factors, $f_t = (f_{1,t}, f_{2,t}, \dots, f_{m,t})$. These factors influence the dynamic of y_{it} through factor loadings $(\gamma_{i,1}, \gamma_{i,2}, \dots, \gamma_{i,k})$. As these factor loadings are heterogeneous, the different cross sections units are differently impacted by the common factors. Two main difficulties arise once a factor model is considered:

- determination of the "true" number of common factors, k
- estimation of these k unobserved common factors

The first issue is important for the empirical and theoretical validity of factor models (Bai and Ng, 2002). That is why, Bai and Ng (2002) propose different criteria to consistently estimate the number of factors. Their method consists to specify a penalty function which depends on both the cross sectional and time-series dimensions of the panel data. Prior to the specification of the penalty function is the estimation of the k unobserved factors and their heterogeneous factor loadings. The unobserved common factors are estimated relying on the asymptotic principal component estimator. Then, heterogeneous factor loadings are obtained by solving the following optimization problem:

$$V(k, \widehat{f_{m,t}}) = \min_{\gamma} (NT)^{-1} \sum_{i=1}^N \sum_{t=1}^T (y_{it} - \gamma_{i,k} \widehat{f_{m,t}}) \quad (2.C.9)$$

where $\widehat{f_{m,t}}$ is the estimation of the unobserved common factors. As argued by Bai and Ng (2002),

as the model is linear and the factors are observed, γ_{ik} can be estimated by applying ordinary least squares to each equation. Then, a loss function denoted $PC(k)$ can be used to determine the k number of factors:

$$PC(k) = V(k, \widehat{f_{m,t}}) + kg(N, T) \quad (2.C.10)$$

where $g(N, T)$ is the penalty function for overfitting.

However, the procedure proposed by Bai and Ng (2002) is only applicable in the presence of stationary data. To overcome this drawback, Bai and Ng (2004) propose the Panel Analysis of Nonstationarity in Idiosyncratic and Common components (PANIC) methodology. This approach consists to decompose the series into two unobserved components: idiosyncratic and common components. To deal with potential non stationary variables, the first difference is applied to the series. Then, the principal component method is applied to estimated the first-differenced common and idiosyncratic components. The level of the common and idiosyncratic components is then recovers through a difference reaccumulation approach.

Pesaran (2006) proposes an easier way to get ride of the two issues previously mentioned. He shows that an approximation of the linear unobserved common factors is consistently estimated by a cross-section average of the dependent variables and its first lagged difference. Moreover, this approach does not require the knowledge of the number of unobserved factors. It must only have a fixed number of factors. Rather than being mutually exclusive, the cross-section average (CA) augmentation and PANIC approaches can be combined in an efficient way (Reese

and Westerlund, 2016).³⁷ Reese and Westerlund (2016) propose the PANICCA methodology which is PANIC applied on CA. This methodology exploits advantages from both approaches. The CA of Pesaran (2006) proposes an easy way to obtain consistent estimation of the unobserved factors, while the PANIC methodology is interesting as it allows inference based on normal distribution. That is why Reese and Westerlund (2016) develop CA based tests that support asymptotically normal inference.

2.C.2 Panel unit root tests

Our presentation of the CIPS test starts by outlining a benchmark specification for the unit root hypothesis in a heterogeneous panel:

$$y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + \varepsilon_{it} \quad (2.C.11)$$

where ρ_i is the heterogeneous autoregressive parameter. We subtract each side of the equation by $y_{i,t-1}$, we get:

$$\Delta y_{it} = \alpha_i + \phi_i y_{i,t-1} + \varepsilon_{it} \quad (2.C.12)$$

where $\phi_i = (\rho_i - 1)$. Pesaran (2007) shows that cross-section dependency can be controled for through the add of the contemporaneous and lagged average of the endogenous variable to the regression. The test is named the cross-section augmented Dickey-Fuller CADF. We get the following equation:

$$\Delta y_{i,t} = \alpha_i + \phi_i y_{i,t-1} + b_i \overline{y_{t-1}} + c_i \Delta \overline{y_t} + \varepsilon_{it} \quad (2.C.13)$$

³⁷See Urbain and Westerlund (2015) for a comparison between CA and PANIC methodologies.

where $\bar{y}_t = N^{-1} \sum_{i=1}^N y_{it}$ and $\overline{\Delta y}_t = N^{-1} \sum_{i=1}^N \Delta y_{it}$. The set of hypotheses for the CIPS test is the following:

$$\left\{ \begin{array}{l} H_0 : \rho_i = 1 \text{ for } i = 1, \dots, N \\ H1 : \rho_i = 1 \text{ for } i = 1, \dots, N_1 \\ H1 : \rho_i < 1 \text{ for } i = N_1 + 1, \dots, N \end{array} \right. \quad (2.C.14)$$

The test statistic is obtained as the average of the N individual CADF t-statistics:

$$CIPS = \frac{1}{N} \sum_{i=1}^N CADF_i \quad (2.C.15)$$

where $CADF_i$ is the ADF statistics obtained for a cross section i from the individual regression.³⁸ As shown by Pesaran (2007), the joint asymptotic limit distribution of the CIPS statistic is nonstandard and critical values for each values of N and T are provided. Although controlling for CSD, the CIPS test does not include the existence of structural breaks in its procedure. Failure to properly control for the existence of structural breaks in the testing procedure can lead to misleading conclusions regarding the order of integration of a time-series (Bai and Carrion-I-Silvestre, 2009). To circumvent this drawback, we thus use the BCIS test. Assuming that we test the null hypothesis of unit root for a variable X_t , we have the following set of hypotheses:

$$\left\{ \begin{array}{l} H_0 : \rho_i = 1 \text{ for } i = 1, \dots, N \\ H1 : |\rho_i| = 1 \text{ for some } i \end{array} \right. \quad (2.C.16)$$

Following Bai and Carrion-I-Silvestre (2009), we consider the following general panel model:

³⁸It is worth mentioning that Pesaran et al. (2013) extend this approach to a multifactor error term structure. They show that a way to control for the cross-section dependence is to use the information contained in additional variables, which are assume to share the same common factor of the variable of interest. Then, the trick is to include in the ADF regression test the average of these variables.

$$X_{i,t} = D_{i,t} + F'_t \pi_i + e_{i,t} \quad (2.C.17)$$

$$(I - L)F_t = C(L)u_t \quad (2.C.18)$$

$$(1 - \rho_i L)e_{i,t} = H_i(L)\epsilon_{i,t} \quad (2.C.19)$$

where $C(L) = \sum_{j=0}^{\infty} C_j L^j$ and $H_i(L) = \sum_{j=0}^{\infty} H_{i,j} L^j$. D_{it} stands for the deterministic part of the model and $e_{i,t}$ is the idiosyncratic error term. F_t is a vector that accounts for the common factors of the panel. Regarding the deterministic component $D_{i,t}$, two deterministic models are considered:

$$D_{i,t} = \mu_i + \sum_{j=1}^{l_i} \theta_{i,j} DU_{i,j,t} \quad (2.C.20)$$

$$D_{i,t} = \mu_i + \beta_i t + \sum_{j=1}^{l_i} \theta_{i,j} DU_{i,j,t} + \sum_{k=1}^{m_i} \gamma_{i,k} DT_{i,k,t} \quad (2.C.21)$$

Bai and Carrion-I-Silvestre (2009) allow for l_i structural breaks affecting the mean and m_i structural breaks affecting the trend of the time-series.³⁹ The dummy variables are defined as $DU_{i,j,t}=1$ for $t > T_{a,j}^i$ and 0 elsewhere, and $DT_{i,k,t}=(t-T_{b,k}^i)$ for $t > T_{b,k}^i$ and 0 elsewhere, where $T_{a,j}^i$ and $T_{b,k}^i$ denote the j -th and k -th dates of the breaks in level and the trend, respectively for the i -th individual, $j=1, \dots, l_i$, $k=1, \dots, m_i$. The first specification of the deterministic component consists of breaks affecting the level of the series. In the second specification, breaks in level and trend are allowed. As can be seen from the two previous specifications, BCIS is a very general test which

³⁹Bai and Carrion-I-Silvestre do not constraint the number of break(s) in mean to be equal to the number of break(s) in trend.

allows a significant degree of individual heterogeneity. Indeed, in both models structural breaks can be positioned at different dates for different individuals, different magnitudes of shift, different numbers of structural breaks by individuals, different locations for the breaks for the level and the slope. As the number and location of the different structural breaks are unknown, they have to be estimated. Following, Bai and Carrion-I-Silvestre (2009)'s suggestion, we rely on the Bai and Perron's (1998) procedure to estimate the number and the location of the breaks. Three different test statistics have been proposed by Bai and Carrion-I-Silvestre (2009):

$$Z = \sqrt{N} \frac{MSB(\lambda - \bar{\xi})}{\bar{\sigma}} \rightarrow \mathcal{N}(0, 1) \quad (2.C.22)$$

where MSB stands for the modified Sargan-Bhargava tests. $\overline{MSB}(\lambda) = N^{-1} \sum_{i=1}^N MSB_i(\lambda_i)$, $\bar{\xi} = N^{-1} \sum_{i=1}^N \xi_i$, and $\bar{\sigma}^2 = N^{-1} \sum_{i=1}^N (\sigma_i)^2$, where ξ_i and σ_i^2 respectively denote the mean and the variance of the individual $MSB_i(\lambda_i)$ statistics respectively.

$$P = -2 \sum_{i=1}^N \ln(P_i) \rightarrow \chi^2(2N) \quad (2.C.23)$$

$$P_m = \frac{-2 \sum_{i=1}^N \ln P_i - 2N}{\sqrt{4N}} \rightarrow \mathcal{N}(0, 1) \quad (2.C.24)$$

where P_i are the P-value associated with the individual MSB tests. According to Bai and Carrion-I-Silvestre (2009), the P-stat is designed for fixed N, while the P_m -stat is suitable for large N panel.

2.C.3 Cross-sectional augmented distributed lags model

The goal of the Cross Sectional-Distributed Lag (CS-DL) estimator (Chudik et al., 2016) is to estimate a long-run relationship as follows:

$$y_{i,t} = \alpha_i + \gamma_i X_{i,t} + \epsilon_{i,t} \quad (2.C.25)$$

Where i denotes the country and t the year of observation. α_i stands for the country fixed effects. $X_{i,t}$ is the matrix of exogenous variables of interest, γ is the vector of the corresponding long-run parameters. $\epsilon_{i,t}$ is an error term which can be cross-sectionally correlated across countries. To explain how the CS-DL approach works, we write equation (2.C.25) as an ARDL model assuming one lag of the exogenous variables:⁴⁰

$$y_{i,t} = \phi y_{i,t-1} + \beta_1 X_{i,t} + \beta_2 X_{i,t-1} + \epsilon_{i,t} \quad (2.C.26)$$

$$\epsilon_{i,t} = \gamma'_i f_t + u_{i,t} \quad (2.C.27)$$

$\epsilon_{i,t}$ is assumed to be a serially uncorrelated error term that, potentially, could be dependent across countries due to the presence of unobserved common factors as shown by (2.C.27). In this framework, the long-run coefficients are usually inferred from the short-run coefficients of the explanatory variables (i.e, ϕ , β_1 and β_2). The approach proposed by Chudik et al. (2016) consists to rewrite equation (2.C.26):

$$y_{i,t} = \gamma X_{i,t} + \alpha \Delta X_{i,t} + \tilde{\epsilon}_{i,t} \quad (2.C.28)$$

⁴⁰For the simplicity of presentation, we omit deterministic elements.

where $\tilde{\epsilon}_{it} = \frac{\epsilon}{1 - \phi}$ and $\alpha = \beta_1 + \beta_2$. The unobserved common factors, f_t , can be captured by adding cross-sectional averages of the observables in our regressions (Pesaran, 2006; Chudik and Pesaran, 2015). Eq (2.C.25) can be estimated using the MG (Pesaran and Smith, 1995) and Pooled Mean Group (PMG; Pesaran et al., 1999) estimators. The MG estimator is obtained as follows:

$$MG = N^{-1} \sum_{i=1}^N \gamma_i \quad (2.C.29)$$

Where the γ_i is the individual coefficients obtained from a country OLS regression. To obtain the PMG estimator, the individual long-run coefficients are restricted to be the same across countries. The PMG estimator uses a maximum likelihood approach to estimate the model based on the Newton-Raphson algorithm. The MG estimator allows us to take into account full heterogeneity of the individuals in the panel, but this estimator produces consistent estimates of the average of the parameters only for sufficiently long time-series dimensions (Pesaran and Smith, 1995). Given the moderate time dimensions of our panel data, we thus prefer to rely on the PMG estimator.

Chapitre 3

Infrastructures and the real exchange rate[†]

[†]Une première version de ce chapitre est en révision en tant que Document de travail EconomiX. Je suis très reconnaissant envers Valérie Mignon pour ses précieux commentaires et suggestions. Je remercie également Cécile Couharde pour ses remarques et conseils.

3.1 Introduction

One of the explanations for the stagnation of productivity in developing economies is the absence of adequate infrastructures (Iimi and Smith, 2007). Braese et al. (2019b) estimate that deficient infrastructures result in losses of capacity utilization rates of firms, amounting to \$151 billion per year for low- and middle-income countries. The lack of reliable infrastructures is a key issue because they are essential to overall competitiveness (Braese et al., 2019b) due to the associated productivity gains. The latter are of primary importance since they can reduce domestic production costs, influencing the dynamic of the Real Exchange Rate (RER). Surprisingly, the literature dealing with the effects of infrastructures on the RER is very scarce. This chapter aims at filling up this gap.

Within the literature dealing with the RER determinants, the work from Du et al. (2013) is the closest to ours. They find evidence of a robust negative effect of transport network on countries' international competitiveness.¹ Their results are encompassed in a theoretical framework within which an infrastructure improvement introduces more competition among domestic firms, lowering thus the mark-up of firms selling. If the subsequent decrease in the domestic price level is higher in this country than in other economies, it creates a depreciation of the domestic currency. Galstyan and Lane (2009) examine the effects of infrastructures using government investment. However, this variable is not suitable for this purpose for at least two reasons. First, the monetary measures of public investment are inadequate to track the effect of physical capital stock (Calderón et al., 2015). Indeed, as noted by Pritchett (1999) and Arestoff and Hurlin (2010), higher government investment does not automatically translate into a higher capital stock due to public inefficiency.

¹The transport network includes the following elements: quantitative measures of infrastructures (kilometres of roads and rail lines), and countries' transportation capacity (goods transported by roads, railways, air and inland waterway).

Second, over time, the public sector investment is not devoted only to the financing of productive activities.

Falling into this strand of the literature, we contribute to the existing studies in three ways. Our first contribution is to take into account the multidimensionality of the infrastructure network, while Du et al. (2013) consider only one dimension. Accordingly, we propose three new Real Effective Exchange Rate (REER) determinants. Second, while the literature dealing with the REER determinants typically assumes linear relationships, we show the relevance of the nonlinearity hypothesis when accounting for infrastructures. Finally, our third contribution is to provide several transmission channels associated with these new determinants.

To this aim, this chapter investigates the effects of infrastructures on the REER using a heterogeneous panel of 31 countries over the period 1973-2014. Our empirical analysis takes into account the multidimensionality of the infrastructure network by examining the impacts of Electricity Generating Capacity (EGC) and telecommunications. While the two previous variables constitute quantitative measures of infrastructures, we also examine the quality of the electrical network using electric power transmission and distribution losses. Since infrastructure investment is characterized by the existence of network effects (Agénor and Moreno-Dodson, 2006; Candelon et al., 2013; Calderón and Servén, 2015), nonlinearities in their marginal productivities appear. To account for the presence of these network effects, we rely on the Panel Smooth Transition Regression model (Gonzalez et al., 2017). This methodology allows us to examine the nonlinear relationship between infrastructures and the REER, by investigating whether the effects of our infrastructure variables depend on their levels.

Our results show strong evidence of a nonlinear relationship between telecommunications, electric power, and the REER. When the telecommunications network is not totally completed, an increase in telecommunications per 1000 workers is associated with a REER depreciation. Once the network is completed, the additional depreciation associated with a rise in this variable is rather small. Considering the EGC per 1000 workers, we only observe a REER depreciation for "low" levels of electric power. We explain these results through the *productivity* transmission channel. As a rise in the infrastructure stock is associated with productivity gains, it leads to a reduction in production costs lowering the domestic price level and, in turn, causing a depreciation of the REER. The additional depreciation associated with higher telecommunications and EGC per worker is small or non-existent as the productivity gains are mainly concentrated when the network is not completed. Finally, higher electric power losses are associated with a REER depreciation. The latter is higher in the regime of "high" electric power losses: to face power losses, more firms have to implement costly coping measures, which may increase the price of traded goods. Considering the internal definition of the REER, it results in a depreciation of the domestic currency.

Our chapter is organized as follows. Section 3.2 reviews the related literature. Section 3.3 presents the data and methodology. Section 3.4 reports and discusses our empirical results. Finally, Section 3.5 concludes the chapter.

3.2 Related literature

This section reviews the relevant literature to determine the transmission channels through which infrastructures can influence the RER.² Section 3.2.1 presents the macroeconomic and microeconomic effects of infrastructures. Since transmission channels are likely to differ depending on the type of infrastructure considered, electricity and telecommunications infrastructures are discussed separately. Section 3.2.2 is devoted to the presentation of the impacts of the telecommunication network. Finally, Section 3.2.3 reviews the literature on the effects of electricity generating capacity. This section also discusses how the quality of the power grid affects the economy.

3.2.1 Macroeconomic and microeconomic effects of infrastructures

To shed light on the potential effects of the infrastructure stock, Barro's (1990) model constitutes a useful benchmark. He builds an endogenous growth model where public services serve as inputs to private production. In his theoretical framework, a raise in public services provided to each household-producer increases the marginal productivity of private input factors (capital and labor), thereby promoting growth. This transmission channel is one of the three "conventional channels" identified by Agénor and Moreno-Dodson (2006) in their review of the infrastructure-growth nexus. Hulten et al. (2006) refer to this mechanism as the "non-market mediated" infrastructure effects. Infrastructure-augmented production function estimations corroborate the existence of this transmission channel. Indeed, examining a heterogeneous panel of 88 countries over the period 1960-2000, Calderón et al. (2015) obtain a long-run elasticity between infrastructure stock³ and GDP per 1000 workers ranging from 0.07 to 0.10. Investigations at the firm level also support the previous result. Indeed, Mitra et al. (2016) find that an overall higher infrastructure stock in-

²Our review draws heavily upon the literature investigating the relationship between infrastructures and growth (see the surveys of Calderón and Servén (2014) and Bom and Ligthart (2014), for overviews of the infrastructures-growth nexus).

³Calderón et al. (2015) rely on a synthetic infrastructure indicator built as the first principal component of the following variables: energy power, roads and telecommunications.

creases the productivity of Indian manufacturing firms. Furthermore, Anos-Casero and Udomsaph (2009) show that an improvement in infrastructure quality ameliorates significantly Total Factor Productivity (TFP) of the Eastern European firms examined.

One potential drawback of the previous empirical investigations is the assumption of a linear relationship between infrastructure stock and marginal productivity. This hypothesis may be potentially misleading for two reasons. On the one hand, infrastructure is "lumpy" since the existence of a specific amount of infrastructure assets is required to observe a positive effect of infrastructure investment on private sector productivity (Agénor, 2010). On the other hand, infrastructure presents network effects as the marginal productivity of higher investment in infrastructures is a function of existing stocks (Candelon et al., 2013). Given these two characteristics, a nonlinear specification is thus more appropriate to investigate infrastructure effects. To this end, Candelon et al. (2013) rely on a Panel Threshold Regression (PTR) model. They confirm the existence of network effects for several infrastructure variables (electricity, telecommunications, and transportation) in developing economies. Once a sufficient level of infrastructure stock is reached, infrastructure investments have higher marginal productivity than other investments,⁴ while their marginal effects are smaller once the network is completed. In other words, the marginal productivity of infrastructures should be higher if the network is not entirely established, while it is expected to be lower if the network is totally completed.

The second channel stems from the existence of a complementary effect between infrastructure stock and private investment. The increase in private productivity leads to a rise in the expected return of private capital, which pushes up the private investment rate. Agénor and Moreo-Dodson

⁴The other types of investments examined by Candelon et al. (2013) are human and physical capital stocks.

(2006) identify a third channel dealing with the crowding-out effects of higher public infrastructure. Crowding-out effects work through different transmission channels. Assuming that an increase in distortionary taxes finances the rise in the public infrastructure stock, it may reduce the propensity to invest. Thus, it leads to a decrease in private investment. Domestic borrowing is the second option available for the government to finance increasing capital infrastructures. In this situation, it may reduce private investment because of the rise in the domestic interest rate. The emergence of these crowding-out effects may be understood in the light of the "innovation driven endogenous growth model" of Zagler and Durnecker (2003). In this framework, private investment is crowded-out if the marginal productivity of public infrastructure is lower than its marginal costs. The model of Zagler and Durnecker (2003) raises the question of the optimal level of infrastructure stock in the economy. Based on a "reduced-form" estimable equation, Canning and Pedroni (2008) find that infrastructure provisions are on average at their optimal level. Furthermore, Egert et al. (2009) provide evidence of overinvestment in infrastructures in some advanced economies.

Infrastructures may also affect growth through "new channels". Agénor and Moreno-Dodson (2006) propose the "adjustment costs channel". They define adjustment costs as "frictions that prevent firms from adjusting their capital stock fully and instantaneously in response to, say, a demand shock, a change in the relative price of capital, or an increase in productivity." These adjustment costs may be lower if the infrastructure stock and its quality improved. For example, in the presence of an electrical power network subject to frequent power outages, firms may have to invest in their own additional generators to meet higher demand. As a result, an improvement in the quality of the public power grid reduces their adjustment costs. Infrastructure provision also affects firm production costs through the "market-mediated" channel of Hulten et al. (2006).

For their productive activity, firms purchase intermediate goods and services that are produced by industry using infrastructures such as roads, electricity and telecommunications. An improvement in the stock of infrastructures therefore helps to lower the costs of these inputs for firms.

3.2.2 Telecommunications: transmission channels

Telecommunication infrastructures have the potential to improve overall productivity (Datta and Agarwal, 2004). The development of the telecommunication network reduces the acquisition cost of information and facilitates the flows of information, thus promoting the innovation process (Leff, 1984; Roller and Wavermann, 2001). To investigate the relevance of this transmission channel, Mitra et al. (2016) examine the effects of Information and Communications Technology (ICT)⁵ on Indian manufacturing firms over the period 1994-2010. They show that an improvement in ICT leads to an increase in TFP in several sectors in India. This effect is particularly strong in the textile, transport equipment and metal and products industries. Using the number of telephone lines per worker, Yeaple and Gollub (2007) find that this variable affects positively TFP in the sector of transport and instrument (Yeaple and Gollub, 2007).

Mobile telephones have been increasingly popular since the 1990s (Lee and Ward, 2016) and play on the ability to conduct business (Straub, 2011). This is particularly important for the agricultural sector, where new opportunities are emerging with the availability of mobile-based applications (Aker, 2011). Based on these applications, farmers have access to information such as market prices, weather, transport and agricultural techniques. Increasing mobile coverage reduces the costs of obtaining information price for consumers, traders, and producers in agricultural mar-

⁵The ICT indicator is obtained by applying the PCA methodology on the following variables: number of internet users, number of mobile of cellular subscription, and telephone main lines.

kets (Aker and Mbiti, 2010). As a result, better telecommunications reduce the variable cost of market participation, increasing competition between firms (Egert et al., 2009; Deichmann, 2016). This transmission channel is supported by the study of Muto and Yamano (2009) who examine how mobile phone expansion affects market participation of farmers in Uganda between 2003 and 2005. They show that mobile phone network expansions have a higher effect on remote markets producing perishable goods.⁶

Macroeconomic studies have also paid attention to the relationship between the availability of telecommunications and agricultural productivity. Bravo-Ortega and Lederman (2004) fail to find evidence of a significant effect of telephone density, while Lio and Liu (2006) confirm that ICT and agricultural productivity are positively correlated in a sample of 88 countries. Lio and Liu (2006) also find evidence that ICT has a higher marginal effect on productivity for richer countries.

3.2.3 Electric power and power grid quality: transmission channels

Access to electricity and sufficient energy power are essential for both households and firms. An improvement in the energy-generating capacity per worker has the potential to increase industries' productivity as it is a key input in the production process, especially for energy-intensive firms. Yeaple and Gollub (2007) validate this transmission channel. In their investigation of the effects of infrastructure provision on industry-level productivity, they show that higher electrical power-generating capacity positively affects TFP of the chemicals and food products industries. The literature has also paid particular attention to the agricultural sector, since productivity improvements in this industry can be hampered by inadequate infrastructure provision (Iimi and Smith,

⁶Higher mobile coverage also results in lower price dispersion in the grain market (see Aker (2010) and Aker and Fafchamps (2015) on this issue for Niger).

2007). The relevance of this argument has been investigated by Bravo-Ortega and Lederman (2004). They find that an increase in the total plant generating capacity per capita improves agricultural productivity for 77 countries. Access to electricity is also crucial because it contributes to improving the hygiene and health of the population, thus increasing the productivity of the economy (Agénor, 2010).⁷

Electric power alone is not enough to increase productivity if it is not combined with a reliable power grid. Hallegatte et al. (2019) identify three main channels through which firms are likely to be affected by poor quality electrical infrastructures. First, frequent power outages have a direct impact on firms' activities by reducing their timely business activity (Iimi, 2011; Alby et al., 2013; Hallegatte et al., 2019). This event affects firms differently, depending on their operating industry. Some sectors such as construction, manufacturing, hotel and restaurant industries are particularly vulnerable to power outages (Iimi, 2011). This reduction in business activity is critical because it leads to a reduction in revenues. Using district-level data for Indonesian manufacturers over the period 1985-2010, Pötzner (2017) confirms the relevance of this transmission channel. Relying on an Instrumental Variable (IV) approach, she finds that a deterioration in the electrical network is associated with a reduction in firms' value-added. Allcott et al. (2016) obtain similar results for Indian manufacturers. Using an alternative IV approach, they show that average electricity level shortages reported reduce firms' revenues from 5% to 10%.

Secondly, an unreliable electrical network can also push firms to adopt costly coping measures, such as investing in their own generators (Dethier et al., 2011; Alby et al., 2013; Braese et al.,

⁷As noted by Agénor (2010), access to electricity allows the population to avoid the use of unwholesome cooking accessories harmful for their health. It is worth mentioning that access to a reliable electrical network is also essential for the proper functioning of hospitals and schools.

2019b). This decision is particularly costly as it increases firms' operational costs because it requires the installation, maintenance, and operation of additional machinery (Braese et al., 2019a). Part of these additional operational costs comes from the cost of own-generated electricity. Steinbuck and Voster (2010) provide evidence that own generated electricity can be particularly costly for firms. They estimate that the price of purchasing (subsidized) electricity from the public grid is three times lower than the costs of own-generation for 8483 operating firms in Africa. The costs of these coping measures may be illustrated using Fisher et al. (2015)'s study. Coping measures are estimated to increase the unit production costs of the most energy-consuming Chinese firms by 8%. Allcott et al. (2016) provide a more nuanced analysis. They show that, due to electricity shortages, Indian firms experience an increase in their fuel expenditures, which is mostly offset by a reduction of their electricity bills. The increased operational costs induced by a low quality electricity grid also creates a distortion in the size of companies in the economy. There is a lower share of small firms in electricity-intensive sectors located in high-outages countries (Alby et al., 2013).

An electrical network of poor quality also biases technological progress towards labor-intensive technology (Alby et al., 2013) deterring the most productive investment. Indeed, frequent power outages reduce firms' productivity in Africa and Asia (Hallegatte et al., 2019). More precisely, Allcott et al. (2016), Pötzner (2017) and Guarra and Tessema (2018) respectively show that electricity disruptions hamper productivity for Indian, Indonesian and Ethiopian firms. Power grid quality affects not only firms' productivity but also their international competitiveness. In his investigation of the effects of power outages on firms' employment in Africa, Mensah (2018) also tests for the presence of this trade competitiveness channel. Since an unreliable electrical network

increases firms' production costs and leads to productivity losses, it is expected to have a negative effect on firms' trade competitiveness. Mensah (2018) finds that electricity shortages reduce exports from 6% to 12% for exporting African firms.

3.3 Data and methodology

3.3.1 Data

Infrastructure development being a long-term process, it is crucial to rely on long time-series to identify and assess its effects accurately. Given the broader availability of infrastructure variables over a long time horizon, the selection of our sample is then primarily guided by the existence of an adequate proxy for the Balassa-Samuelson (Balassa, 1964; Samuelson, 1964; BS hereafter) effect over a long-time period for a reasonable number of countries. The literature investigating the BS hypothesis has proposed various measures to take into account this key RER determinant (see Couharde et al. (2019) for a detailed description of the different proxies employed by the literature).⁸ The Gross Domestic Product Per Capita (GDP PC) and the GDP per worker (GDP PW) are potential candidates as they are available over a long horizon for a large panel of countries. However, GDP PC has the drawback to assume a stable participation rate in the economy (Couharde et al., 2019). To cope with the previous limitation, GDP PW can be used but is also inadequate to measure the BS effect correctly. Indeed, assuming an increase in productivity in the tradable and non-tradable sectors, GDP PW increases while it is expected to have a neutral effect on the REER following the BS hypothesis (Ricci et al., 2013). These two drawbacks justify our decision to do not use these two measures. Another possible proxy is the ratio of the consumer

⁸It is worth mentioning that the RPROD database, which is part of the EQCHANGE database, provides five different proxies for the BS effect (see Couharde et al., 2019).

price index to the producer price index (CPI-PPI). In practice, the use of this measure is, however, hardly compatible with our prerequisite of long time-series as PPI covers only the most recent years.

Considering the external version of the BS hypothesis,⁹ the relative price of non-tradables to tradables appears to be a potential appropriate proxy. The BS effect was therefore taken into account using three and/or six-sectoral deflators (see Lee and Tang, 2007; Bénassy-Quéré et al., 2009; Ricci et al., 2013).¹⁰ We choose to use a six-sectors deflator because it allows us to have a narrower sectoral classification, resulting in a more accurate distinction between tradable and non-tradable sectors.¹¹ The construction of the relative price of non-tradables to tradables is carried out using the Groningen Growth and Development Centre (GGDC) database as the primary source (Inklaar and Timmer, 2008). It provides value-added series in current and constant prices over ten sectors for 42 countries of Africa, Asia, and Latin America. To extend the GGDC series up to 2014, we rely on the United Nations (UN) database, which also makes available current and constant value-added series. As the sectoral classification of the previous database consists of 6 sectors, we aggregate the 10 sectors from the GGDC database into the six sectors available in the UN database.¹² It results in the six following sectors: (i) Agriculture, hunting, forestry, fishing; (ii) Mining, manufacturing, utilities (sum of C,D and E sectors); (iii) Construction; (iv) Wholesale, retail trade, restaurants and hotels; (v) Transport, storage and communications, and (vi) Other

⁹According to the external version of the BS effect, higher relative price of non-tradables to tradables appreciates the RER.

¹⁰The productivity differential between tradable and non-tradable sectors can also be used. However, this choice is complicated in practice due to data availability issues. The use of the productivity differential might be inadequate to identify the effects of infrastructures accurately. Indeed, as our literature review suggests, the infrastructure stock is likely to have a positive effect on productivity growth. Therefore, the simultaneous inclusion of this proxy and our infrastructure variables will come at the cost of difficulty in the disentangling of the "pure" infrastructure effect as part of this effect is probably captured by the productivity differential variable. Moreover, a proper examination of sectoral employment series between the ILOSTAT and GGDC databases over the period 1991-2011 shows considerable discrepancies between these two series. The obtention of reliable sectoral employment series over the period 1973-2014 is thus difficult. Hence, it is somewhat "heroic" to use the productivity differential as a measure of the BS effect if productivity is computed as the ratio between the sectoral value-added and employment.

¹¹We decide to rely upon a six-sectors deflator because Morvillier (2020) provides evidence of a robust effect of the non-traded to traded relative price on the REER in a sample of developing and emerging economies. Indeed, the use of three or six sectors deflators both confirms the external version of the BS hypothesis.

¹²It should be noted that the GGDC and UN databases are both in ISIC Rev 3.1 classification. Another possibility would be to use the UNDATA database and start in 1980. However, as argued previously, our preference goes to longer time-series. The description of the divisions associated with each of these sectors is available in Table 3.A.1 in the Appendix.

activities (sum of sectors I to P).¹³ The use of the relative price of non-traded to traded goods requires a classification of the sectors between tradable and non-tradable. To do so, we rely on the classification proposed by De Gregorio et al.'s (1994)¹⁴ according to which construction, wholesale, retail trade, restaurants and hotels, and other services are classified in the non-tradable sector, while agriculture, manufacturing, mining, utilities and transport are treated as tradable goods.

To derive the six-sectors' deflator, we follow Lee and Tang (2007) and compute country-specific weights for each sector ($\omega_{i,k}$), measured by their value-added ($VA_{i,t}$) share in total output:

$$\omega_{i,k} = \frac{\sum_{t=1}^T VA_{i,k,t}}{\sum_{k \in h} (\sum_{t=1}^T VA_{i,k,t})} \quad (3.1)$$

where i is the country, h denotes the nature of the sector k under consideration, i.e., tradable (T) or non-tradable (NT) sector.

For each country i , the aggregated value-added deflator of the non-tradable ($pva_{i,t}^{NT}$) and tradable ($pva_{i,t}^T$) sectors is then calculated as a weighted average of value added deflators for respectively all non-tradable sectors and all tradable sectors:

$$pva_{i,t,f}^{NT} = \sum_{k \in NT} (\omega_{i,k} \times pva_{i,t}^k) \quad (3.2)$$

$$pva_{i,t,f}^T = \sum_{k \in T} (\omega_{i,k} \times pva_{i,t}^k) \quad (3.3)$$

where $pva_{i,t,f}^{NT}$ and $pva_{i,t,f}^T$ are expressed in logarithmic terms. Denoting $def6$ the BS measure based on six-sectors' value-added deflators, we get for a country i at time t :

¹³The description of the divisions associated with each of these sectors is available in Table 3.A.2 in the Appendix.

¹⁴This classification has been widely used in the literature (see Lee and Tang, 2007; Ricci et al., 2013; Gubler and Sax, 2019; among others).

$$def6_f_{i,t} = (pva_{i,t,f}^{NT} - pva_{i,t,f}^T) \quad (3.4)$$

This variable is expressed as a deviation from the main trading partners:

$$def6_fr_{i,t} = def6_f_{i,t} - \sum_{j=1}^N w_{i,j,t} (pva_{j,t,f}^{NT} - pva_{j,t,f}^T) \quad (3.5)$$

Since we seek to measure the pure BS effect rather than investigate its robustness, we assume fixed weights in the aggregation process of sectors into non-tradables and tradables.¹⁵ Among the 42 countries initially available in the GGDC database, 11 of them are not included due to data availability issues as the PSTR methodology requires a balanced panel.¹⁶ Given this constraint, our final sample consists of 31 countries: 11 advanced (Denmark, France, Germany, Italy, Japan, the Netherlands, Singapore, Spain, Sweden, the United Kingdom and the United States of America), 15 emerging (Argentina, Brazil, Chile, Colombia, Egypt, India, Indonesia, Korea, Malaysia, Mexico, Morocco, Peru, Philippines, Thailand and Venezuela) and 5 developing (Kenya, Ghana, Senegal, Tanzania and Zambia) economies. Our dataset spans from 1973 to 2014. The end date of our sample is guided by data availability regarding the electricity power and distribution losses variables.

The Electricity Generating Capacity (1000 kilowatts, EGC hereafter) series are extracted from the Canning database (1998) ending in 2002. In order to obtain a consistent time series for each country, we filled up the missing values for the period 2003-2014 using the same source as Canning. To do so, we rely on the United Nations Energy Statistics Yearbooks. The quality of the

¹⁵The assumption of fixed weights in the aggregation process of the sectors into non-tradables and tradables can be relaxed (see Morvillier (2020) on this issue). However, this issue is probably not important for our purpose as the aggregation process strategy does not affect the validation of the BS hypothesis for developing and emerging economies, explaining our choice.

¹⁶The following countries are not included: Bolivia, Botswana, China, Costa Rica, Ethiopia, Hong Kong, Malawi, Mauritius, Nigeria, South Africa, and Taiwan.

electrical network is measured using electric power and distribution losses (% GDP).¹⁷ It is the loss transmission between sources of supply and point of distribution. An increase in this indicator means a deterioration of the electrical network quality. This variable comes from the World Development Indicators (WDI) database of the World Bank. Our telecommunication indicator is the sum of the number of main-line and mobile subscriptions.^{18,19} The first variable is extracted from the International Telecommunication Union database, while the second one comes from WDI. We also consider mobile subscriptions as abstracting the significant development of mobile phones will not allow us to take into consideration the entire expansion of the telecommunication network.

Transport facilities are another essential dimension of a country's infrastructure network, which includes the road network. However, several difficulties hamper the inclusion of this variable in our analysis. The main issue is to obtain consistent road series over a long time period for our sample of countries. On this point, Canning (1998) notes that: "For total roads, the definition and coverage of the data vary too much over time and across countries to produce a consistent series." This variation in the definition also makes difficult the extension of the time series up to 2014. Due to this inconsistency, we are unfortunately unable to include the roads network in our empirical analysis. To avoid scale effects in the network, we express EGC and telecommunications per 1000 workers (see Candelon et al. (2013) and Calderón et al. (2015) for similar uses).

The Real Effective Exchange Rate (REER) series against 186 trading partners –based on a time-varying weighting scheme (non-overlapping five-year average weights)– are extracted

¹⁷This variable has been used, for example, by Calderón and Chong (2004) in their investigation of the relationship between infrastructures and income distribution.

¹⁸See Egert et al. (2009) for a similar use.

¹⁹It is worth mentioning that telecommunications are part of a more general concept, known as the Information and Communications Technology (ICT). However, the development of ICT is a relatively recent fact. It is therefore difficult to include this evolution coherently in our framework, explaining our focus on the telecommunication dimension alone.

from the EQCHANGE database (Couharde et al., 2018). An increase in the REER indicates an appreciation of the domestic currency. Based on the literature dealing with the RER determinants, we include the following control variables in our model: trade openness (GDP share), the logarithm of the fertility rate, government consumption expenditures (GDP share), Net Foreign Asset (NFA) position (GDP share).²⁰ All the control variables are extracted from WDI, except the NFA series which come from Lane and Milesi-Ferretti database (2004). In the presence of numerous potential candidate variables, a variable selection approach can be appropriate to select the most relevant determinants. Since the start date of our sample is earlier than usual, the number of potential determinants is rather small limiting the relevance of such an approach. Moreover, as the PSTR methodology can be subject to omitted variable bias, we chose to include the most commonly used REER determinants to avoid this issue. It should be noted that Terms of Trade (TOT) are not included due to data availability issues as this variable is only available since 1980 for developing economies. Turning to the number of workers, they are extracted from the Penn World Table 9.0 (Timmer et al., 2015). A summary of all the variables, as well as their sources, is available in Table 3.A.3 in the Appendix.

3.3.2 Methodology

To investigate the existence of a nonlinear relationship between infrastructures and the REER, we rely on the PSTR model proposed by Gonzalez et al. (2017). The PSTR can be viewed as a linear heterogeneous panel data model that allows the coefficients to vary across time and cross-section depending on the values of the transition variable (Gonzalez et al., 2017). The adjustment of the estimated coefficients is smooth. The basic PSTR model with two extreme regimes is defined as

²⁰See Edwards (1988), Froot and Rogoff (1991, 1995), Lane and Milesi-Ferretti (2002) and Rose et al. (2009) for the use and justifications of these different RER determinants.

follows:

$$y_{it} = \mu_i + \beta'_1 X_{it} + \beta'_2 X_{it} \times F(q_{it}; \gamma, c) + \phi' Z_{it} + \epsilon_{it} \quad (3.6)$$

for $i=1, \dots, N$, N being the number of countries, and $t=1, \dots, T$. y_{it} denotes the dependent variable, μ_i are country fixed effects, X_{it} is the set of variables to which the nonlinearity is applied, Z_{it} is a vector of control variables, and ϵ_{it} is an independent and identically distributed error term. $F(\cdot)$ is a transition function which is bounded between 0 and 1, expressed as follows considering a logistic specification:

$$F(q_{it}; \gamma, c) = \left(1 + \exp\left(-\gamma \prod_{j=1}^m (q_{it} - c_j)\right) \right)^{-1} \quad (3.7)$$

with $\gamma > 0$ denotes the speed of transition, $c_1 < c_2 < \dots < c_m$ are the threshold parameters and q_{it} is the transition variable.

Considering equation (3.6), the marginal effect of X_{it} is given by:

$$\frac{\partial y_{it}}{\partial X_{it}} = \beta'_1 + \beta'_2 \times F(q_{it}; \gamma, c)$$

The marginal effect of X_{it} is thus a weighted average of the coefficients β'_1 and β'_2 that depends on the values of the transition variable.

The implementation of the PSTR methodology involves three steps: (i) specification, (ii) estimation, and (iii) evaluation. The specification step tests the null hypothesis of linearity against the alternative of PSTR. To this aim and for robustness purposes, we rely on the six homogeneity

tests proposed by Gonzalez et al. (2017). Two of them consist of different versions of a Lagrange Multiplier (LM) test. To handle heteroskedasticity and cluster-dependency issues, we also use the bootstrapped version of the LM test with the residual-based wild bootstrap (WB) and the wild cluster bootstrap (WCB) tests (see Gonzalez et al. (2017) for details). In the PSTR model, the parameters are estimated using nonlinear least squares on demeaned data. Following the procedure of Gonzalez et al. (2017), we also implement two misspecification tests. As explained by the authors, these tests are used to check if the estimated model "provides an adequate description of the data". The first specification test consists of testing the null hypothesis of PSTR against the alternative hypothesis of Time-Varying PSTR (TV-PSTR). Finally, a WCB specification test is implemented to check if the null hypothesis of our PSTR specification is rejected in favor of the alternative hypothesis of PSTR with two transition functions.

Our literature review suggests that part of our infrastructure variables' effects may occur through an increase in productivity. This transmission channel is likely to cause difficulty in the identification of the "pure" infrastructure effect if a proxy for the BS effect is simultaneously included in the specification. This issue is probably mitigated by the use of the relative price of non-traded to traded goods as a measure of the BS effect. However, to check the robustness of our results to this issue, we consider two different specifications for our infrastructure variables. To disentangle the "pure" infrastructure effect, our first specification excludes the BS effect. As the previous specification suffers from an obvious omitted variable bias, our second specification augments the first one with the relative price of non-traded to traded goods. Our first specification aims to investigate the existence of a nonlinear relationship between the telecommunications network and the REER:

$$reer_{it} = \mu_i + \beta'_1 telecom_{it} + \beta'_2 telecom_{it} \times F(telecom_{it}; \gamma, c) + \phi' Z_{it} + \epsilon_{it} \quad (3.8)$$

where $reer_{it}$ denotes the logarithm of the REER, and $telecom_{it}$ is the logarithm of the telecommunication per 1000 workers for country i at time t . This variable acts as the transition variable. Z_{it} is the vector of control variables which include: government consumption expenditures (gov cons), trade openness (open), the fertility rate (fertility) and the NFA position (nfa). According to equation (3.8), the effect of the telecommunication stock on the REER depends upon its own level. Depending on the values reached by the telecommunication stock, the link between telecommunication infrastructures and the REER is given by β'_1 in the first regime (when $F(.)=0$) and $\beta'_1 + \beta'_2$ in the second regime (when $F(.)=1$). Turning to the second specification, we have:

$$reer_{it} = \mu_i + \beta'_1 telecom_{it} + \beta'_2 telecom_{it} \times F(telecom_{it}; \gamma, c) + \phi' W_{it} + \epsilon_{it} \quad (3.9)$$

where W_{it} includes all the aforementioned control variables, to which we add the proxy for the BS effect def_6r . This specification aims to check the robustness of our results to the interaction between our infrastructure variable and the BS effect. The telecommunications stock constitutes only one dimension of an infrastructure network. Hence, we also examine the nonlinear relationship between electricity generating capacity and the REER:

$$reer_{it} = \mu_i + \beta'_1 egc_{it} + \beta'_2 egc_{it} \times F(egc_{it}; \gamma, c) + \phi' Z_{it} + \epsilon_{it} \quad (3.10)$$

where egc_{it} denotes the logarithm of the Electricity Generating Capacity per 1000 workers of country i at time t . This specification allows us to focus only on the nonlinear effect of the power plant capacity per workers and disentangle the "pure" effect of the EGC per 1000 workers on the

REER. As before, we check the robustness of the findings emerging from equation (3.10) using the following second specification:

$$reer_{it} = \mu_i + \beta'_1 egc_{it} + \beta'_2 egc_{it} \times F(egc_{it}; \gamma, c) + \phi' W_{it} + \epsilon_{it} \quad (3.11)$$

We further investigate the nonlinear relationship between the power grid quality and the REER dynamic through the estimation of the following equations:

$$reer_{it} = \mu_i + \beta'_1 eleclosses_{it} + \beta'_2 eleclosses_{it} \times F(eleclosses_{it}; \gamma, c) + \phi' Z_{it} + \epsilon_{it} \quad (3.12)$$

$$reer_{it} = \mu_i + \beta'_1 eleclosses_{it} + \beta'_2 eleclosses_{it} \times F(eleclosses_{it}; \gamma, c) + \phi' W_{it} + \epsilon_{it} \quad (3.13)$$

where $eleclosses_{it}$ is the electric power and distribution losses (% GDP). Note that all explanatory variables are stationary, some of them being expressed in first difference to reach stationarity. Table 3.B.1 in the Appendix provides a summary of the panel unit root tests results.²¹

3.4 Estimation results

3.4.1 Telecommunication infrastructures

We start our empirical analysis by testing the null hypothesis of linearity in equations (3.8) and (3.9) using the logarithm of telecommunications per 1000 workers as the transition variable. Here, our purpose is to test whether the effect of telecommunications on the REER depends on the level

²¹The detailed results of the panel unit root tests are available upon request from the author.

of the telecommunication network reached. The results of the homogeneity tests are reported in Table 3.B.2 in Appendix, and show that the null hypothesis of homogeneity is strongly rejected in favor of the nonlinearity alternative for both equations (3.8) and (3.9). Therefore, the inclusion of the BS effect in our specification does not affect the existence of a nonlinear relationship between the telecommunication stock and the REER. Overall, our results provide evidence that the telecommunication per 1000 workers impacts the REER differently, depending on the level of the telecommunications stock reached. Table 3.1 below reports the estimates of equations (3.8) and (3.9); the associated transition functions being displayed in Figures 3.C.1 and 3.C.2 in the Appendix.

Table 3.1 Telecommunications: results

	Regime 1	Regime 2	Regime 1	Regime 2
	(1.1)	(2.1)	(3.1)	(4.1)
Δ_{open}	-0.311**		-0.295*	
Δ_{nfa}	0.069		0.028	
gov cons	-0.607		-1.434*	
$\Delta_{fertility}$	0.486		0.0833	
telecom	-0.696*	-0.220***	-0.614**	-0.187***
def6_fr			0.560***	
gamma	0.714***		0.711**	
c	4.475***		4.475***	
TVP parameters WCB test	0.992		0.927	
RNL WCB test	0.968		0.993	

Note: This table reports the estimation of PSTR models (Eq. (3.8) in columns (1.1) and (2.1) and Eq. (3.9) in columns (3.1) and (4.1)). *** (resp. **, *) denotes significance at the 1% (resp. 5% and 10%) level based on robust standard errors. The TVP parameters WCB test checks the null hypothesis of our PSTR specification against the alternative hypothesis of time-varying PSTR. The RNL WCB tests the null hypothesis of our PSTR specification against the alternative hypothesis of PSTR with two transition functions. 10.000 bootstrap replications used.

Let us first start with a brief discussion of our control variables. Our estimations provide sup-

port for the negative effect of trade openness on REER found by previous studies (see Dufrénot and Yehoue, 2005). Trade openness being included as a proxy for trade liberalization, an increase in this variable is thus expected to lower domestic prices leading to a depreciation of the REER.

We find no evidence of a significant effect for the NFA position and fertility rate growth rate. Turning to government consumption expenditures, their effect is significantly negative only in the second specification (column 3.1). This result is contrary to the Froot-Rogoff effect (Froot and Rogoff, 1991, 1995). Indeed, an increase in government consumption expenditures is expected to appreciate the REER since the former are biased towards non-tradable goods.

Finally, following the BS effect, a rise in the productivity in the tradable sector leads to an increase in wages in the same sector. Assuming wage equalization across sectors, it leads to a rise in the relative price of non-traded to traded goods, pushing up the general price level and leading, therefore, to a RER appreciation. Our results show that the relative price of non-tradables to tradables is significant at the 1% level (see column 3.1). A 1% increase in the relative price of non-tradables to tradables leads to a REER appreciation of about 0.560%. We thus find evidence in favor of the external version of the BS effect.

Let us now examine the nonlinear relationship between telecommunications per 1000 workers and the REER. The PSTR methodology allows us to make the distinction between two regimes, depending on the level of infrastructures. In the case of the telecommunications infrastructure, the first regime may be viewed as the situation in which the network is not totally completed. The second regime corresponds to a state in which the network is totally completed. Our results show

that, in the first regime, an increase in the telecommunications per 1000 workers has a negative effect on the REER. In this regime, the telecommunication infrastructure is more or less significant depending upon the specification considered. The elasticities associated to our telecommunication indicator vary a little across our different specifications. The inclusion of the BS effect thus does not substantially affect the estimated elasticities. Indeed, the estimated coefficients go from -0.614 to -0.696 in the first regime, while they range from -0.801 to -0.916 in the second regime. Our results provide evidence of a strong marginal effect of the telecommunications per 1000 workers on the REER: in the first regime, a 1% increase in the telecommunication stocks per 1000 workers leads to a REER depreciation of 0.614% to 0.696%.

We explain this negative relationship between the telecommunication stock and the REER in light of three transmission channels. The first one is based upon the productivity-enhancing effect of telecommunications. We refer to this transmission channel as the *productivity* channel. An increase in the telecommunication stock per worker leads to an increase in the marginal productivity of private inputs. Indeed, an improvement in the telecommunication network lowers the acquisition cost of information and fosters the innovation process (Leff, 1984; Roller and Wavermann, 2001). This productivity surge leads to a reduction in the domestic unit cost of production, resulting in lower domestic prices. As a consequence, the REER depreciates.

The *market mediated* channel of Hulten et al. (2006) is the second transmission channel explaining our results. According to Hulten et al. (2006), a larger infrastructure stock reduces the purchasing costs of intermediate goods and services. This channel is relevant in the case of the telecommunication network as its development allows firms to reach a greater number of potential

suppliers for the purchase of their inputs. Firms are thus likely to obtain a lower price for intermediate goods and services. Depending on their mark-up strategy, domestic firms may decide to lower their selling price. Thus, it leads to a reduction in the domestic price level, causing a REER depreciation.

According to the third, competition channel, an improvement in the telecommunication network facilitates the flow of information. Moreover, the extension of mobile phone favourably affects the ability to do business (Straub, 2011). These different effects are likely to increase the number of market participants. This higher competition between firms may lead to a price reduction, depreciating the domestic currency. This transmission channel may be more limited to specific sectors of the economy. Among the three channels proposed to explain our results, the *productivity* channel is probably the most relevant one, as supported by Candelon et al. (2013) and Calderón et al. (2015). The *market mediated* and *competition* channels come in support to the *productivity* channel.

Another interesting result is that most part of the depreciation of the domestic currency is concentrated in the network establishment phase, which we considered to be the first regime. Indeed, in the extreme case (when $F(.)=1$), the marginal effect of telecommunication is given by -0.916 (resp. -0.801) for equation (3.8) (resp. equation (3.9)). The additional depreciation caused by an increase in the telecommunication per 1000 workers is therefore relatively small. This result is consistent with the fact that the majority of the productivity gains occurs at the beginning of the network. Thus, the major part of the reduction in the production costs is settled in the first regime, where the potential domestic price reduction is higher, explaining the higher REER depreciation. The evidence that the majority of the productivity gains are concentrated in the

construction phase of the telecommunications network is supported by the findings from Candelon et al. (2013).

3.4.2 Electricity Generating Capacity

Table 3.2 shows that the linearity hypothesis is strongly rejected for equation (3.10), suggesting that the electricity generating capacity has a nonlinear impact on the REER. Our empirical strategy also aims to check the robustness of this nonlinearity to the potential interaction with the BS effect. The results of homogeneity tests applied to equation (3.11) provide weaker evidence in favor of the nonlinearity hypothesis. Indeed, half of the tests implemented do not reject the null hypothesis of linearity. The interaction between the BS effect and the EGC per worker thus affects the existence of a nonlinear relationship. Table 3.2 below reports the estimation results of equations (3.10) and (3.11), using the logarithm of the electricity generating capacity per 1000 workers as the transition variable.²² Results concerning our control variables are almost similar to those obtained previously. The most noticeable difference is the significance of the growth rate of fertility in the first specification (see column 1.2). The fertility rate is expected to influence the REER through two main channels. The first one is the savings channel, according to which a rise in the fertility rate leads to lower savings as the young dependency ratio increases. Moreover, a rise in the fertility rate also increases young consumption, which is biased towards non-traded goods. The positive expected sign for this determinant is confirmed by our results (see column 1.2).

Regarding our variable of interest, the estimation results show that the electricity generating capacity per 1000 workers is significant at the 1% level in the first regime (columns 1.2 and 3.2). Although the significance of the electric power is not affected by the inclusion of the BS effect, the

²²The associated transition functions are reported in Figures 3.C.3 and 3.C.4 in the Appendix.

Table 3.2 Electricity generating capacity: results

	Regime 1	Regime 2	Regime 1	Regime 2
	(1.2)	(2.2)	(3.2)	(4.2)
Δ_{open}	-0.385***		-0.368**	
Δ_{nfa}	0.097		0.056	
gov cons	1.578		0.323	
$\Delta_{fertility}$	0.768***		0.423	
egc	-0.428***	-0.0734	-0.324***	-0.111
def_6r			0.639***	
gamma	609.8**		609.8*	
c	0.127***		0.126***	
TVP parameters WCB test	0.244		0.395	
RNL WCB test	0.850		0.374	

Note: This table reports the estimation of PSTR models (Eq. (3.10) in columns (1.2) and (2.2) and Eq. (3.11) in columns (3.2) and (4.2)). *** (resp. **, *) denotes significance at the 1% (resp. 5% and 10%) level based on robust standard errors. The TVP parameters WCB test checks the null hypothesis of our PSTR specification against the alternative hypothesis of time-varying PSTR. The RNL WCB tests the null hypothesis of our PSTR specification against the alternative hypothesis of PSTR with two transition functions. 10.000 bootstrap replications used.

marginal effect varies somewhat considerably across both specifications. Indeed, the elasticities range from a low of -0.324 to a high of -0.428. In the first regime (column 1.2), a 1% increase in the electricity generating capacity per 1000 workers is associated with a REER depreciation of about 0.428%. In other words, for low levels of EGC per 1000 workers, an increase in this variable depreciates the domestic currency. Two of the transmission channels previously detailed are helpful to understand how an improvement in energy affects the REER. Indeed, we also explain the negative effect of the EGC per 1000 workers in light of the *productivity* channel. Increasing electrical energy helps to realize productivity gains, especially in energy-intensive industries. Then, these productivity gains may lead to a domestic price reduction, generating, in turn a REER depreciation. The "market mediated channel" is also useful to understand our findings. Indeed, the costs of intermediate inputs are potentially lower as higher energy power per worker is available in

the economy. This reduction in the costs of intermediate inputs is probably stronger in industries relying heavily on inputs produced by energy-intensive firms. As a result of this reduction, firms may choose to lower their selling price, resulting in a depreciation of the REER.

In the case of the telecommunication network, we find that the additional depreciation is rather weak once the network is totally completed. Considering the EGC effect in the second regime, no additional depreciation is present as shown by the non significance of this variable (see columns 2.2 and 4.2). Another interesting difference is that the EGC marginal effect seems to be lower than the one obtained for telecommunication (-0.428 for EGC versus -0.696, in a comparable specification). This difference may be due to the divergence in productivity gains associated to these two infrastructure variables. Assuming that the majority of the effect works through the *productivity* channel, it means that the productivity gains associated to telecommunications are higher than the ones offered by electric power. Based on this assumption, the domestic price reduction would be higher than the one due to an increase in EGC per worker. This assumption appears to be relevant for two reasons. On the one hand, one could expect that the productivity gains associated to a rise in electric power are concentrated in energy-intensive sectors leading to more limited productivity gains. On the other hand, an improvement in the telecommunication network should increase overall productivity as it is not concentrated only in specific sectors, as suggested by Datta and Agarwal (2004).

3.4.3 Electric power losses

The investigation of the effects of electric power losses on the REER is probably richer than the one offered by the analysis of the EGC. Indeed, as suggested by our literature review, the transmission

channels through which electricity power losses could affect the REER are more numerous. We begin our empirical investigation with the results of the homogeneity tests. For our first specification (equation 3.12), we are unable to reject the null hypothesis of homogeneity at the 5% significance level. Since this specification yields no evidence for nonlinearity, equation (3.12) is not estimated. Turning to our second specification, Table 3.B.2 shows that three of the six tests implemented do not reject the null hypothesis of linearity. Because of the weak evidence of rejection of the null hypothesis, we have to be cautious about the existence of a non-linear relationship between electric power losses and the REER. Table 3.3 below reports the estimation results of equation (3.13); the related transition function being displayed in Figure 3.C.5 in the Appendix.

Table 3.3 Electric power loss: results

	Regime 1	Regime 2
Δ_{open}	-0.290**	
Δ_{nfa}	0.032	
gov cons	-0.146	
$\Delta_{\text{fertility}}$	-0.333	
eleclosses	-0.016**	-0.017***
def6	0.709***	
gamma	0.853	
Coefficient	9.369	
TVP parameter WCB test	0.941	
RNL WCB test	0.558	

Note: This table reports the estimation of PSTR models (Eq. (3.13)). *** (resp. **, *) denotes significance at the 1% (resp. 5% and 10%) level based on robust standard errors. The TVP parameters WCB test checks the null hypothesis of our PSTR specification against the alternative hypothesis of time-varying PSTR. The RNL WCB tests the null hypothesis of our PSTR specification against the alternative hypothesis of PSTR with two transition functions. 10.000 bootstrap replications used.

In the first regime, characterized by a level of electric power transmission and distribution losses

below 9.369% of GDP, there is a significantly negative effect of the electrical network quality. A 1% increase in electric power losses (in % GDP) is associated with a REER depreciation of 0.016 %. Two different transmission channels may explain this finding. On the one hand, electric power losses affect the economy by forcing firms to adopt costly coping measures. On the other hand, an electrical network of weak quality lowers firms' revenues and also leads to a demand reduction. We examine how these two transmission channels affect the REER using the standard definition of the REER and its internal version.²³ Given the standard REER definition, electric power losses may be associated with an appreciation or a depreciation of the domestic currency. The implementation of costly coping measures by firms increases their production costs, pushing the domestic price level upwards. Thus, a deterioration of the electrical network could lead to a REER appreciation. In the following, we refer to this channel as the *coping measures* channel. Furthermore, higher electric losses may also reduce domestic demand due to the cut in firms' activity. Decreasing domestic demand may lower the domestic price level, causing a REER depreciation. This channel is called the *demand* channel. As we find evidence of a depreciation of the domestic currency, this suggests that the *demand* channel outweighs the effects of the *coping measures* channel.

Although power outages impact firms by pushing them to adopt costly coping measures, this effect probably affects firms differently depending on their operating sector. Therefore, the use of the internal RER definition is probably more appropriate to explain our findings. The implementation of these coping measures is likely to be more expensive in the tradable sector (manufacturing industries) than in the non-tradable sector (hotels and restaurants, for example) as tradables rely more heavily on machines for their production. Thus, the cost increase would be higher in the tradable sector than in the non-tradable one. Hence, we can expect that the non-tradable price

²³According to the internal version, the RER is defined as the ratio between the non-tradables and tradables prices.

increase is lower than the one observed in the tradable sector, explaining the REER depreciation. Our second transmission channel states that higher electric power losses are associated with shrinking revenues and lower demand in the economy, affecting both sectors. It is thus difficult to know which sector is more strongly affected by this shrinking demand, and infer about the potential impact on the internal RER. Following the effects on the non-tradable and tradable sectors, two situations can be distinguished. Assuming that the non-tradable sector is more hardly influenced by this demand decrease, the REER would depreciate. On the contrary, the REER would appreciate if the tradable sector is more strongly affected than the non-tradable sector. Although significant, it is worth noting that the marginal effect of electric power losses is rather economically weak. The presence of antagonist effects may explain this weakness.

Turning to the second regime, it corresponds to a situation in which the electric power losses are higher than 9.369% of GDP. We interpret this regime as the "high" electrical power loss regime. In this regime, a 1% increase in the electric power losses depreciates the REER by 0.033% (-0.016-0.017). We thus observe an intensification of the depreciation of the domestic currency for higher electric power losses. To explain this result, let us rely on the internal definition of the RER and the *coping measures* channel. In the first regime, as power outages are less frequent, some firms may decide to do not invest in their own generators. Once the power outages become more frequent, firms may buy their own generators to face this event. Thus, they experience higher costs of own generated electricity, higher production costs, and higher tradable prices. The depreciation is higher since higher electric power losses make firms coping measures more costly.

3.5 Conclusion

This chapter aims to show the relevance of infrastructures in explaining the dynamic of the REER. We investigate the existence of a nonlinear relationship between several infrastructure variables (telecommunications, electric power, and power grid quality) and the REER, depending on their own levels. To this aim, we apply a PSTR model to a panel of 31 countries over the 1973-2014 period. We also provide an in-depth discussion on the potential transmission channels for each of these determinants.

Our results show strong nonlinear relationships between the telecommunications, EGC per 1000 workers and the REER. When the network is not totally completed (first regime), an increase in the EGC and telecommunications depreciates the REER, while the additional depreciation is lower or non-existent once the network is established (second regime). These different results are mainly explained in light of the *productivity* and *market mediated* channels. According to the *productivity* channel, an improvement in the EGC and telecommunication network leads to productivity gains that reduce production costs. Thus, the domestic price level is lower and the REER depreciates. Following the *market mediated* channel from Hulten et al. (2006), an increase in the infrastructure stock in the economy lowers the cost of purchasing intermediate goods and services, reducing the domestic production costs. Consequently, as previously, the REER depreciates due to the fall in the domestic price level. Furthermore, our results show that the majority of the effect of EGC and telecommunications is concentrated in the network construction phase, where productivity gains are higher (Candelon et al., 2013). Since productivity gains are concentrated in the first regime, the domestic price level reduction is also mainly present in this regime, in line with our results.

Although the EGC and telecommunications share similarities in terms of transmission channels, we also propose a specific canal for the telecommunication infrastructures. Improvements in the telecommunication network are associated with an increase in competition between domestic firms, in line with the *competition* channel. Thus, the domestic price level is reduced and the REER depreciates.

Furthermore, our results show that higher electrical power losses are associated with a REER depreciation that is stronger in the "high" electric power loss regime. To face power losses, firms may adopt costly coping measures, increasing their production costs and leading thus to a rise in the tradables' price. As a result, the REER depreciates following an increase in the loss of electric power.

Overall, our findings show the existence of three additional RER determinants that lead to domestic currency depreciation. These factors can be useful in the assessment of equilibrium exchange rates, which is required in the computation of currency misalignments.

Appendix

Appendix 3.A Data

Table 3.A.1 Sectors decomposition: GGDC database

ISIC Rev. 3.1 code	ASD sector name	ISIC Rev. 3.1 description
AtB	Agriculture	Agriculture, Hunting and Forestry, Fishing
C	Mining	Mining and Quarrying
D	Manufacturing	Manufacturing
E	Utilities	Electricity, Gas and Water supply
F	Construction	Construction
G+H	Trade services	Wholesale and Retail trade; Repair of motor vehicles, motorcycles and personal and household goods, Hotels and Restaurants
I	Transport services	Transport, Storage and Communications
J+K	Business services	Financial Intermediation, Renting and Business Activities (excluding owner occupied rents)
L,M,N	Government services	Public Administration and Defense, Education, Health and Social work
O,P	Personal services	Other Community, Social and Personal service activities, Activities of Private Households

Table 3.A.2 Six sectors' classification

Sector	Divisions
Agriculture, hunting, forestry, fishing	01-05
Mining, manufacturing, utilities	10-41
Construction	45
Wholesale, retail trade, restaurants and hotels	50-55
Transport, storage and communications	60-64
Other activities	65-99

Source: International Standard Industrial Classification of All Economic Activities (ISIC), Revision 3.1, United Nations.

Table 3.A.3 Data sources

Primary	Abbreviation	Data sources	Comments
Government consumption expenditures	gov cons	WDI	Expressed as share of GDP
Net Foreign asset	nfa	Lane and Milesi-Ferretti (2007)	Expressed as share of GDP
Trade openness	open	WDI	Sum of exports and imports as share of GDP
Fertility rate	fertility	WDI	Births per woman
Real Effective Exchange Rate	reer	EQCHANGE	REER based on 186 trade partners using time-varying weights
Commercial weights	w_ijt	CEPII EQCHANGE	Time-varying weighting scheme
Electricity Generating Capacity	egc	Canning (1998) and UN energy Statistical Year books	Electricity Generating Capacity per 1000 kilowatts
Electric power transmission and distribution losses	elec_losses	WDI	Percentage of GDP
Number of main-lines		International Telecommunication Union	
Mobile cellular subscriptions		WDI	subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology
Number of workers		PWT 9.0	Number of persons engaged
Values added of division 01-05		GGDC and UNCTAD	Value added of the sector 01-05 in constant/current 2010 us dollars
Values added of division 10-41		GGDC and UNCTAD	Value added of of the sector 10-41 measured in constant/current 2010 us dollars
Values added of division 45		GGDC and UNCTAD	Value added of the sector 45 measured in constant/current 2010 us dollars
Values added of division 50-55		GGDC and UNCTAD	Value added of the sector 50-55 measured in constant/current 2010 us dollars
Values added of division 60-64		GGDC and UNCTAD	Value added of the sector 60-64 measured in constant/current 2010 us dollars
Values added of division 65-99		GGDC and UNCTAD	Value added of the sector 65-99 measured in constant/current 2010 us dollars

Note: CEPII=Centre d'Études Prospectives et d'Informations Internationales; WDI=World Development Indicators (World Bank); PWT=Penn World Table; UNCTAD=United Nations Conference on Trade and Development; GDP= Gross Domestic Product.

Appendix 3.B Supplementary results

Table 3.B.1 Panel unit root tests: summary

Variable	Abbreviation	Integration order
Real Effective Exchange Rates	reer	I(0)
Openess	open	I(1)
Fertility rate	fertility	I(1)
Deflator 6 sectors relative (fixed weights)	def6_fr	I(0)
Government consumption expenditures	gov cons	I(0)
Net Foreign Asset (NFA) position	nfa	I(1)
Electricity power transmission and distribution losses	eleclosses	I(0)
Electricity Generating Capacity per 1000 workers	egc	I(0)
Telecommunication per 1000 workers	telecom	I(0)

Source: Author's calculations

Table 3.B.2 Summary of the homogeneity tests

Equation	Transition variable	LM_X	LM_F	HAC_X	HAC_F	WB_PV	WCB_PV
Equation (3.8)	telecom	0.000***	0.000***	0.011**	0.012**	0.000***	0.000***
Equation (3.9)	telecom	0.000***	0.000***	0.006***	0.007***	0.000***	0.000***
Equation (3.10)	egc	0.000***	0.000***	0.030**	0.030**	0.000***	0.010**
Equation (3.11)	egc	0.000***	0.000***	0.118	0.122	0.000***	0.128
Equation (3.12)	eleclosses	0.080*	0.080*	0.480	0.490	0.203	0.545
Equation (3.13)	eleclosses	0.004***	0.005***	0.36	0.37	0.049**	0.380

Note: LM_X denotes the χ^2 Lagrange Multiplier (LM) test, LM_F the LM test with a Fisher distribution, HAC_X the LM test with Heteroskedasticity Autocorrelation Consistent (HAC) error term, HAC_F the LM test with a Fisher distribution with HAC error term, WB (resp. WCB) stands for residual-based wild (resp. wild clustered) bootstrap. All these tests are based on the null hypothesis of linearity/ homogeneity against the PSTR model. ***(resp. **,*) denotes the rejection of the null hypothesis at the 1% (resp. 5%, 10%) significance level. 10.000 bootstrap replications used.

Appendix 3.C Figures

Figure 3.C.1: Transition function: telecommunication per 1000 workers (logarithm): equation (3.8)

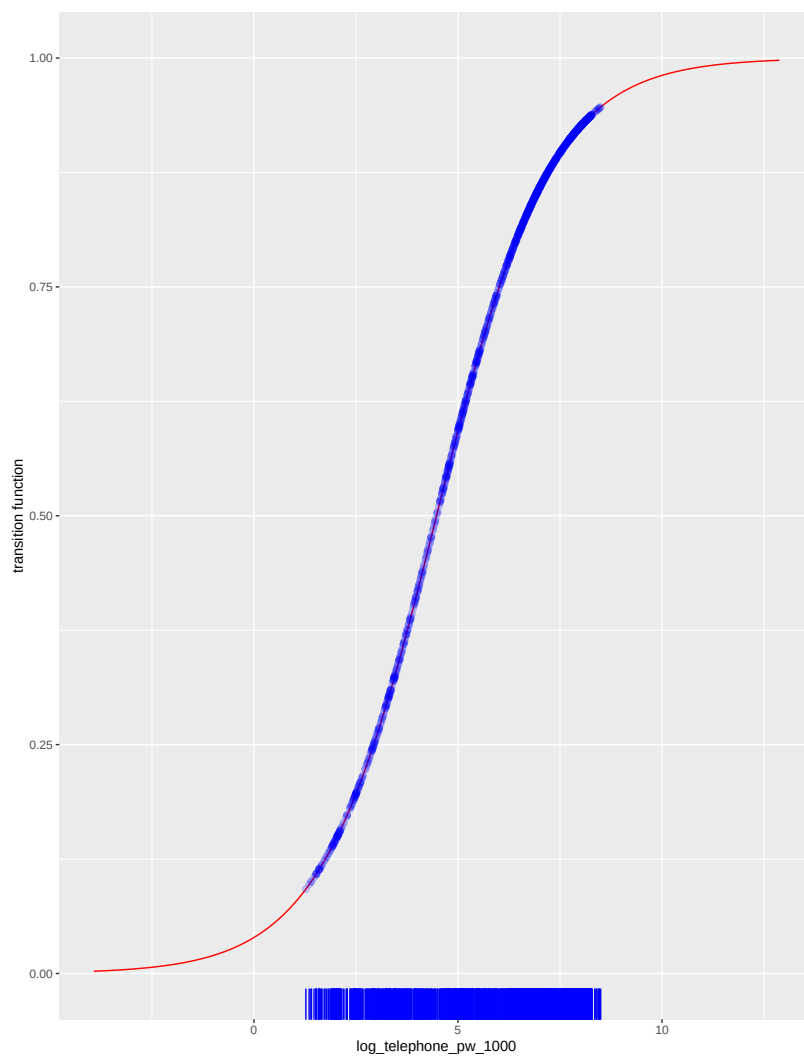


Figure 3.C.2: Transition function: telecommunication per 1000 workers (logarithm): equation (3.9)

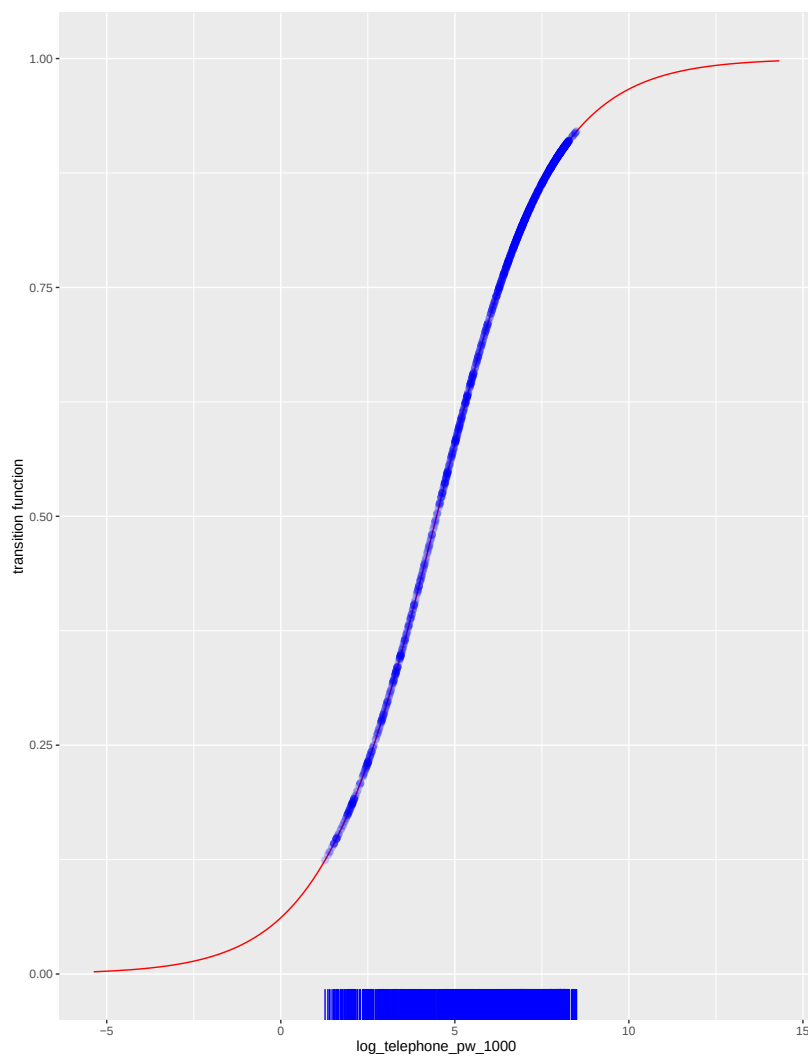


Figure 3.C.3: Transition function: EGC per 1000 workers (logarithm): equation (3.10)

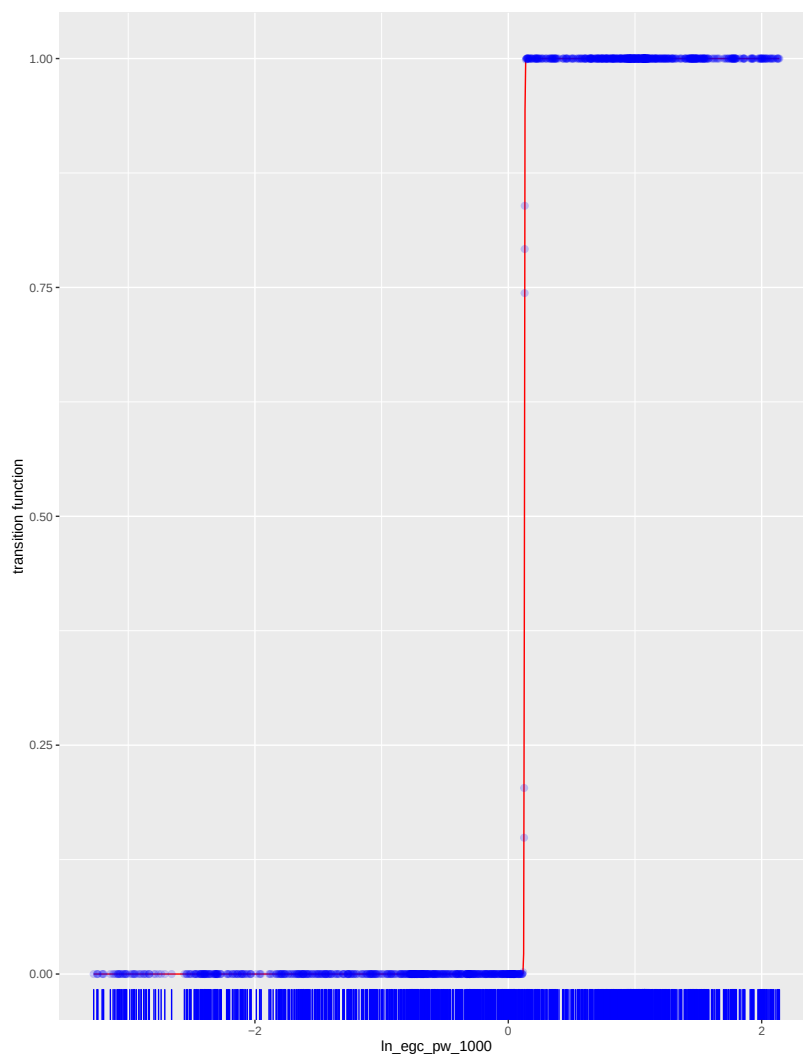


Figure 3.C.4: Transition function: EGC per 1000 workers (logarithm): equation (3.11)

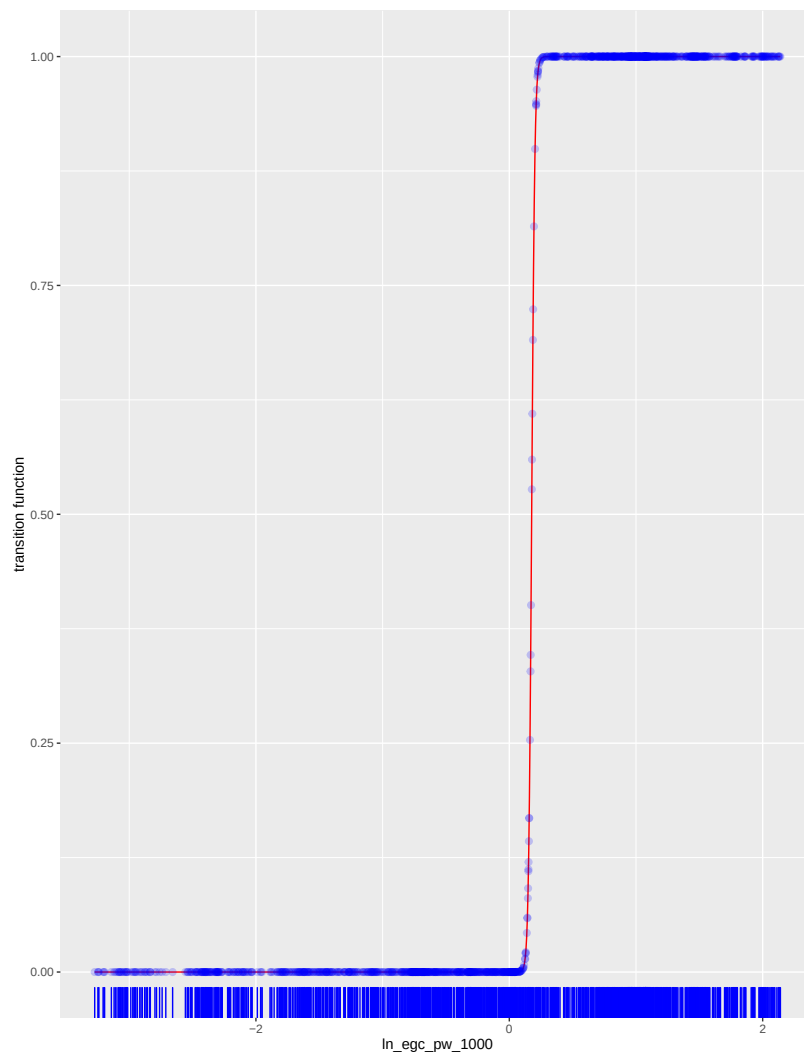
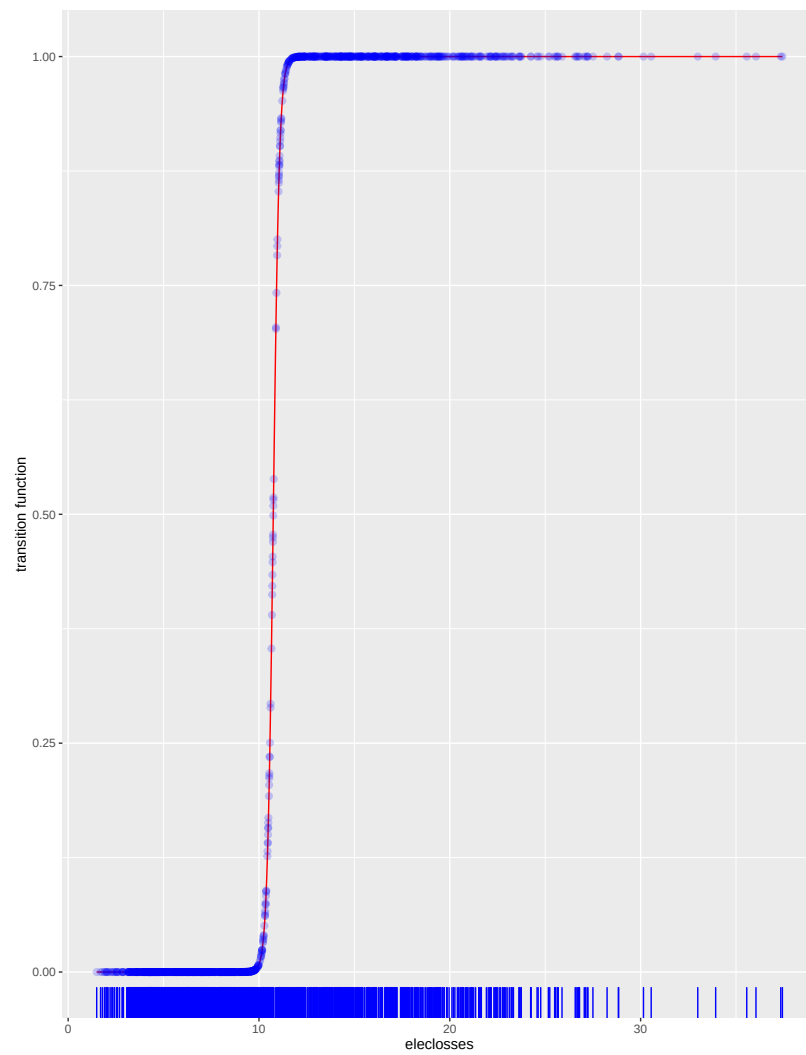


Figure 3.C.5: Transition function: electricity power loss: equation (3.13)



Conclusion générale

La récente guerre commerciale entre la Chine et les États-Unis a fourni une illustration particulièrement éloquente du lien entre taux de change et déséquilibres externes. En effet, la Chine a été accusée à maintes reprises de maintenir une monnaie sous-évaluée afin de bénéficier d'un avantage compétitif par rapport à ses partenaires commerciaux. Cependant, aucun consensus n'a émergé quant à l'existence d'une sous-évaluation du renminbi. Cette guerre commerciale entre la Chine et les États-Unis illustre l'incertitude entourant l'estimation du Taux de Change d'Equilibre (TCEQ), ainsi que le lien entre mésalignements de change et apparition de déséquilibres externes. Cela nous a conduit à **étudier de façon approfondie la dynamique et les déterminants des taux de change, en accordant une attention particulière à leurs effets sur les déséquilibres internes et externes.**

Outre la constitution de bases de données originales, trois principales contributions émanent de notre thèse. La première est de documenter comment l'adhésion à la zone euro affecte l'ajustement externe aux chocs de demande et de mésalignements de change. C'est l'objet du premier chapitre dans lequel nous estimons le mésalignements de change et le déséquilibre du compte courant pour onze pays membres de la zone euro. Puis, un modèle *Panel Vector AutoRegressive* incluant l'*output gap*, le mésalignement de change et le déséquilibre du compte courant est estimé sur deux sous

périodes : 1980-1998 et 1999-2016. Nos résultats montrent qu’avec l’adoption de la monnaie unique, la vulnérabilité du compte courant aux chocs de demande et de mésalignements de change augmente considérablement. La correction des déséquilibres externes au sein de la zone euro devient également plus difficile en raison de la disparition de la dévaluation comme outil d’ajustement.

La deuxième contribution de la thèse est de fournir un nouvel éclairage sur les déterminants de long terme du Taux de Change Effectif Réel (TCER). Cette thématique a fait l’objet des deuxième et troisième chapitres. Dans le deuxième chapitre, nous avons montré comment le choix du *proxy* influence la validation de l’effet Balassa-Samuelson (BS) pour un panel de 38 économies en développement et émergentes sur la période 1980-2016. Pour ce faire, nous avons examiné les versions interne et externe de l’hypothèse BS en nous basant sur cinq mesures différentes de l’effet BS^{24,25}. Pour dépasser les limites des études précédentes, nous avons utilisé l’estimateur *Cross Sectional-Distributed Lag* (CS-DL) qui nous a permis de contrôler pour la présence de dépendance inter-individuelle. Seule l’utilisation du différentiel de productivité du travail entre les secteurs échangeables et non échangeables a permis de valider la version interne de l’effet BS, tandis que l’emploi du Produit Intérieur Brut par travailleur nous conduit à rejeter la version interne. Le troisième chapitre de la thèse, quant à lui, contribue à la littérature s’intéressant aux déterminants de long terme du TCER en mettant en avant la pertinence des infrastructures. En effet, nous avons montré que le réseau de télécommunications, les capacités de production énergétiques (CPE) et la qualité du réseau électrique affectent la dynamique du TCER. Les potentiels canaux de transmission expliquant nos résultats sont également discutés en profondeur.

²⁴La version interne de l’effet BS suppose une relation positive entre le différentiel de productivité entre les secteurs échangeable et non échangeable et le prix relatif des biens non échangeables

²⁵La version externe de l’effet BS consiste en la relation positive entre le prix relatif des biens non échangeables et le TCER.

Notre troisième contribution est de montrer la pertinence de l'hypothèse de non linéarité dans la dynamique du TCER. Le troisième chapitre utilise, ainsi, une modélisation non linéaire dans laquelle l'effet des infrastructures dépend du stock de ces dernières. Lorsque le réseau n'est pas achevé ou que le stock d'infrastructures est faible, une augmentation des CPE et du stock de télécommunications déprécie le TCER, tandis que la dépréciation supplémentaire est plus faible ou inexistante une fois le réseau établi. Ce résultat est discuté à la lumière du canal de la productivité selon lequel les gains de productivité des infrastructures sont majoritairement concentrés lors de l'établissement du réseau. Ainsi, une hausse du stock d'infrastructures se traduit par une réduction des coûts de production domestique principalement lorsque le réseau est en cours d'établissement, expliquant notre résultat.

A l'issue des travaux empiriques menés dans cette thèse, plusieurs prolongements sont envisageables. Le premier chapitre de la thèse a porté une attention toute particulière aux déterminants du compte courant d'une économie. En effet, afin de calculer la valeur d'équilibre du compte courant, nous avons considéré près d'une vingtaine de déterminants. Cependant, la littérature n'a jamais porté attention aux déterminants *spécifiques* des comptes courants sectoriels. En effet, s'il existe une vaste littérature s'intéressant aux déterminants du compte courant agrégé (Chinn et Prasad, 2003; Ca'Zorzi et al., 2012; Moral-Benito et Roehn, 2016), celle-ci ne s'est jamais attachée à étudier en détail ses déterminants sectoriels. Le compte courant peut-être obtenu comme la somme de quatre composantes distinctes : le compte courant du gouvernement, des ménages, des sociétés non financières et des sociétés financières. La littérature spécifique au compte courant a souvent mobilisé le canal de l'épargne de précaution pour expliquer la dynamique du compte courant. Ce canal de transmission peut servir dans l'explication de la dynamique du compte courant des

ménages. En effet, on s'attend à ce qu'une augmentation de l'incertitude macroéconomique se traduise par une hausse de l'épargne de précaution des ménages (Brzozowski et Prusty, 2013; Fogli et Perri, 2015), affectant positivement le compte courant des ménages. Ce canal de transmission peut-être étudié en utilisant l'incertitude macroéconomique ou les dépenses publiques en santé. On s'attendrait à un effet négatif de ces dernières car celles-ci affectent négativement le compte courant des économies en réduisant le besoin de constituer une épargne de précaution (Tressel et Wang, 2014). La dynamique des prix de l'immobilier est également en mesure d'affecter le compte courant de ce secteur institutionnel car l'épargne des ménages peut diminuer par l'intermédiaire d'effets de richesse négatifs (Geerolf et Grjebine, 2013; Unger, 2017). Récemment, Moral-Benito et Roehn (2016) ont mis en évidence un effet robuste de la dérégulation financière sur le compte courant. Il serait donc également intéressant d'étudier comment ces différents aspects de la dérégulation financière sont en mesure d'affecter les comptes courants sectoriels, notamment ceux des sociétés non financières et financières.

Le troisième chapitre de la thèse s'intéresse aux effets non linéaires des infrastructures sur le Taux de Change Effectif Réel (TCER). Dans ce chapitre, du fait de disponibilités de données limitées, nous ne considérons pas les infrastructures de transport. Un prolongement intéressant du troisième chapitre serait donc d'étudier l'effet non linéaire exercé par les infrastructures de transport sur le TCER. Pour ce faire, nous pouvons utiliser la base de données récemment créée par Jedwad et Storeygard (2019), laquelle met à disposition des séries temporelles sur la longueur totale des routes (pavées) et des chemins de fer²⁶. Le recours à cette base de données nous permettrait de nous intéresser aux effets non linéaires des infrastructures de transport dans les pays d'Afrique Subsaharienne. Ce prolongement est d'autant plus intéressant que Du et al. (2013)

²⁶Il faut noter que la cohérence des séries de temporelles pour ces deux variables est assurée par Jedwad et Storeygard (2019).

n'offrent aucune analyse formelle de la potentielle non linéarité entre infrastructures de transport et TCER. Or, une telle non linéarité apparaît comme particulièrement pertinente dans la mesure où les infrastructures de transport constituent des infrastructures de réseaux où des non linéarités peuvent apparaître, ainsi que l'ont démontré Candelon et al. (2013). Ce type d'infrastructures peut affecter la dynamique du TCER par l'intermédiaire de plusieurs canaux de transmission. Le premier canal potentiel est celui suggéré par Du et al. (2013) dans leur analyse du TCER, selon lequel une amélioration des infrastructures de transport se traduit par une augmentation de la concurrence entre les firmes domestiques. Celle-ci a pour effet de contracter le taux de marge des entreprises, conduisant à une réduction du niveau général des prix domestiques et, en conséquence, à une dépréciation de la monnaie domestique. Par ailleurs, un réseau autoroutier plus dense permet également une réduction des coûts de transport des consommations intermédiaires pour les sites de production qui produisent les biens finaux (Jaimovich, 2019) favorisant une réduction du niveau des prix domestiques et affectant la dynamique du TCER.

Le troisième chapitre de la thèse propose plusieurs canaux de transmission pouvant expliquer les effets des infrastructures sur le TCER. Cependant, au vu des données utilisées, il est difficile de se prononcer sur le canal de transmission le plus pertinent pour chacune des infrastructures examinées. C'est pourquoi ce chapitre peut être prolongé en analysant en profondeur les différents mécanismes de transmission. A cette fin, le recours aux séries de TCER sectorielles fournies par Patel et al. (2019) nous permettrait de tester si les infrastructures de télécommunications affectent davantage le secteur primaire, secondaire ou tertiaire. De même, nous serions en mesure de vérifier si les capacités de production énergétique ont plus d'impact sur la compétitivité du secteur primaire ou secondaire. Ce prolongement est d'autant plus intéressant que Yeaple et Gollub (2007) trouvent

un effet différent des infrastructures sur la productivité sectorielle.

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