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Structural Change, Mobility and Economic Policies

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Changement Structurel, Mobilité et Politique Economique

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July 17, 2017

Défis pour les économies développées

Que ce soit pour des motifs exogènes ou endogènes, les économies développées font face à de nombreux nouveaux défis tel que le changement structurel du secteur de l'agriculture vers celui des services, ou encore le vieillissement de la population; lorsque plus spécifiquement on s'intéresse à la zone euro, on peut citer le manque d'intégration et la faible mobilité ne permettant alors pas de converger vers une zone monétaire optimale. Enfin, la crise financière de 2008 a conduit à la crise en face de nouvelle politique, comme les politiques monétaires non conventionnelles.

Le changement structurel

Le changement structurel fait parti des phénomènes les plus remarquables pour la croissance d'une économie. Durant cette étape de croissance économique, les travailleurs se déplacent d'abord de l'agriculture à l'industrie, et en suite de l'industrie aux services. Pendant les décennies qui suivent, on observe alors un phénomène de redistribution de travailleurs entre secteurs. La figure 1 tirée de Herrendorf et al. (2015) montre les séries temporelles des emplois et des valeurs ajoutées sectoriels. La figure montre que la proportion agricole baisse et la proportion du service augmente en fonction du PIB par tête. La proportion manufacturière monte dans un premier temps et en suite baisse lorsque le PIB par tête continue à croître.

Le phénomène de changement structurel est devenu récent central dans le débat économique, avec l'idée que la redistribution des travailleurs était inefficace. **?** montre que les pays pauvres ont des proportions élevées de travailleurs dans l'agriculture. Pour la pluspart des pays en développement, les travailleurs se déplacent du secteur de l'agriculture vers celui de l'industrie, rattrapant la croissance de la productivité par rapport aux pays développés. Par la suite, la croissance génère un déplacement des travailleurs du secteur de l'industrie

*Avec tous mes remerciements à mes encadrants de thèse - Stéphane Auray et Aurélien Eyquem.

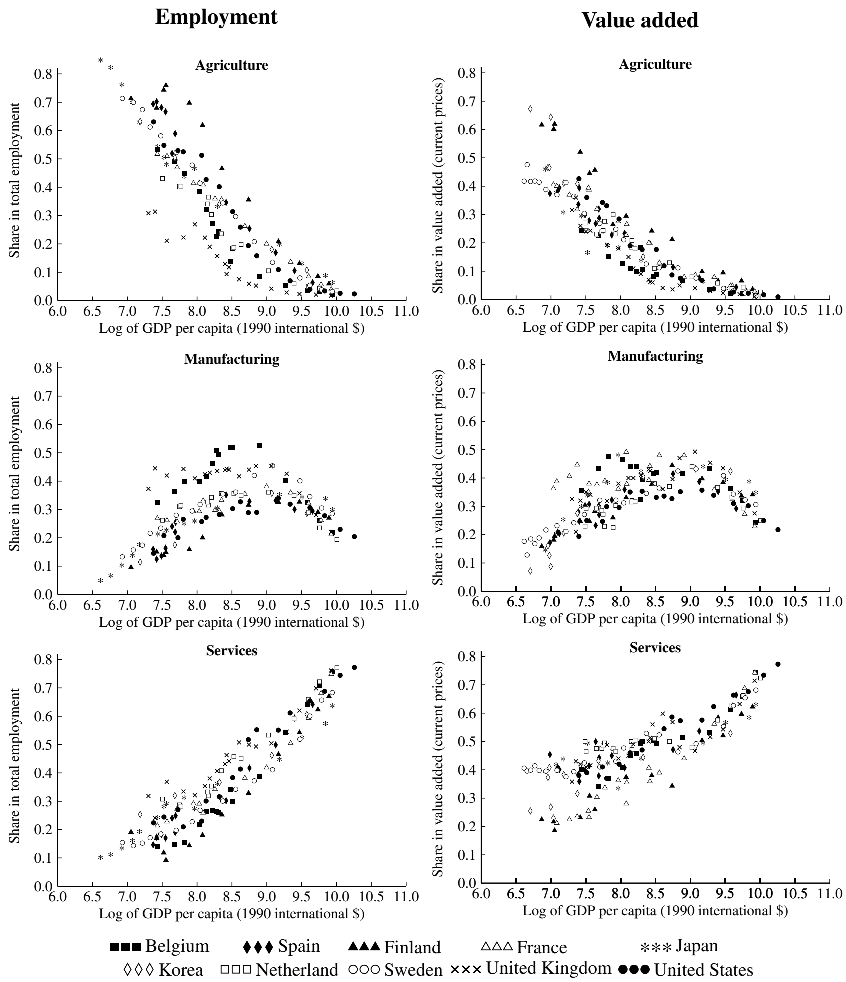

Figure 1: Proportion d'emploi et de valeur ajoutée par secteur, Source: Herrendorf et al. (2015)

vers celui des services. La Figure 2 montre que la croissance de la productivité sectorielle est plus élevée dans les secteur de l'agriculture et de l'industrie (soient 3-4% par an) et plus faible dans le secteur des services (soit 2% par an). Ainsi, la redistribution des travailleurs au cours du développement s'accompagne d'un ralentissement et même d'une stagnation de la croissance.

Le viellissement de la population

Le viellissement de la population est un phénomène le plus important et remarquable dans le monde moderne. Comme le système médical s'améliore, la longevité augmente dans la plupart des pays du monde. D'après l'ONU [1], l'espérance de vie moyenne mondiale était de

[1] l'Organisation des Nations Unies

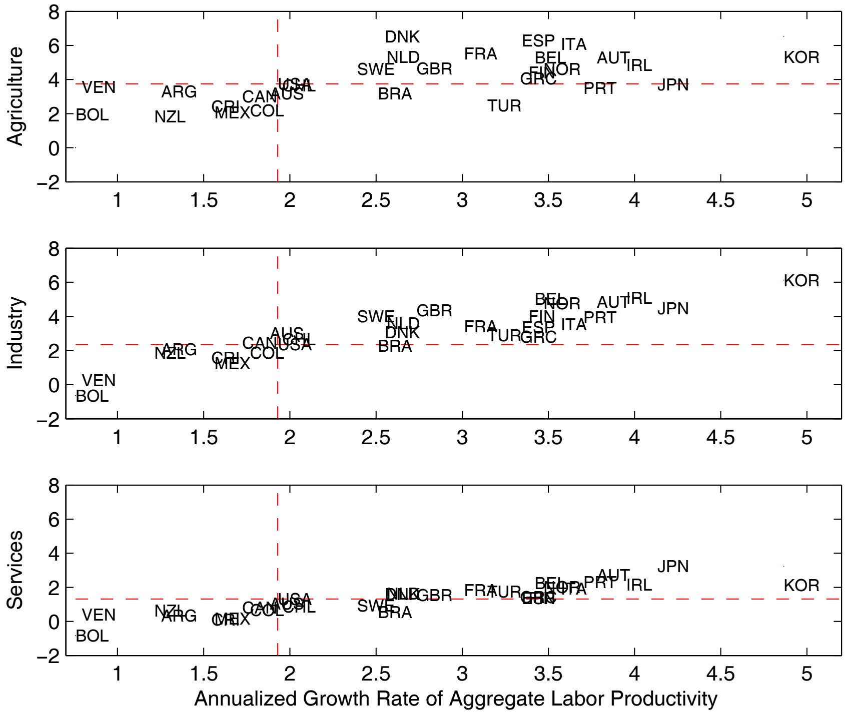

Figure 2: Croissance de la productivité sectorelle dans les différents pays, Source: **?**

52,5 années en 1960, et de 71,5 années en 2014. Dans les années passées, la proportion des personnes âgées (60 ans ou plus) a beaucoup augmenté, notamment dans les pays développés comme l'Europe et l'Amérique du Nord (Figure 3).

Le viellissement de la population conduit à se poser des questions sur la durabilité du système de protection sociale, la structure industrielle, sur l'impact sur le marché du travail, etc. Parmi les conséquences potentielles, la durabilité du système de protection sociale est la plus urgente d'après les économistes et les décideurs de politique économique.

Comme la sécurité sociale pour les personnes à la retraite dépend largement de la contribution de la population qui travaille, le vieillissement de la population pose la question sur la durabilité du système de protection et le bien être des personnes âgées. D'après la projection de l'ONU (Figure 4), en 2015, le ratio entre la population en âge de travailler et la population ayant 65 ans ou plus est 7:1. En 2050, ce ratio deviendra 3,5 : 1 dans le monde entier, 2,4 : 1 en Amérique du Nord, et 1,9 : 1 en Europe.

Du côté du marché du travail, le vieillissement de la population peut conduire à une baisse de population en âge de travailler, ainsi qu'une baisse de l'offre de travail. Le vieillissement de la population est aussi associé à une plus faible mobilité des travailleurs. En combinant avec le phénomène de changement structurel, le vieillissement de la population risque de causer une augmentation du taux de chômage. Autrement dit, le changement réduit le

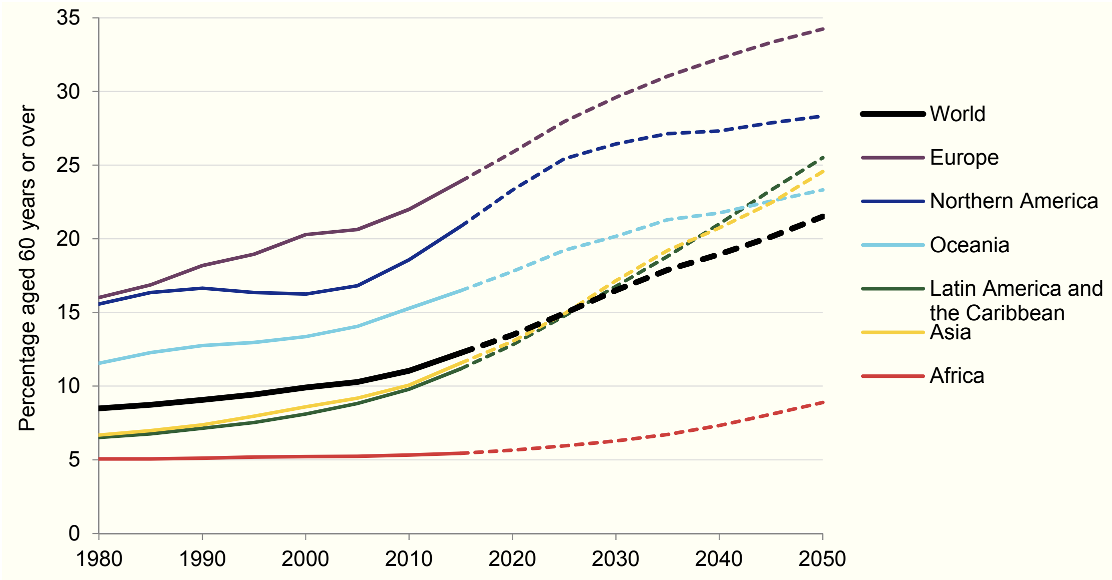

Figure 3: Pourcentage des personnes ayant 60 ans ou plus, Source: World Population Ageing 2015, ONU

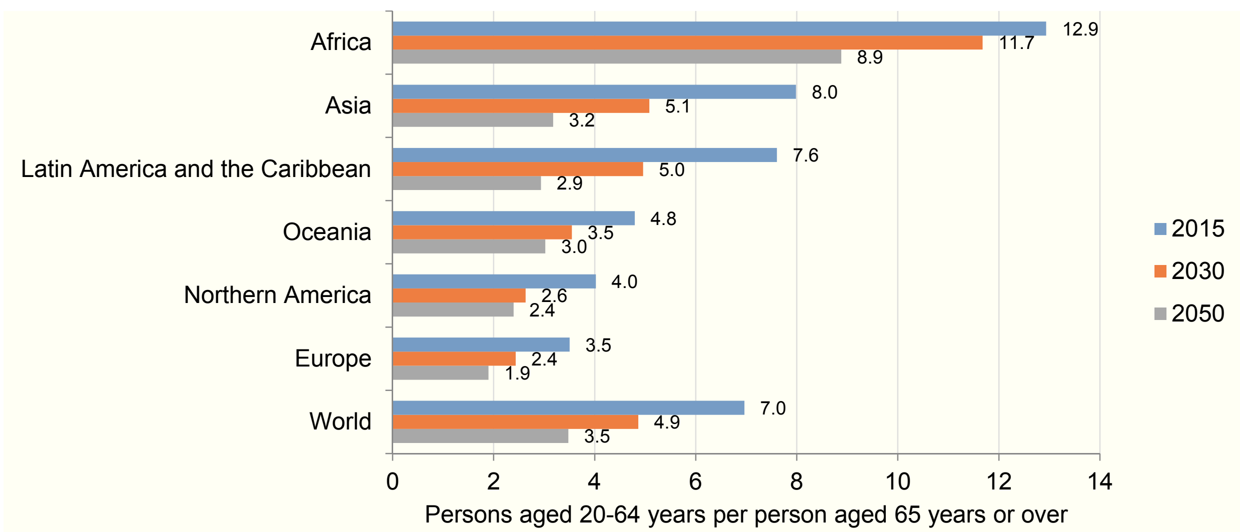

Figure 4: Ratio de dépendance, Source: World Population Ageing 2015, ONU

nombre d'emploi dans certains secteurs et conduit à de nouvelles opportunités dans les secteurs émergents. Comme la jeune génération est plus flexible et plus mobile par rapport aux personnes plus âgées, les plus jeunes ont tendance à aller au travail dans les nouveaux secteurs. De nombreux auteurs s'intéressent à l'importance de ces nouveaux entrants dans la redistribution de travailleurs au sein des différents secteurs. [2]

[2] Voir, par exemple, dans Kim and Topel (1995).

L'intégration de l'Europe

Au cours des années passées, l'Europe a fait des progrès en terme d'intégration. Les obstacles en terme de commerce international, le marché du travail, et les services financiers se sont progressivement réduits. De plus, l'effet positif de l'intégration en terme de la croissance économique pour les nouveaux membres est nonnégligeable. Les études confirment l'effet positif de l'intégration européenne sur la croissance économique[3].

Malgré ces effets positifs, la crise récente et les performances divergentes parmi les membres de la zone euro a remis en question le rôle positif de l'intégration. En effet, dans la zone euro, il existe un déséquilibre des comptes courants depuis les années 1990s. La Figure 5 montre la divergence des comptes courants au sein des membres de l'UEM. Les pays comme l'Allemagne et les Pays Bas ont des surplus du compte même pendant la période de la crise financière en 2008. Au contraire, les pays comme l'Espagne, le Portugal, et la Grèce ont des déficits; ces pays sont aussi sévèrement touchés par la crise.

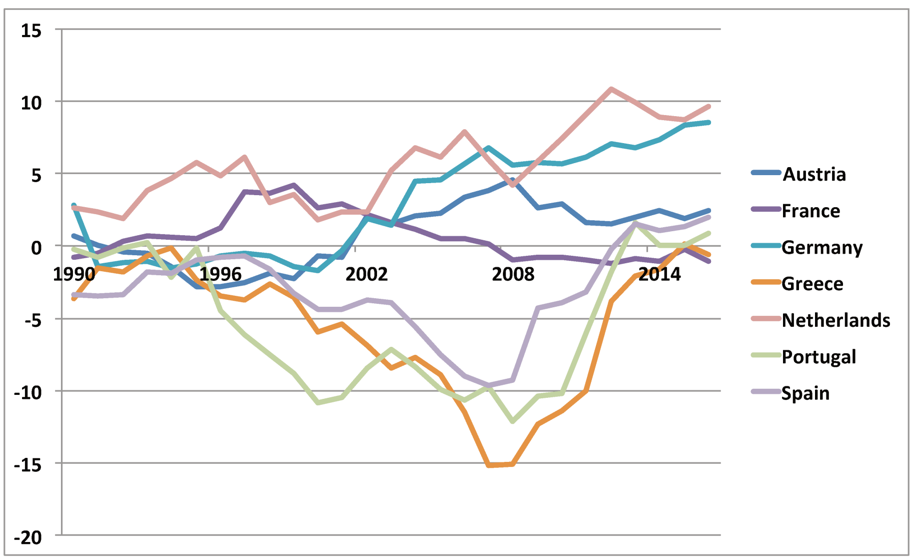

Figure 5: Comptes courants (1990-2016) dans l'UEM mésurés par le pourcentage du PIB (%), Source: FMI

Après la crise financière, les pays périphériques connaissent des augmentations de leurs dettes souveraines, car les dépenses publiques ont augmenté afin de soulager l'impact de la crise sur le marché du travail et sur le secteur financier. Le ratio dette sur PIB pour la Grèce est passé de 107% en 2005 à 172% en 2011. L'augmentation de la dette fait augmenter le taux d'intérêt, qui déprime le marché du credit dans l'économie. Combiné avec une croissance du PIB faible, certains pays périphérique risquent de faire défaut. Par conséquent, les banques européennes sont exposées à un risque de défaut souverain des pays périphériques. Cette crise jumelle entre la banque et la dette souveraine impose des pertes potentielles pour

[3]Voir, par exemple, dans Cuaresma et al. (2011) et Schadler et al. (2006)

les banques qui investissent beaucoup dans le marché des obligations gouvermentales, et conduit à une certaine réticence des banques à offrir du crédit aux entreprises. Ceci permet de comprendre la crise de la dette souveraine et son lien avec les performances économiques divergentes au sein des pays de la zone euro.

Ainsi, malgré une convergence des taux de chômage des membres au cours des 9 première années de l'UEM, cette tendance s'inverse depuis la crise financière de 2008[4] (Figure 6). La politique économique visant à stabiliser les chocs asymétriques, par exemple, la politique économique pour améliorer la mobilité des travailleurs, l'assouplissement monétaire, le fonds d'emprunt en dernier ressort, et les réformes fiscales sont dorénavant des outils les plus importants pour le décideur de politique économique.

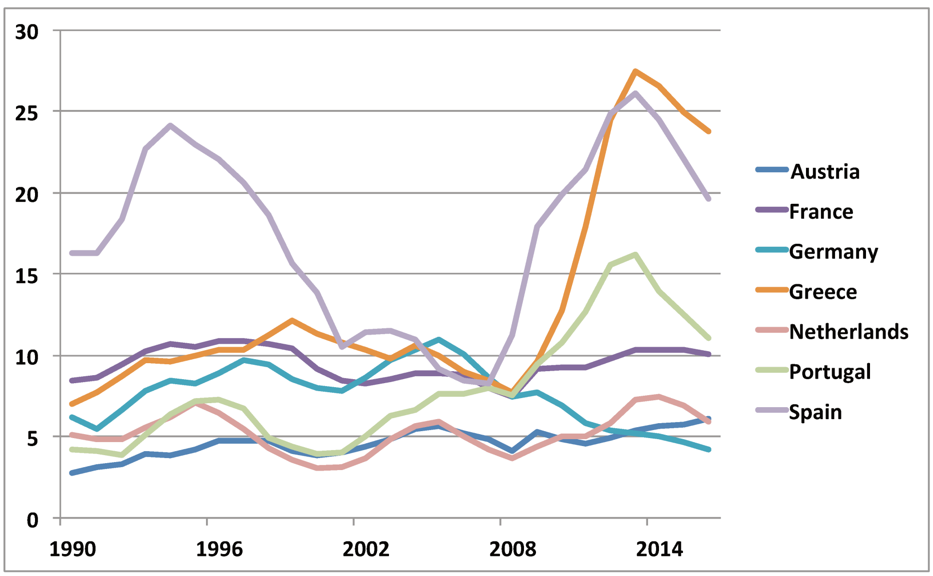

Figure 6: Taux de chômage dans la zone euro (1990-2016), Source: FMI

La mobilité des travailleurs

La mobilité des travailleurs, et plus spécifiquement la faible mobilité est une question importante pour les pays de zone euro. Un taux de change fixe limite la capacité à s'ajuster via la dépréciation de la monnaie nationale face à des chocs asymétriques. Combiné à une rigidité nominale des prix, les chocs asymétriques peuvent conduire à des déséquilibre des marchés du travail au sein des pays de zone euro. La mobilité des travailleurs pouvait engendre à une solution afin d'absorbe les impacts des chocs asymétriques.

Cependant, comparée aux Etats Unis, la mobilité des travailleurs en Europe est relativement faible. La figure 7 montre que le pourcentage des migrants entre les états des Etats Unis est supérieur à 27%. En Europe, ce ratio est égal ou inférieur à 3%. D'après Arpaia et al.

[4]voir Estrada et al. (2012)

(2015), la faible mobilité des travailleurs en Europe est due à la différence de langues et de cultures, au systèmes de protection sociale, mais surtout aux différents régulations des marchés du travail.

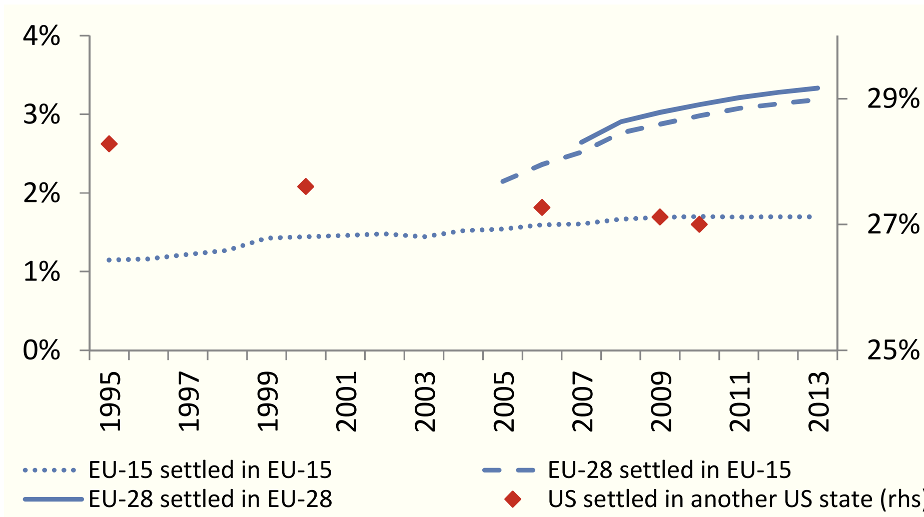

Figure 7: Proportion des immigrants intra-EU et intra-US (rhs), Source: Arpaia et al. (2015)

L'autre défi en terme de mobilité des travailleurs concerne l'immigration. Avec le vieillissement de la population, l'Europe et les autres pays développés pouvaient observer une population en âge de travailler à la baisse, et une faible immobilité des travailleurs due à la faible proportion de jeunes travailleurs. Ainsi, ces pays ont besoin d'attirer les jeunes travailleurs bien qualifiés des pays en développement, par exemple, la Chine, l'Inde, ou l'Europe du centre-est. Cependant, la proportion des migrants internationaux est seulement de 2,9% de la population mondiale[5], ce qui implique que les économies développées auront des difficultés afin de réduire le coût d'entrée pour les immigrants internationaux.

La politique économique

La politique monétaire conventionnelle vise à stabiliser le taux d'inflation en suivant la règle de Taylor. Avant la crise financière en 2008, cet instrument populaire était efficace pour maintenir un taux d'inflation autour de 3%.

Cependant, la crise financière en 2008 a remis en question l'efficacité de la politique monétaire conventionnelle. Premièrement, l'instabilité du système financier et le risque de défaut des grande banques a réduit la corrélation entre le taux d'intérêt proposé par la banque centrale et le spread de crédit. Ainsi, les banques centrales donnent plus de poids sur la politique macroprudentielle qui demande aux banques privées de retenir une proportion minimum du capital de risque bas (Basel III). Les banques centrales font également attention

[5] Zimmermann (2004)

à renforcer les bilans des banques privées en achetant des actifs risqués des banques privées. Le deuxième défi tient au fait que pendant la grande récession de 2008, le taux d'inflation était proche de zéro ou négatif. Dans ce scénario, la politique monétaire qui suit la règle de Taylor va suggérer un taux d'intérêt négatif. Cependant, le taux ne peut pas être plus bas que zéro, car sinon les agents privés vont préférer concerver leurs liquidités plutôt que de faire des investissements (trappe à liquidité). Face à ces défis, la politique monétaire non conventionnelle apparaît comme une solution alternative.

Dans la politique monétaire non-conventionnelle, les banques centrales achètent des actifs risqués des banques privées ou des entreprises, et augmentent leurs bilans de façon massive (Figure 8). Le Quantivative Easing (QE) est un exemple de politique monétaire non-conventionnelle. La banque centrale japonaise était la première à appliquer le QE dans les années 1990s en achetant les obligations gouvernementales des banques privées. Fédérale Américaine a aussi appliqué le QE pendant et après la crise financière de 2008. Banque Centrale Européenee a aussi adopté le QE pendant la crise de la dette souveraine.

En terme de politique fiscale, la dévaluation fiscale devient populaire dans la zone euro. A cause de l'inflexibilité du taux de change entre membres de l'union monétaire, le canal d'ajustement par la dépréciation de la monnaie nationale est fermé. En même temps, la dévaluation fiscale - une augmentation des impôts sur la consommation (la TVA, par exemple) associée avec une baisse du taux d'impôt sur le revenu du travail - devient une solution potentielle. Il y a des pays comme le Danemark (en 1987), l'Allemagne (en 2007), et la France (en 2012) qui ont déjà appliqué la politique qui déplace la charge d'imposition du revenu à la consommation. Les effets anticipés sont une baisse du coût de travail, ainsi qu'une baisse du coût de production afin de faire baisser le prix des biens échangés et d'améliorer la compétitivité dans le commerce international, avec des effets positifs sur la production et l'emploi.

Sujet de la thèse

Dans ce doctorat, on s'intéresse à l'importance des phénomènes de changement structurel aujourd'hui à la mobilité des travailleurs et enfin à l'impact des politiques économiques mises en place dans la zone euro après la crise. Ces thèmes sont importantes pour l'UEM faisant face à des chocs asymétriques après la crise financière en 2008. La politique économique aide à réduire l'impact de la récession, la divergence parmi les membres de l'UEM, et la relation entre dette souveraine et crise bancaire. La mobilité des travailleurs pouvant permettre d'absorber les effets des chocs asymétriques dans l'union monétaire.

Pour répondre à ces questions, on utilise un modèle d'équilibre général. Les modèles d'équilibre général avec fondement microéconomique constituent une solution à la critique de Lucas pendant les années 1970s, qui dit qu'il est naif de prévoir les effets d'un choc en se basant sur les données historiques.

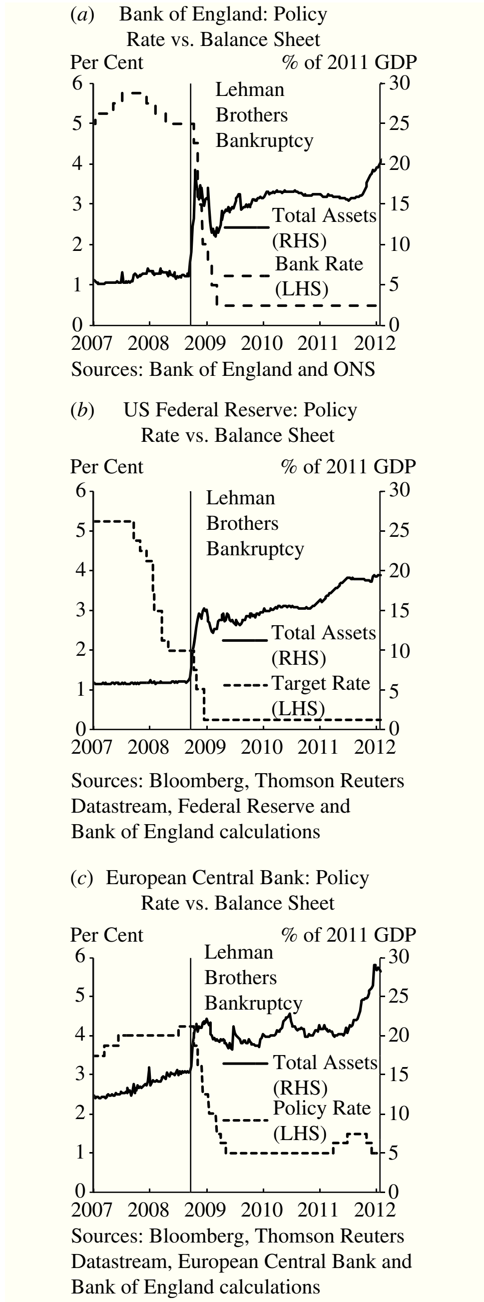

Figure 8: Bilans des banques centrales pendant les périodes de crise, Source: Joyce et al. (2012)

Les modèles d'équilibre général permettent d'analyser les intéractions entre les consommateurs, les entreprises, le secteur financier, le gouvernement, et la banque centrale, et ainsi d'analyser les impacts des politiques économiques. Par exemple, dans le cas de la crise jumelle entre la dette souveraine et le secteur bancaire, les modèles d'équilibre général permettent de comprendre les effets de la politique monétaire sur la consommation, le bien être des ménages, l'investissement, le taux de chômage, le niveau de crédit, le taux d'intérêt, et le niveau de la dette souveraine. Les modèles d'équilibre général permettent également d'analyser le canal de transmission de la politique monétaire ou fiscale, et ses effets généraux sur l'économie. Les modèles d'équilibre général présentés dans cette thèse reproduisent les faits stylisés que l'on trouve dans les données. Par exemple, les modèles reproduisent correctement séries temporelles des cycles économiques sur les biens, les indicateurs financiers et fiscaux. Il explique aussi la corrélation entre le taux de croissance, la différence entre le taux d'intérêt des obligations gouvernementales et le taux proposé par la banque centrale, les prêts interbancaires, et le taux d'intérêt. Les modèles constituent comme un laboratoire pour les expérimentations de politique économique. Ils simulent les scénarios économiques avec les différentes politiques monénaires non conventionelles et bugétaires pemettant alors une comparaison avec les politiques alternatives. Les modèles permettent de quantifier les effets de la dévaluation fiscale dans un mécanisme avec deux pays et entrées endogènes dans le commerce international.

Concernant le sujet de la mobilité des travailleurs, il y a deux possibilités de modélisation. La première est d'implémenter la mobilité des travailleurs dans un modèle d'équilibre général avec plusieurs secteurs, comme Lee and Wolpin (2006). A chaque période, les travailleurs peuvent choisir le secteur dans lequel ils veulent travailler. Les travailleurs font leurs choix en se basant sur le salaire sectoriel moins le coût de mobilité. La deuxième possibilité est d'adopter la théorie des choix discrets, dans laquelle les travailleurs ont des préférences qui suivent une certaine distribution de probabilité. Ce mécanisme nous permet d'éviter les solutions en coin et a été utilisé, par exemple, par Artuc et al. (2010) et Pilossoph (2014). Dans cette thèse, on considère également le mécanisme d'appariement, qui nous permet d'analyser les dynamiques dans les marchés du travail et du capital (voir Wasmer and Weil (2004)). Le modèle explique les co-mouvements à long terme entre la croissance du secteur des services et le pourcentage de population jeune qui est le plus mobile dans le marché du travail. Il explique la corrélation négative entre la croissance du secteur des services et le pourcentage de population d'âge moyen. Le modèle permet de simuler le scénario contre-factuel dans lequel la croissance démographique augmente ou baisse de 1 point de pourcentage, ainsi que les impacts de la mobilité des travailleurs et du capital dans une union monétaire. Les résultats permettent en fin de faire des recommandations de politique économique.

Il y a quatre chapitres dans cette thèse:

Dans le premier chapitre, nous analysons les intéractions entre le marché interbancaire et le risque de défaut souverain dans un modèle d'équilibre général à deux pays, en focalisant sur la transmission de la crise financière récente et la politique monétaire non conventionnelle. Le rôle spécifique du marché interbancaire est pris en compte. Le marché interbancaire est très important car il est au coeur du secteur financier. Les dynamiques observée sur ce marché influencent le montant du crédit dans l'économie donc l'investissement et le PIB. Il est aussi important en terme de politique monétaire, car les banques centrales implémentent les opérations d'open market afin d'influencer le taux d'intérêt dans le marché interbancaire, ce qui affecte la courbe des taux. Nous développons un modèle à deux pays avec fondements micro-économiques du marché interbancaire et risque de défaut souverain. Les deux éléments s'intéragissent et conduisent à une boucle entre la dette - les banques - le crédit, dans laquelle le risque de défaut souverain a un effet important et restrictif. Le modèle est calibré sur la zone euro, et reproduit les faits principaux des cycles économiques sur les biens et les indicateurs financiers et fiscaux. Le modèle est utilisé afin d'estimer les effets de la grande récession en 2008 et les effets potentiels des différentes politiques non conventionnelles dans les pays de l'UEM. Les politiques non conventionnelles ont des effets non négligeables qui réduisent la perte de bien être provoqués par la grande recession. Parmi les politiques monétaires non conventionnelles, les politiques ciblant des obligations gouvernementales et les emprunts interbancaires sont plus efficaces que les interventions de crédit standard.

Dans le deuxième chapitre, les effets de la dévaluation fiscale sur les indicateurs macroéconomiques et le bien être sont analysés en utilisant un modèle à deux pays en union monétaire où les variétés de biens et le commerce sont endogènes. On montre que le commerce endogène amplifie les effets de la dévaluation fiscale sur le commerce international. Ceci constitue un canal de transmission important pour réformes fiscales. La dévaluation fiscale non seulement baisse le prix relatif des exportateurs domestiques, mais également conduit à une augmentation du nombre de variétés des biens commercialisés, ce qui contribue à l'augmentation des exportations. Un effet contraire apparaît pour les exportations étrangères (importations doméstiques) qui baisse le nombre des variétés importées et renforce la baisse des importations. Les effets de la dévaluation fiscale sur la production, la consommation, les heures de travail et le compte courant sont positifs. Cependant, la marge extensive constitue un canal de transmission supplémentaire. Le commerce endogène amplifie les effets sur les flux d'échange. L'entrée endogène augmente la création des variétés des biens dans les deux pays, ce qui amplifie les dynamiques positives de la production domestique, la consommation et les heures de travail. Elle fait également passer la réponse de la production étrangère de négative à positive.

Dans le troisième chapitre, l'impact du facteur démographique sur la croissance du secteur des services à long terme est mis en exergue. Les travailleurs et la production subissent une redistribution vers le secteur des services dans la plupart des pays développés. En même temps, la tendance au vieillissement de la population dans les économies avancées attire notre attention car cela peut affecter la nature et la vitesse du changement structurel dans les économies développées. Par ailleurs, le vieillissement de la population peut conduire à une baisse de l'offre de travail dans le secteur des services, mais également à une augmentation de la demande pour les services. De plus, le vieillissement de la population peut aussi influencer les croissances des productivités sectorielles via une baisse des activités innovantes[6]. Dans les pays des OCDE et lorsqu'on utilise les données sur les zones d'emploi aux Etats Unis, on trouve qu'il existe des corrélations positives entre le pourcentage de population jeune et la

[6]voir Aghion and Howitt (2009) et Aksoy et al. (2015)

croissance du secteur des services. On utilise alors un modèle à générations imbriquées avec deux secteurs et trois générations, et on montre que si les croissances des productivités sont exogènes, les impacts du choc démographique sont positifs sur le secteur des services. Les effets restent cependant faible: 1 point de pourcentage de plus sur la croissance de la jeune population chaque année augmente la proportion des emplois dans le secteur des services de 2 points de pourcentage pendant les 60 derniers années). Ces effets positifs proviennent de l'offre de travail. Lorsque l'on considère que la croissance est endogène, les effets du choc démographique sur le secteur des services avec croissance endogène sont multipliés par 4.

Dans le quatrième chapitre, on étudie les effets de la mobilité des travailleurs et de la mobilité du capital dans une union monétaire. A cause du taux de change fixe, les pays touchés par des chocs négatifs ne peuvent pas s'ajuster via une dépréciation de la monnaie nationale. Ainsi, la mobilité des facteurs comme la mobilité des travailleurs et la mobilité du capital constitue une solution potentielle afin de stabiliser les effets des chocs asymétriques dans une union monétaire. La mobilité des travailleurs réduit la pression du chômage dans les pays touchés par des chocs négatifs sur la demande, et permet aux chômeurs de trouver un travail plus facilement dans les pays où le marché du travail est plus actif. La mobilité du capital ou l'intégration financière diversifie les choix d'investissement et réduit ainsi le risque de défaut. On considère un modèle à deux pays, permettant d'étudier les effets potentiels de l'inéraction entre la mobilité des travailleurs et la mobilité du capital face à des chocs asymétriques. On montre que la mobilité des travailleurs réduit le taux de chômage alors qu'au contraire la mobilité du capital le fait augmenter. Cependant, les effets de la mobilité financière sont secondaires. Il est intéressant de remarquer que la mobilité des travailleurs ou la mobilité du capital n'ont pas systématiquement un effet positif sur la production. Le modèle est calibré sur la zone euro permettant de simuler les effets de la crise financière de 2008. Les effects contre-factuels montrent que la divergence entre les pays n'est pas causée par les chocs asymétriques sur la productivité, mais plutôt par leurs associations avec une augmentation du coût de la mobilité des travailleurs. Ce résultat contribue aussi à expliquer le puzzle de Shimer qui dit que la fluctuation des taux de chômage générée par le modèle d'appariement est plus petite que ce que l'on observe dans les données.

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Groupe d'Analyse et de Théorie Economique

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Présentée par

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Changement Structurel, Mobilité et Politique Economique

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Acknowledgement

To be completed

Sommaire

Chapitre 1

Introduction

Version Française

Défis pour les économies développées

Que ce soit pour des motifs exogènes ou endogènes, les économies développées font face à de nombreux nouveaux défis tel que le changement structurel du secteur de l'agriculture vers celui des services, ou encore le vieillissement de la population; lorsque plus spécifiquement on s'intéresse à la zone euro, on peut citer le manque d'intégration et la faible mobilité ne permettant alors pas de converger vers une zone monétaire optimale. Enfin, la crise financière de 2008 a conduit à la crise en face de nouvelle politique, comme les politiques monétaires non conventionnelles.

Le changement structurel

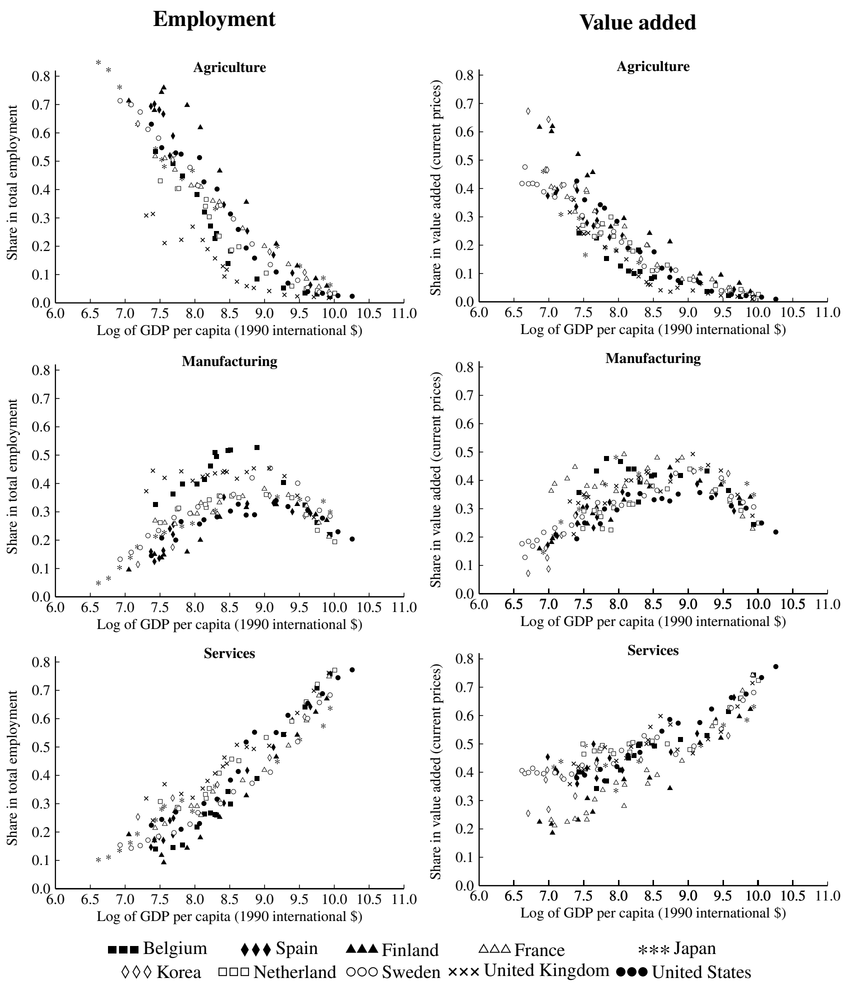
Le changement structurel fait parti des phénomènes les plus remarquables pour la croissance d'une économie. Durant cette étape de croissance économique, les travailleurs se déplacent d'abord de l'agriculture à l'industrie, et en suite de l'industrie aux services. Pendant les décennies qui suivent, on observe alors un phénomène de redistribution de travailleurs entre secteurs. La figure 1.1 tirée de Herrendorf et al. (2014) montre les séries temporelles des emplois et des valeurs ajoutées sectoriels. La figure montre que la proportion agricole baisse et la proportion du service augmente en fonction de la croissance du PIB par tête. La proportion manufacturière monte dans un premier temps et en suite baisse lorsque le PIB par tête continue à croître.

Le phénomène de changement structurel est devenu récent central dans le débat économique, avec l'idée que la redistribution des travailleurs était inefficace. Duarte et Restuccia (2009) montre que les pays pauvres ont des proportions élevées de travailleurs dans l'agriculture. Pour la pluspart des pays en développement, les travailleurs se déplacent du secteur de l'agriculture vers celui de l'industrie, rattrapant la croissance de la productivité par rapport aux pays développés. Par la suite, l'augmentation continue de la croissance génère un déplacement des travailleurs du secteur de l'industrie vers celui des services. La Figure 1.2 montre que la croissance de la productivité sectorielle est plus élevée dans les secteur de l'agriculture et de l'industrie (soient 3-4% par an) et plus faible dans le secteur des services (soit 2% par an). Ainsi, la redistribution des travailleurs au cours du développement s'accompagne d'un ralentissement et même d'une stagnation de la croissance.

Le viellissement de la population

Le viellissement de la population est un phénomène le plus important et remarquable dans le monde moderne. Comme le système médical s'améliore, la longevité augemente dans la

Figure 1.1: Proportion d'emploi et de valeur ajoutée par secteur, Source: Herrendorf et al. (2014)



plupart des pays du monde. D'après l'ONU [1], l'espérance de vie moyenne mondiale était de 52,5 années en 1960, et de 71,5 années en 2014. Dans les années passées, la proportion des personnes âgées (60 ans ou plus) a beaucoup augementé, notamment dans les pays développés comme l'Europe et l'Amérique du Nord (Figure 1.3).

Le viellissement de la population conduit à se poser des questions sur la durabilité du système de protection sociale, la structure industrielle, sur l'impact sur le marché du travail, etc. Parmi les conséquences potentielles, la durabilité du système de protection sociale est la plus urgente d'après les économistes et les décideurs de politique économique.

Comme la sécurité sociale pour les personnes à la retraite dépend largement de la contribution de la population qui travaille, le vieillissement de la population pose la question sur la durabilité du système de protection et le bien être des personnes âgées. D'après la projection de l'ONU (Figure 1.4), en 2015, le ratio entre la population en âge de travailler et la population ayant 65 ans ou plus est 7:1. En 2050, ce ratio deviendra 3,5 : 1 dans le monde entier, 2,4 : 1 en Amérique du Nord, et 1,9 : 1 en Europe.

Du côté du marché du travail, le vieillissement de la population peut conduire une baisse

[1] l'Organisation des Nations Unies

Figure 1.2: Croissance de la productivité sectorelle dans les différents pays, Source: Duarte and Restuccia (2009)

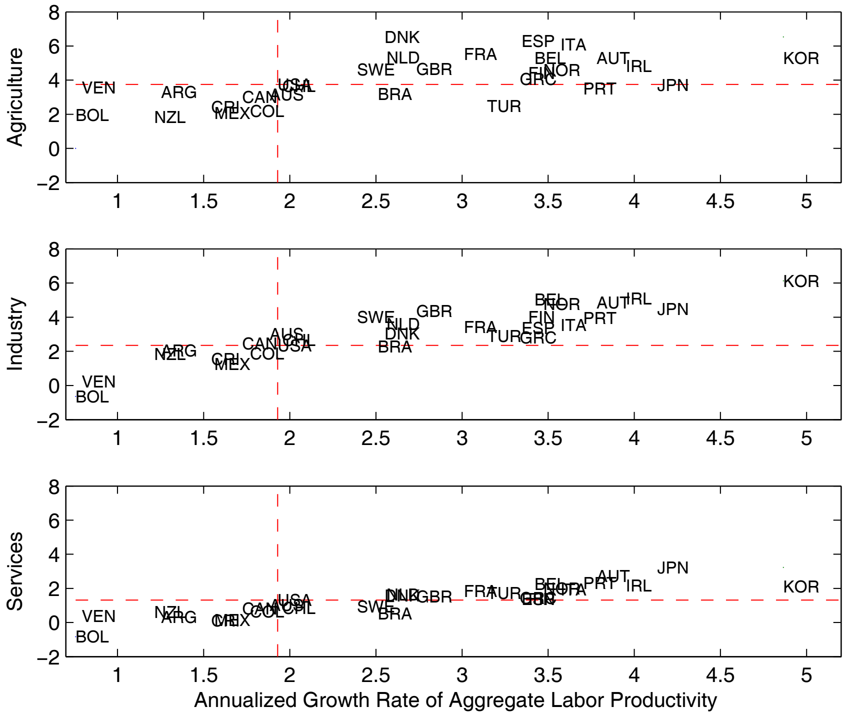
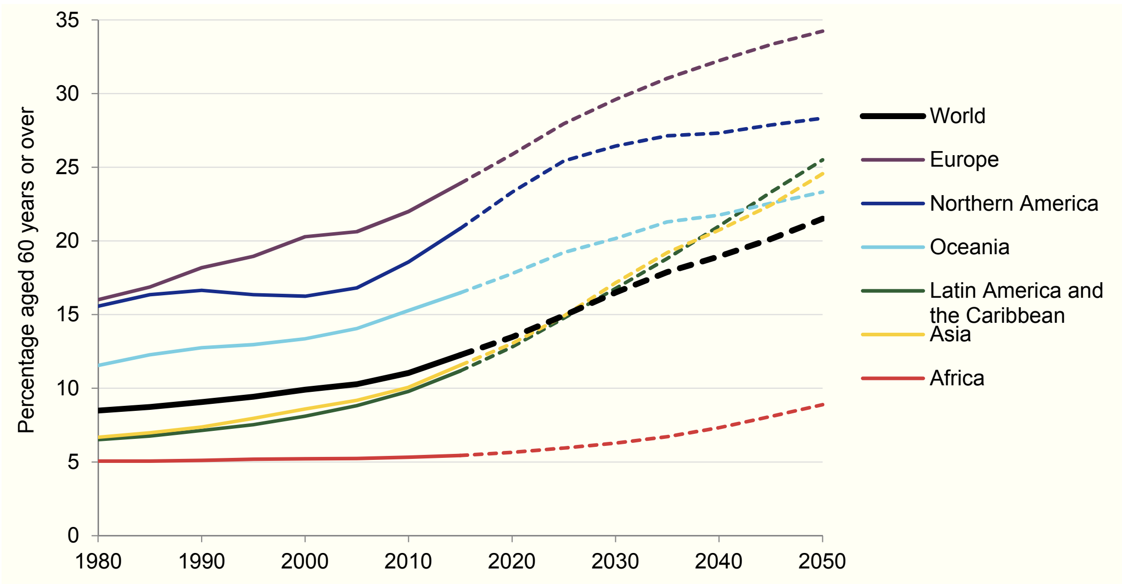
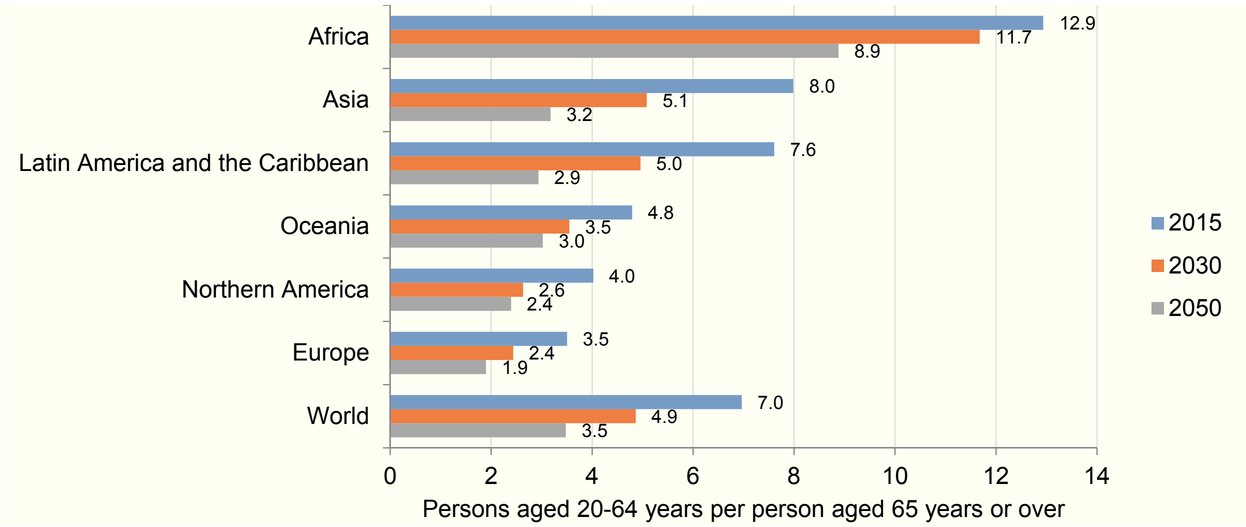


Figure 1.3: Pourcentage des personnes ayant 60 ans ou plus, Source: World Population Ageing 2015, ONU



de population en âge de travailler, ainsi qu'une baisse de l'offre de travail. Le vieillissement de la population est aussi associé à une plus faible mobilité des travailleurs. En combinant avec le phénomène de changement structurel, le vieillissement de la population risque de causer une augmentation du taux de chômage. Autrement dit, le changement réduit le nombre d'emploi

Figure 1.4: Ratio de dépendance, Source: World Population Ageing 2015, ONU



dans certains secteurs et conduit à de nouvelles opportunités dans les secteurs émergents. Comme la jeune génération est plus flexible et plus mobile par rapport aux personnes plus âgées, les plus jeunes ont tendance à aller au travail dans les nouveaux secteurs. De nombreux auteurs s'intéressent à l'importance de ces nouveaux entrants dans la redistribution de travailleurs au sein des différents secteurs. [2]

L'intégration de l'Europe

Au cours des années passées, l'Europe a fait des progrès en terme d'intégration. Les obstacles en terme de commerce international, le marché du travail, et les services financiers se sont progressivement réduits. De plus, l'effet positif de l'intégration en terme de la croissance économique pour les nouveaux membres est nonnégligeable. Les études confirment l'effet positif de l'intégration europénne sur la croissance économique[3].

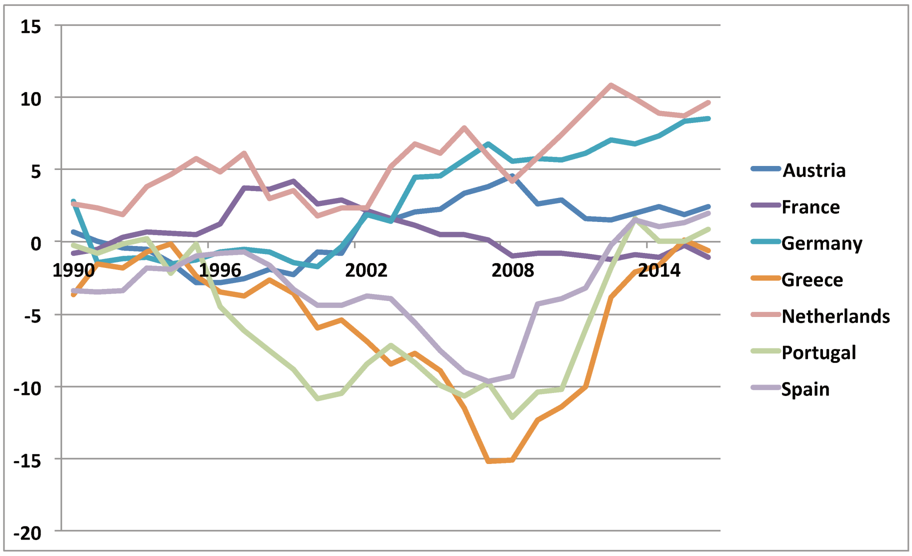
Malgré ces effets positifs, la crise récente et les performances divergentes parmi les membres de la zone euro a remis en question le rôle positif de l'intégration. En effet, dans la zone euro, il existe un déséquilibre des comptes courants depuis les années 1990s. La Figure 1.5 montre la divergence des comptes courants au sein des membres de l'UEM. Les pays comme l'Allemagne et les Pays Bas ont des surplus du compte même pendant la période de la crise financière en 2008. Au contraire, les pays comme l'Espagne, le Portugal, et la Grèce ont des déficits; ces pays sont aussi sévèrement touchés par la crise.

Après la crise financière, les pays périphériques connaissent des augmentations de leurs dettes souveraines. Car les dépenses publiques ont augumenté afin de soulager l'impact de la crise sur le marché du travail et sur le secteur financier. Le ratio dette sur PIB pour la Grèce est passé de 107% en 2005 à 172% en 2011. L'augmentation de la dette fait augmenter le taux d'intérêt, qui déprime le marché du credit dans l'économie. Combiné avec une croissance du PIB faible, certains pays périphérique risquent de faire défaut. Par conséquent, les banques européennes sont exposées à un risque de défaut souverain des pays périphériques. Cette crise jumelle entre la banque et la dette souveraine impose des pertes potentielles pour les banques qui investissent beaucoup dans le marché des obligations gouvermentales, et conduit à une

[2] Voir, par exemple, dans Kim and Topel (1995).

[3] Voir, par exemple, dans Crespo-Cuaresma et al. (2002), Schadler et al. (2006), Falcetti et al. (2006) et Iradian (2007) and Cihak and Fonteyne (2009).

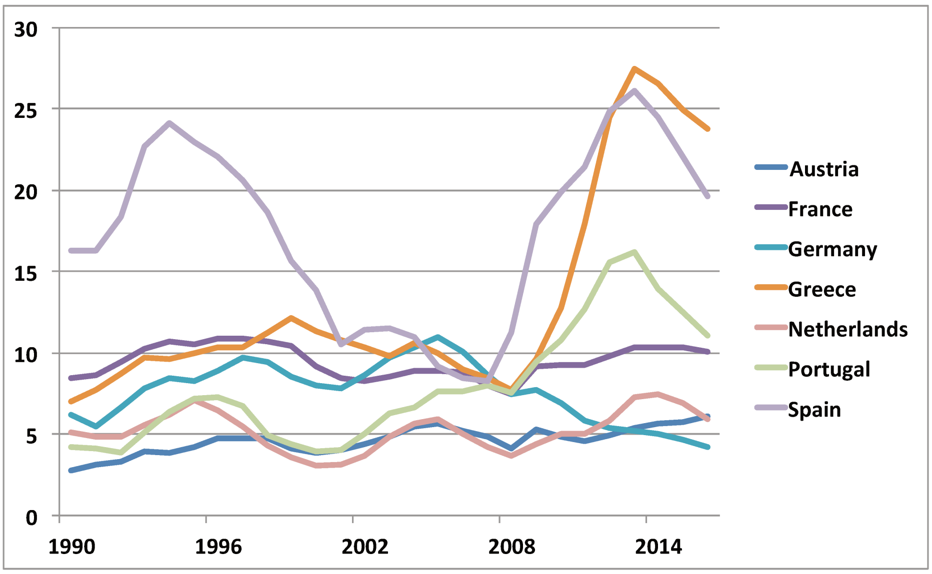
Figure 1.5: Comptes courants (1990-2016) dans l'UEM mésurés par le pourcentage du PIB (%), Source: FMI



certaine réticence des banques à offrir du crédit aux entreprises. Ceci permet de comprendre la crise de la dette souveraine et son lien avec les performances économiques divergentes au sein des pays de la zone euro.

Ainsi, malgré une convergence des taux de chômage des membres au cours des 9 première années de l'UEM, cette tendance s'inverse depuis la crise financière de 2008[4] (Figure 1.6). La politique économique visant à stabiliser les chocs asymétriques, par exemple, la politique économique pour améliorer la mobilité des travailleurs, l'assouplissement monétaire, le fonds d'emprunt en dernier ressort, et les réformes fiscales sont dorénavant des outils les plus importants pour le décideur de politique économique.

Figure 1.6: Taux de chômage dans la zone euro (1990-2016), Source: FMI



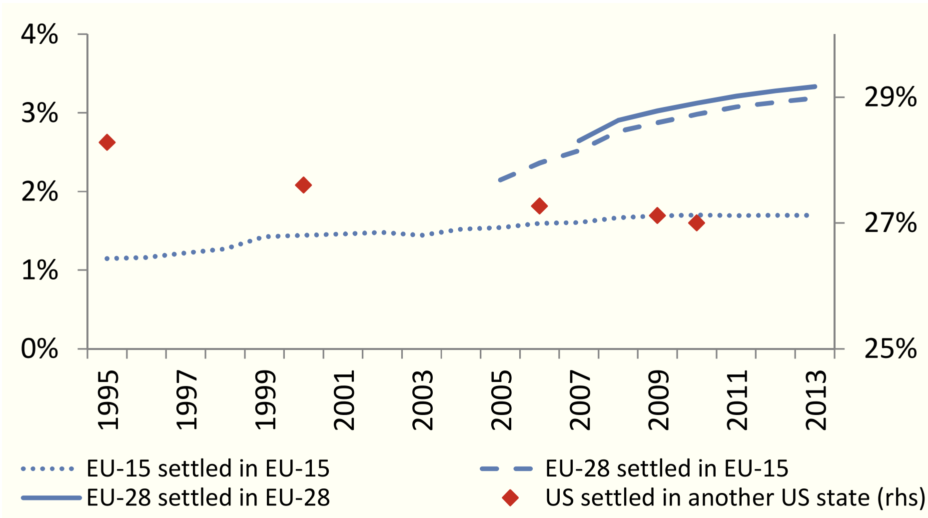
[4]voir Estrada et al.(2012)

La mobilité des travailleurs

La mobilité des travailleurs, et plus spécifiquement la faible mobilité est une question importante pour les pays de zone euro. Un taux de change fixe limite la capacité à s'ajuster via la dépréciation de la monnaie nationale face à des chocs asymétriques. Combiné à une rigidité nominale des prix, les chocs asymétriques peuvent conduire à des déséquilibre des marchés du travail au sein des pays de zone euro. La mobilité des travailleurs pouvait engendre à une solution afin d'absorbe les impacts des chocs asymétriques.

Cependant, comparée aux Etats Unis, la mobilité des travailleurs en Europe est relativement faible. La Figure 1.7 montre que le pourcentage des migrants entre les états des Etats Unis est supérieur à 27%. En Europe, ce ratio est égal ou inférieur à 3%. D'après Arpaia, Kiss, Palvolgyi and Turrini (2014), la faible mobilité des travailleurs en Europe est due à la différence de langues et de cultures, au systèmes de protection sociale, mais surtout aux différents régulations des marchés du travail.

Figure 1.7: Proportion des immigrants intra-EU et intra-US (rhs), Source: Arpaia et al. (2014)



L'autre défi en terme de mobilité des travailleurs concerne l'immigration. Avec le vieillissement de la population, l'Europe et les autres pays développés pouvaient observe une population en âge de travailler à la baisse, une faible immobilité des travailleurs due à la faible proportion de jeunes travailleurs. Ainsi, ces pays ont besoin d'attirer les jeunes travailleurs bien qualifiés des pays en développement, par exemple, la Chine, l'Inde, ou l'Europe du centre-est. Cependant, la proportion des migrants internationaux est seulement de 2,9% de la population mondiale[5], ce qui implique que les économies développées auront des difficultés afin de réduire le coût d'entrée pour les immigrants internationaux.

La politique économique

La politique monétaire conventionnelle vise à stabiliser le taux d'inflation en suivant la règle de Taylor. Avant la crise financière en 2008, cet instrument populaire était efficace pour maintenir un taux d'inflation autour de 3%.

Cependant, la crise financière en 2008 a remis en question l'efficacité de la politique

[5] Zimmermann (2004)

monétaire conventionnelle. Premièrement, l'instabilité du système financier et le risque de défaut des grande banques a réduit la corrélation entre le taux d'intérêt proposé par la banque centrale et le spread de crédit. Ainsi, les banques centrales donnent plus de poids sur la politique macroprudentielle qui demande aux banques privées de retenir une proportion minimum du capital de risque bas (Basel III). Les banques centrales font également attention à renforcer les bilans des banques privées en achetant des actifs risqués des banques privées. Le deuxième défi tient au fait que pendant la grande récession de 2008, le taux d'inflation était proche de zéro ou négatif. Dans ce scénario, la politique monétaire qui suit la règle de Taylor va suggérer un taux d'intérêt négatif. Cependant, le taux ne peut pas être plus bas que zéro, car sinon les agents privés vont préférer concerver leurs liquidités plutôt que de faire des investissements (trappe à liquidité). Face à ces défis, la politique monétaire non conventionnelle apparaît comme une solution alternative.

Dans la politique monétaire non-conventionnelle, les banques centrales achètent des actifs risqués des banques privées ou des entreprises, et augementent leurs bilans de façon massive (Figure 1.8). Le Quantitative Easing (QE) est un exemple de politique monétaire non-conventionnelle. La banque centrale japonaise était la première à appliquer le QE dans les années 1990s en achetant les obligations gouvernementales des banques privées. Fédérale Américaine a aussi appliqué le QE pendant et après la crise financière de 2008. Banque Centrale Européenee a aussi adopté le QE pendant la crise de la dette souveraine.

En terme de politique fiscale, la dévaluation fiscale devient populaire dans la zone euro. A cause de l'inflexibilité du taux de change entre membres de l'union monétaire, le canal d'ajustement par la dépréciation de la monnaie nationale est fermé. En même temps, la dévaluation fiscale - une augmentation des impôts sur la consommation (la TVA, par exemple) associée avec une baisse du taux d'impôt sur le revenu du travail - devient une solution potentielle. Il y a des pays comme le Danemark (en 1987), l'Allemagne (en 2007), et la France (en 2012) qui ont déjà appliqué la politique qui déplace la charge d'imposition du revenu à la consommation. Les effets anticipés sont une baisse du coût de travail, ainsi qu'une baisse du coût de production afin de faire baisser le prix des biens échangés et d'améliorer la compétitivité dans le commerce international, avec des effets positifs sur la production et l'emploi.

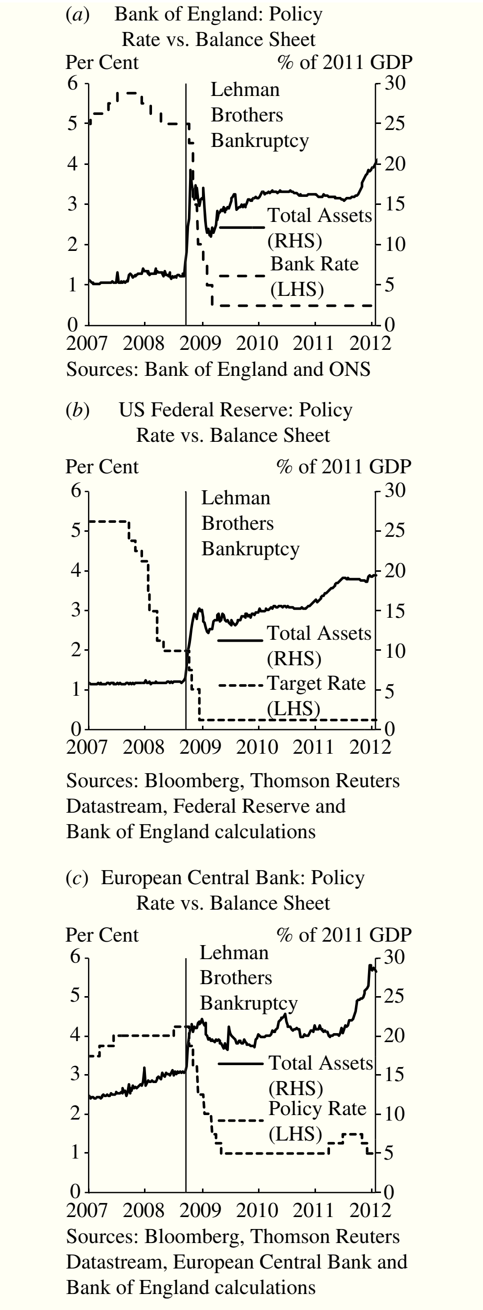
Sujet de la thèse

Dans ce doctorat, on s'intéresse à l'importance des phénomènes de changement structurel aujourd'hui à la mobilité des travailleurs et enfin à l'impact des politiques économiques mises en place dans la zone euro après la crise. Ces thèmes sont importantes pour l'UEM faisant face à des chocs asymétriques après la crise financière en 2008. La politique économique aide à réduire l'impact de la récession, la divergence parmi les membres de l'UEM, et la relation entre dette souveraine et crise bancaire. La mobilité des travailleurs pouvant permettre d'absorber les effets des chocs asymétriques dans l'union monétaire.

Pour répondre à ces questions, on utilise un modèle d'équilibre général. Les modèles d'équilibre général avec fondement microéconomique constituent une solution à la critique de Lucas pendant les années 1970s, qui dit qu'il est naif de prévoir les effets d'un choc en se basant sur les données historiques.

Les modèles d'équilibre général permettent d'analyser les intéractions entre les consommateurs, les entreprises, le secteur financier, le gouvernement, et la banque centrale, et ainsi d'analyser les impacts des politiques économiques. Par exemple, dans le cas de la crise jumelle entre la dette souveraine et le secteur bancaire, les modèles d'équilibre général permettent de

Figure 1.8: Les bilans des banques centrales pendant les périodes de crise, Source: Joyce et al. (2012)



comprendre les effets de la politique monétaire sur la consommation, le bien être des ménages, l'investissement, le taux de chômage, le niveau de crédit, le taux d'intérêt, et le niveau de la dette souveraine. Les modèles d'équilibre général permettent également d'analyser le canal de transmission de la politique monétaire ou fiscale, et ses effets généraux sur l'économie. Les modèles d'équilibre général présentés dans cette thèse reproduisent les faits stylisés que l'on trouve dans les données. Par exemple, les modèles reproduisent correctement séries temporelles des cycles économiques sur les biens, les indicateurs financiers et fiscaux. Il explique aussi la corrélation entre le taux de croissance, la différence entre le taux d'intérêt des obligations gouvernementales et le taux proposé par la banque centrale, les prêts interbancaires, et le taux d'intérêt. Les modèles constituent comme un laboratoire pour les expérimentations de politique économique. Ils simulent les scénarios économiques avec les différentes politiques monénaires non conventionelles et bugétaires pemettant alors une comparaison avec les politiques alternatives. Les modèles permettent de quantifier les effets de la dévaluation fiscale dans un mécanisme avec deux pays et entrées endogènes dans le commerce international.

Concernant le sujet de la mobilité des travailleurs, il y a deux possibilités de modélisation. La première est d'implémenter la mobilité des travailleurs dans un modèle d'équilibre général avec plusieurs secteurs, comme Lee and Wolpin (2006). A chaque période, les travailleurs peuvent choisir le secteur dans lequel ils veulent travailler. Les travailleurs font leurs choix en se basant sur le salaire sectoriel moins le coût de mobilité. La deuxième possibilité est d'adopter la théorie des choix discrets, dans laquelle les travailleurs ont des préférences qui suivent une certaine distribution de probabilité. Ce mécanisme nous permet d'éviter les solutions en coin et a été utilisé, par exemple, par Artuc, et.al. (2010) et Pilossoph (2014). Dans cette thèse, on considère ègalement le mécanisme d'appariement, qui nous permet d'analyser les dynamiques dans les marchés du travail et du capital (voir Wasmer and Weil (2004)). Le modèle explique les co-mouvements à long terme entre la croissance du secteur des services et le pourcentage de population jeune qui est le plus mobile dans le marché du travail. Il explique la corrélation négative entre la croissance du secteur des services et le pourcentage de population d'âge moyen. Le modèle permet de simuler le scénario contre-factuel dans lequel la croissance démographique augmente ou baisse de 1 point de pourcentage, ainsi que les impacts de la mobilité des travailleurs et du capital dans une union monétaire. Les résultats permettent en fin de faire des recommandations de politique économique.

Il y a quatre chapitres dans cette thèse:

Dans le premier chapitre, nous analysons les intéractions entre le marché interbancaire et le risque de défaut souverain dans un modèle d'équilibre général à deux pays, en focalisant sur la transmission de la crise financière récente et la politique monétaire non conventionnelle. Le rôle spécifique du marché interbancaire est pris en compte. Le marché interbancaire est très important car il est au coeur du secteur financier. Les dynamiques observée sur ce marché influencent le montant du crédit dans l'économie donc l'investissement et le PIB. Il est aussi important en terme de politique monétaire, car les banques centrales implémentent les opérations d'open market afin d'influencer le taux d'intérêt dans le marché interbancaire, ce qui affecte la courbe des taux. Nous développons un modèle à deux pays avec fondements micro-économiques du marché interbancaire et risque de défaut souverain. Les deux éléments s'intéragissent et conduisent à une boucle entre la dette - les banques - le crédit, dans laquelle le risque de défaut souverain a un effet important et restrictif. Le modèle est calibré sur la zone euro, et reproduit les faits principaux des cycles économiques sur les biens et les indicateurs financiers et fiscaux. Le modèle est utilisé afin d'estimer les effets de la grande récession en 2008 et les effets potentiels des différentes politiques non conventionnelles dans les pays de l'UEM. Les politiques non conventionnelles ont des effets non négligeables qui réduisent la perte de bien être provoqués par la grande recession. Parmi les politiques monétaires non conventionnelles, les politiques ciblant des obligations gouvernementales et les emprunts interbancaires sont plus efficaces que les interventions de crédit standard.

Dans le deuxième chapitre, les effets de la dévaluation fiscale sur les indicateurs macroéconomiques et le bien être sont analysés en utilisant un modèle à deux pays en union monétaire où les variétés de biens et le commerce sont endogènes. On montre que le commerce endogène amplifie les effets de la dévaluation fiscale sur le commerce international. Ceci constitue un canal de transmission important pour réformes fiscales. La dévaluation fiscale non seulement baisse le prix relatif des exportateurs domestiques, mais également conduit à une augmentation du nombre de variétés des biens commercialisés, ce qui contribue à l'augmentation des exportations. Un effet contraire apparaît pour les exportations étrangères (importations doméstiques) qui baisse le nombre des variétés importées et renforce la baisse des importations. Les effets de la dévaluation fiscale sur la production, la consommation, les heures de travail et le compte courant sont positifs. Cependant, la marge extensive constitue un canal de transmission supplémentaire. Le commerce endogène amplifie les effets sur les flux d'échange. L'entrée endogène augmente la création des variétés des biens dans les deux pays, ce qui amplifie les dynamiques positives de la production domestique, la consommation et les heures de travail. Elle fait également passer la réponse de la production étrangère de négative à positive.

Dans le troisième chapitre, l'impact du facteur démographique sur la croissance du secteur des services à long terme est mis en exergue. Les travailleurs et la production sont subissent une redistribution vers le secteur des services dans la plupart des pays développés. En même temps, la tendance au vieillissement de la population dans les économies avancées attire notre attention car cela peut affecter la nature et la vitesse du changement structurel dans les économies développées. par ailleurs, le vieillissement de la population peut conduire à une baisse de l'offre de travail dans le secteur des services, mais également à une augmentation de la demande pour les services. De plus, le vieillissement de la population peut aussi influencer les croissances des productivités sectorielles via une baisse des activités innovantes[6]. Dans les pays des OCDE et lorsqu'on utilise les données sur les zones d'emploi aux Etats Unis, on trouve qu'il existe des corrélations positives entre le pourcentage de population jeune et la croissance du secteur des services. On utilise alors un modèle à générations imbriquées avec deux secteurs et trois générations, et on montre que si les croissances des productivités sont exogènes, les impacts du choc démographique sont positifs sur le secteur des services. Les effets restent cependant faible: 1 point de pourcentage de plus sur la croissance de la jeune population chaque année augmente la proportion des emplois dans le secteur des services de 2 points de pourcentage pendant les 60 derniers années). Ces effets positifs proviennent de l'offre de travail. Lorsque l'on considère que la croissance est endogène, les effets du choc démographique sur le secteur des services avec croissance endogène sont multipliés par 4.

Dans le quatrième chapitre, on étudie les effets de la mobilité des travailleurs et de la mobilité du capital dans une union monétaire. A cause du taux de change fixe, les pays touchés par des chocs négatifs ne peuvent pas s'ajuster via une dépréciation de la monnaie nationale. Ainsi, la mobilité des facteurs comme la mobilité des travailleurs et la mobilité du capital constitue une solution potentielle afin de stabiliser les effets des chocs asymétriques dans une union monétaire. La mobilité des travailleurs réduit la pression du chômage dans les pays touchés par des chocs négatifs sur la demande, et permet aux chômeurs de trouver un travail plus facilement dans les pays où le marché du travail est plus actif. La mobilité du capital ou l'intégration financière diversifie les choix d'investissement et réduit ainsi le risque de défaut. La mobilité des travailleurs et la mobilité du capital sont ainsi considérées comme des solutions qui stabilisent les effets des chocs asymétriques dans une union monétaire. On considère un modèle à deux pays, permettant d'étudier les effets potentiels de l'inéraction entre la mobilité des travailleurs et la mobilité du capital face à des chocs asymétriques. On montre que la mobilité des travailleurs réduit le taux de chômage alors qu'au contraire la mobilité du capital la fait augmenter. Cependant, les effets de la mobilité financière sont secondaires. Il est intéressant de remarquer que la mobilité des travailleurs ou la mobilité du capital n'ont pas systématiquement un effet positif sur la production. Le modèle est calibré sur la zone euro permettant de simuler les effets de la crise financière de 2008. Les effects contre-factuels montrent que la divergence entre les pays n'est pas causée par les chocs asymétriques sur la productivité, mais plutôt par leurs associations avec une augmentation

[6] voir Romer (1990), Aghion et Howitt (2009), et Aksoy et al. (2015)

du coût de la mobilité des travailleurs. Ce résultat contribue aussi à expliquer le puzzle de Shimer qui dit que la fluctuation des taux de chômage générée par le modèle d'appariement est plus petite que ce que l'on observe dans les données.

English Version

Important Issues in Modern Developed Economies

Developed economies are facing several challenges during the past decades, such as the structural change toward services, population aging, integration of European Monetary Union, the lack of labor mobility among member countries within the EMU, and economic policies to alleviate slow economic growth especially in the aftermath of the 2008 financial crisis.

Structural Change

Structural change is one of the most prominent phenomenon for modern economic growth. When the economy develops, its production and labor force first shifts from agriculture into industry, and then from industry toward services. Modern developed economies have gone through significant labor and production reallocation during the past decades. Figure 1.9 plots the time series of sectoral employment share and value added share documented by Herrendorf et al. (2014). In the figure, we find that along the path of development[7], the share of agriculture declines, the share of service rises, and the share of manufacturing follows a hump shape, i.e. the manufacturing rises in the early stage of development, and then falls when the GDP per capita continues to grow.

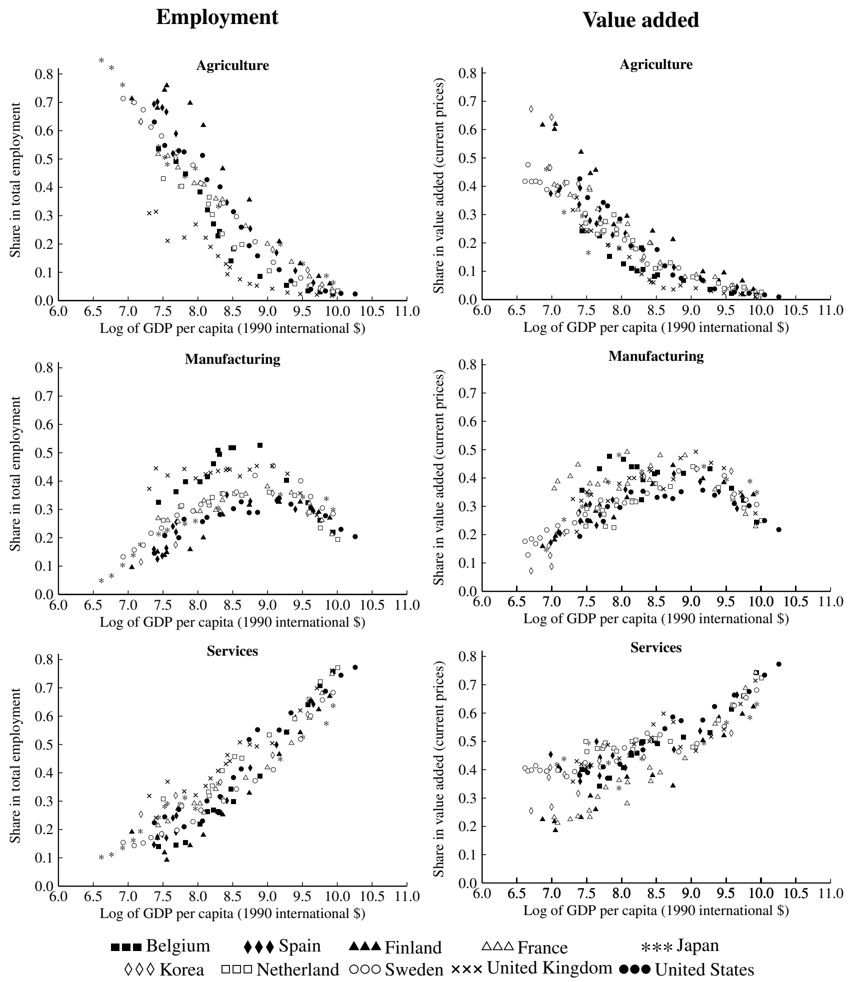
In recent years, structural change has been highlighted in policy debate, arguing that labor reallocation was inefficient. As documented by Duarte and Restuccia (2009), poor countries have highest shares in agriculture. For most of the developing countries, their labor force first reallocates from agriculture to industry/manufacturing, catching up with the productivity relative to developed countries. When the economy continues to grow on their path, labor reallocates from manufacturing to the service sector. As presented in Figure 1.10, the sectoral productivity growth is highest in agriculture and manufacturing (3-4% per year), and lowest in the service sector (2% per year). Therefore, labor reallocation in the later stage of development may lead to slowdown and stagnation of economic growth.

Population Ageing

Population ageing is becoming a major issue in the modern world. As living conditions and medical cares improve, longevity ameliorates in almost everywhere. According to the statistics from the United Nations, the average life expectancy in the world was 52.5 in the year 1960, and 71.5 in 2014. During the last decades, the proportion of aged population (60 years or above) has been increased much, especially in developed economies such as Europe and North America (Figure 1.11).

[7] measured by GDP per capita

Figure 1.9: Sectoral employment and value added shares, Source: Herrendorf et al. (2014)



Population ageing brings concerns in the economy's welfare system, industrial structure, employment, immigration policies, etc. Among the potential influences from population ageing, the sustainability of social welfare system and employment are the most emphasized by the scholars and policy makers.

Since government's pension system for retired population depends largely on the tax contribution of working-aged population, population ageing may raise concerns about the sustainability of the current pension system and welfare state for aged population. According to the projection of the United Nations (Figure 1.12), in 2015, there were 7 working-aged people for each person aged 65 years or over. By 2050, this ratio is projected to decline to 3.5 in the world, with 2.4 in Northern America, and 1.9 in Europe.

On the employment side, population ageing may lead to less working-aged population and therefore less labor supply in the economy. Population ageing is also associated with low labor mobility. Combined with the procedure of structural change, it may bring challenges to a high unemployment rate. In other words, the procedure of structural transformation closes jobs in the falling sector and opens new jobs in the rising sector. As young generation has relatively high mobility and flexibility, they are the source of labor supply for the rising sectors. There is evidence that the role of new entrants is crucial for the labor reallocation across sectors in

Figure 1.10: Sectoral labor productivity growth (%) across countries, Source: Duarte and Restuccia (2009)

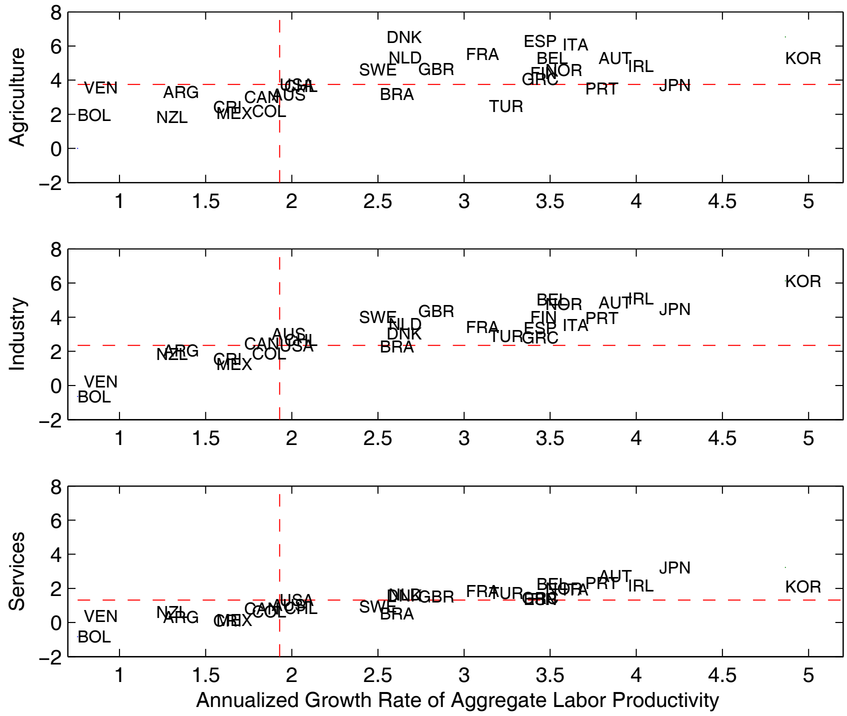
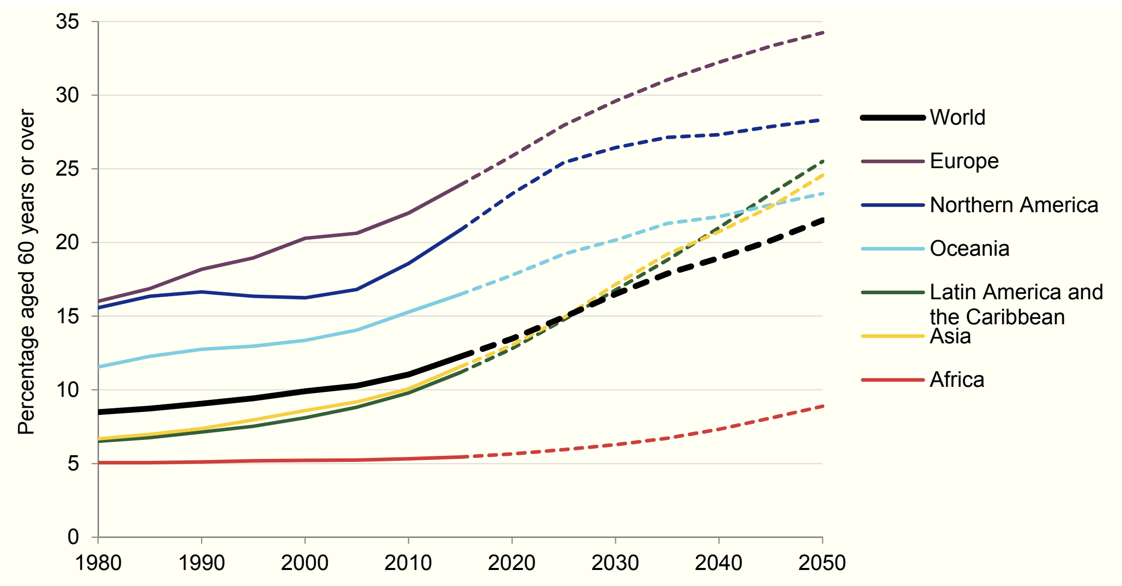


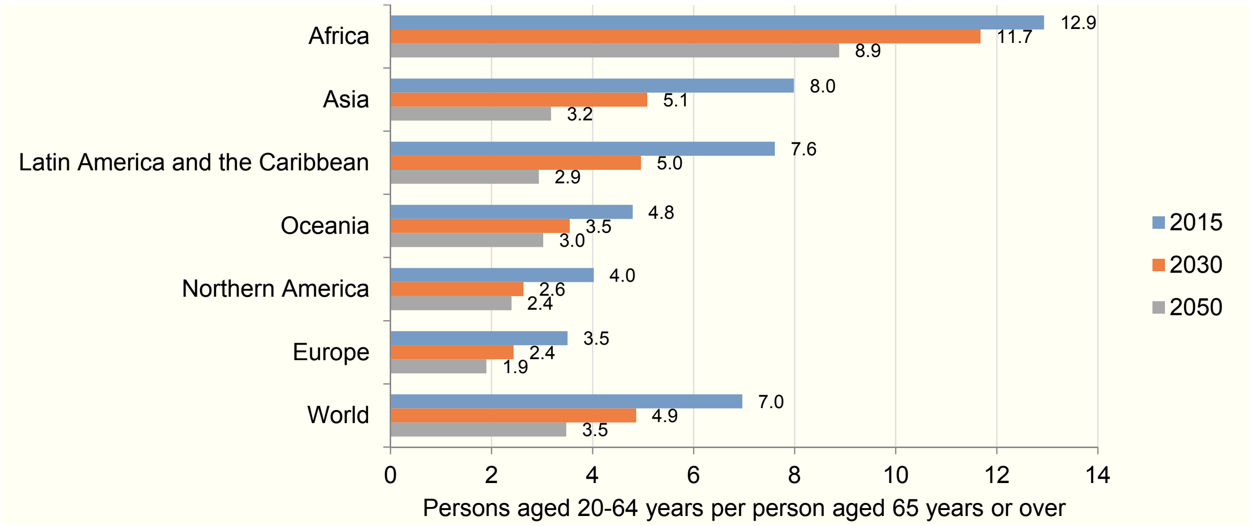
Figure 1.11: Percentage of people aged 60 years or over, Source: World Population Ageing 2015, United Nations



the context of structural transformation[8]. When the labor force lacks mobility, people who lose their jobs in the falling sector may take a long time to find a new job, and raise the unemployment rate in the economy.

[8] see, for example Kim and Topel (1995)

Figure 1.12: Potential support ratio, Source: World Population Ageing 2015, United Nations



European Integration

Over the past decades, Europe has made great progress toward integration. Barriers for trade, labor and financial services have been reduced progressively. Moreover, the positive spill-over effects to new member countries were beneficial. Acadamic studies also confirm the benefits of European integration on economic growth [9].

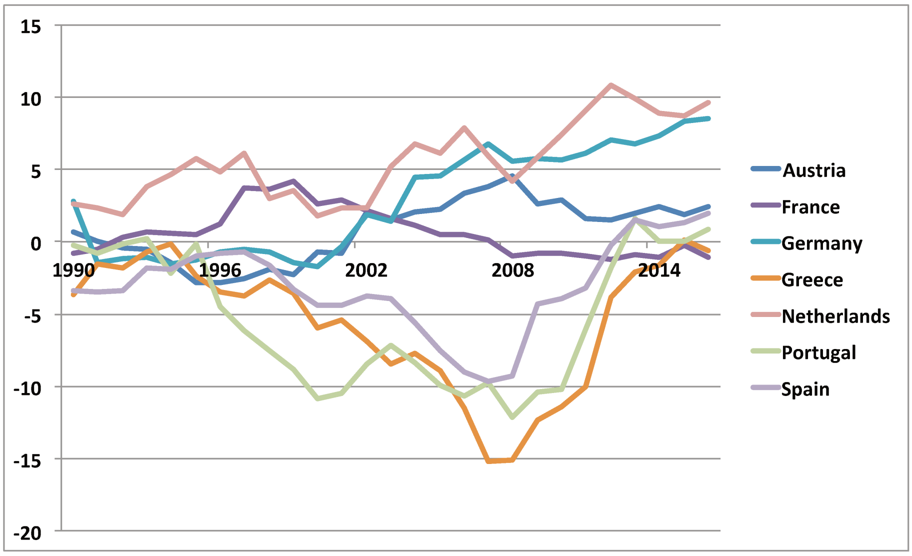
Despite the positive contributions on economic growth from the European integration, the recent sovereign debt crisis and divergent economic performance among the EMU member countries make us rethink about this issue. In fact, within the currency union, there have been non-negligible economic imbalances since 1990s. In Figure 1.13, we see divergence of current account balances among member countries. Countries like Germany and Netherlands consistently have current account surpluses even during the period of the 2008 financial crisis. Meanwhile, countries such as Spain, Portugal and Greece consistently run current account deficits and were seriously touched by the 2008 financial crisis.

After the financial crisis, periphery countries see an important rise of their sovereign debt, because they have to raise their public expenses to mitigate the impact on labor market and financial sector, such as unemployment subvention and bailout funds for banks. For example, the debt/GDP ratio in Greece increased from 107% in 2005 to 172% in 2011. The burden of sovereign debt increased its interest rate, which further depressed the credit market in the economy. High interest rate and sluggish growth almost put some of the peripherial countries on the edge of bankrupcy. As a consequence, European banks were significantly exposed to the sovereign default risk of periphery countries. This vicious spiral of twin crisis between banks and sovereigns imposes potential losses for banks who invested massively in the sovereign market, and resulted into banks' reduced ability and propensity to extend lending to the market. This is how the sovereign debt crisis evolutes following divergent economic performances among EMU member countries.

Therefore, although the first nine years of EMU were associated with a strong convergence in unemployment rates across member countries, this trend was largely reversed by the 2008

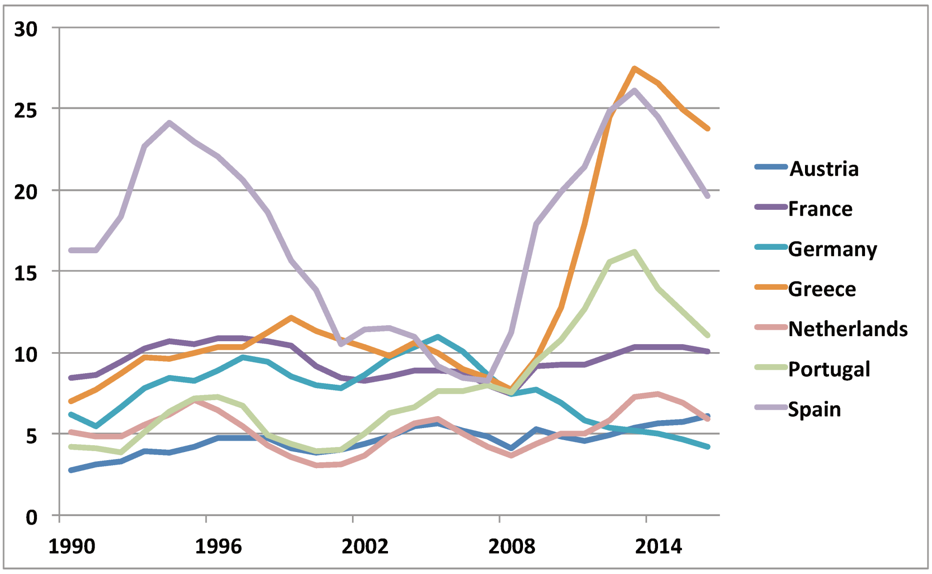
[9] see, for example, Crespo-Cuaresma et al. (2002), Schadler et al. (2006), Falcetti et al. (2006) and Iradian (2007) and Cihak and Fonteyne (2009).

Figure 1.13: Current account (1990-2016) in EMU member countries as percentage of GDP (%), Source: IMF



financial crisis[10] (Figure 5.1). As a result, economic policies concerning stabilising asymmetric shocks within the currency union, such as improving labor mobility, quantitative easing, rescue packages for indebted economies, and fiscal reforms are now on the agenda of policy makers.

Figure 1.14: Unemployment rate (1990-2016) in EMU member countries, Source: IMF



Labor Mobility

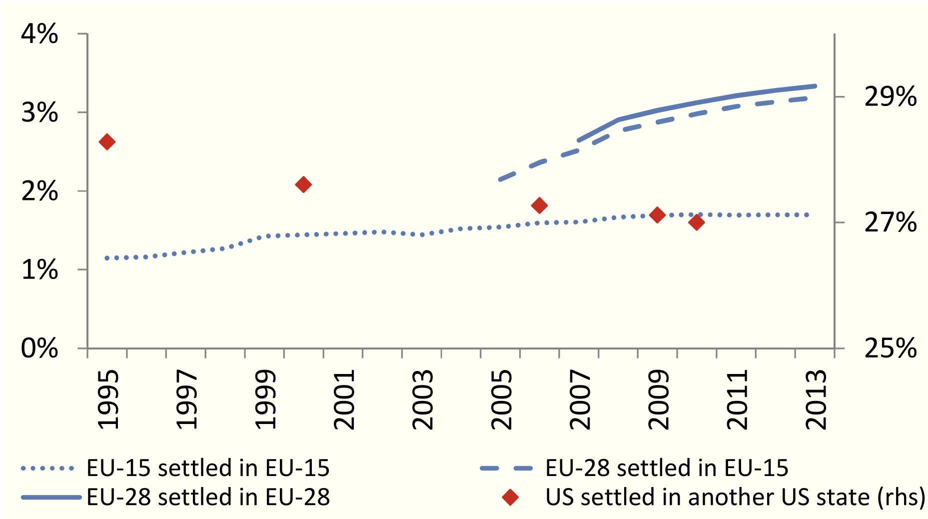
Labor mobility recently received attention from scholars and policy makers, especially in the EMU. In front of the asymmetric shocks among member countries, fixed exchange rate limits those hit by negative shocks to adjust through currency depreciation. Combined with

[10] Estrada et al.(2012)

the rigidities in prices and wages, asymmetric shocks may result to imbalanes of employment/unemployment rates among member countries. In this situation, labor mobility provides a potential solution to rebalance labor markets and absorb excess impacts from asymmetric shocks.

However, compared to US, labor mobility in Europe is very small. As Figure 1.15 show us, the percentage of immigration among US states is above 27%, whereas this ratio in Europe is around or below 3%. The low labor mobility within EU member counties is due to differences in languages and cultures, welfare-states, and especially labor market regulations. Particularly, the language barrier, the accessibility to welfare rights, the verification of labor's competitivity and qualification in the job market, etc.[11]

Figure 1.15: Share of intra-EU immigrants, and share of intra-US immigrants(rhs), Source: Arpaia et al. (2014)



Another challenge about labor mobility is immigration. With population ageing, EU and other advanced economies face challenges from the shortage of working-aged population, and from the immobility of labor force due to the low percentage of young workers. Therefore, these countries need to attract young and qualified workers from less developed countries such as China, India and Central-Eastern Europe. However, the proportion of international immigrants is only about 2.9% of the world population [12]. This issue implies that immigration policies face the challenges to reduce entry barriers for international workers and meanwhile pay attention to the sustainability of their welfare system.

Economic Policies

The traditional/conventional monetary policy is inflation targeting, in which the Central Banks adjust short-term interest rates according to Taylor's rule. Before the 2008 financial crisis, this instrument was widely applied in advanced economies and was proved efficient in maintaining the inflation rate at a reasonable level around 3%.

The conventional monetary policy was challenged by the 2008 financial crisis. First, due to the instability of financial system and the default risk of some big banks, the relationship

[11] Arpaia, Kiss, Palvolgyi and Turrini (2014)

[12] voir Zimmermann (2004)

between Central Banks' key interest rates and the market credit spread becomes less correlated. Therefore, Central Banks put more emphasis on macroprudential policies in which banks are required to hold a minimum amount of qualified and low-risk capital (Basel III). Central Banks also seek to reinforce private banks' balance sheets by purchasing high-risk assets from those banks. The second challenge is that in a great recession, due to the weak demand in the market, inflation rate could be close to zero or negative. In this scenario, conventional monetary policy following the Taylor's rule may suggest a negative interest rate. However, the interest rate cannot be lower than zero, because otherwise private agents would prefer to hold liquidity rather than to invest (the liquidity trap). Facing these challenges, unconventional monetary policies appeared as an alternative solution.

In the unconventional monetary policies, Central Banks buy risky assets from private banks or firms, and extend massively their balance sheets (see Figure 1.16). Quantitative Easing (QE) is a good example of unconventional monetary policy. The Bank of Japan is the first to apply QE. It adopted QE in 1990s by purchasing government bonds from private banks. The Fed also applied QE during and after the 2008 sub-prime crisis, and so does the ECB during the sovereign debt crisis.

In terms of fiscal policies, fiscal devaluation becomes popular among member countries of EMU. Due to inflexibility of exchange rates among currency union member countries, the channel to adjust asymmetric shocks through currency depreciation is no longer valid. At the same time, the fiscal devaluation - a rise in tax rates affecting the consumption of goods (typically VAT) along with a fall in labor income tax or payroll tax rates - comes out to be a potential cure. Some countries such as Denmark (in 1987), Germany (in 2007) or France (2012) already proceeded to shifts in the tax burden from labor income to consumption taxation. The effects expected from such policies are a reduction in labor costs, production costs and a change in the relative price of tradable goods, leading to the improvement of trade balance with positive effects on output and employment.

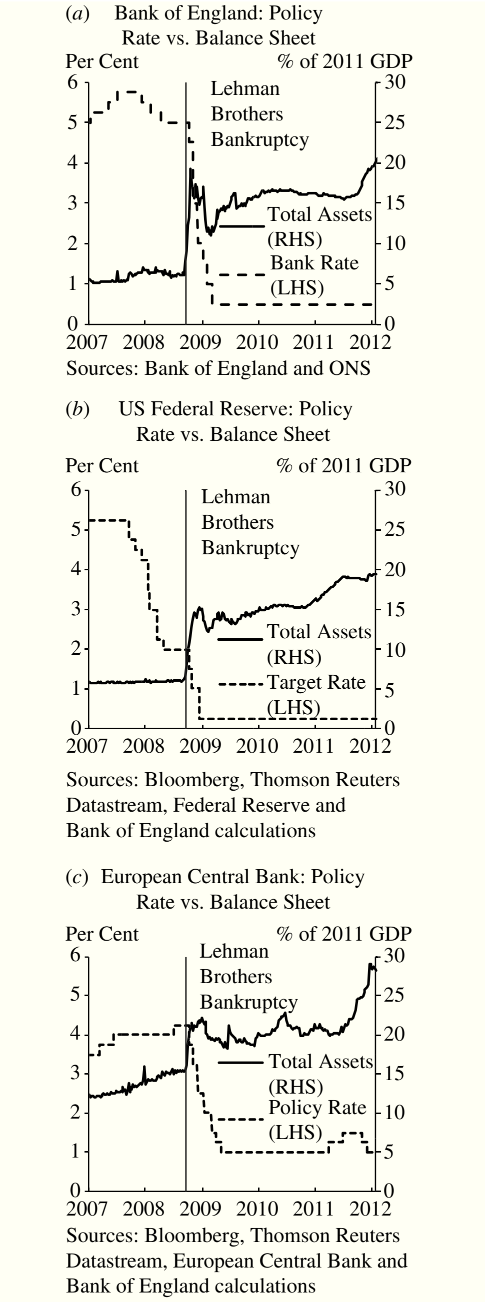
Focus of My PhD Thesis

In my PhD thesis, I focus on two main axis among the economic issues in modern developed countries: economic policies in the EMU and the labor mobility. These two axis are the keys for the EMU facing asymmetric shocks in the aftermath of the 2008 financial crisis: economic policies help alleviate on-going recession, divergence, and the loop between sovereign-debt and financial crisis. Labor mobility concerns the ability to absorb asymmetric shocks within the currency union.

I use general equilibrium model in both subjects. General equilibrium model with microfoundations is a good solution to Lucas critique in 1970s, which argues that it is naive to try to predict the effects of a change in economic policy on historical data.

For economic policies, general equilibrium model allows us to study interactive dynamics among consumers, firms, financial sector, government and the central bank. For example, in the scenario of twin crisis between sovereign debt and financial sector, by applying the general equilibrium framework, we can simulate the effect of monetary policies on consumption, welfare state, investment, labor market, credit market, yield rate of government bonds, and the level of sovereign debt. In such a complicated scheme, general equilibrium model does a good job in analysing the transmission channel of monetary/fiscal policies, as well as their overall impacts on the economy. It is the same for fiscal policy analysis. General equilibrium

Figure 1.16: Central Bank balance sheets during the crisis, Source: Joyce et al. (2012)



framework is widely used in the academic study of economic policies [13]. The results produced in our general equilibrium model explains some important stylized facts which we find in data. For example, the model performs well in matching key business cycle facts on real, financial and fiscal time series. It also reproduces and explains the correlation between growth rate, sovereign spread, interbank loans and interest rates. The model also works as a laboratory for policy experiments. It simulates economic scenarios with different unconventional monetary policies as well as fiscal policies and makes comparisons between alternative approaches. It also quantifies the effects of fiscal devaluations within a two-country monetary union model with endogenous entry and endogenous tradability.

[13]For example, Dib (2010), Gertler and Karadi (2011) and Guerrieri et al. (2012), Bosca et al. (2013), Lipinska and von Thadden (2012), Langot and Lemoine (2014), etc.

For the subject of labor mobility, we have two approaches of modelling. The first is to implement labor mobility cost in a multi-sector general equilibrium model, as in Lee and Wolpin (2006). In each period, workers can choose which sector to work in. Their choice is based on sectoral wages net the mobility cost. The second modelling choice is to adopt the discret choice theory, in which workers have their personal preferences following a certain probabilistic distribution. This modelling choice can avoid corner solution and is applied by studies such as Artuc, et.al. (2010) and Pilossoph (2014). We also adopt the mechanism of search and matching in our general equilibrium framework, which allows us to analyze the dynamics in both capital and labor markets as in Wasmer and Weil (2004). Our model explains the long run co-movement between the growth of service sector and the percentage of young population (those are assumed to be the most mobile and flexible) in the economy, and the negative correlation between the growth of service sector and the percentage of middle-aged population. It simulates the counter-factual scenario in which population growth is 1pp faster or slower than the actual rate. It also simulates the impact of labor/capital mobility within a monetary union. These results may provide potential references for policy makers.

My dissertation includes four chapters:

In the first chapter, we analyze the interaction between interbank markets and default risk using a two-country dynamic general equilibrium model, with a focus on the transmission of the recent financial crisis and unconventional monetary policies. In particular, we emphasize the role of interbank market that match creditor and debtor banks. The interbank markets are at the crossroad of financial and real spheres, as their dynamics crucially affect the amount of credit in the economy, with effects on investment and GDP. They are also critical in the conduct of monetary policy, as Central Banks implement open market operations to control the interest rate in the overnight interbank market to affect the yield curve. We develop a two-country model with an explicitly micro-founded interbank market and sovereign default risk. Both features interact and give rise to a debt-banks-credit loop by which sovereign default risk can have large contractionary effects on the economy. Calibrated to the Euro Area, the model performs well in matching key business cycle facts on real, financial and fiscal time series. We then use the model to assess the effects of the Great Recession and quantify the potential effects of alternative unconventional policies on the dynamics of European economies. All the policies considered can bring sizable reductions in the welfare losses from the Great Recession, but policies targeted at sovereign bonds and interbank loans are more efficient than standard credit interventions.

In the second chapter, we investigate the effects of fiscal devaluations on key macroeconomic aggregates and welfare using a two-country monetary-union model with endogenous varieties and endogenous tradability. In this paper, we show that endogenous tradability magnifies the trade effects of fiscal devaluations, and is therefore an important transmission channel of such tax reforms. The reason is that a fiscal devaluation not only lowers the relative price of domestic exports but also leads to a rise in the number of traded varieties, that contributes to raise exports. An opposite effect is at work for foreign exports (domestic imports) that lowers the number of imported varieties and deepens the fall in imports resulting from a fiscal devaluation. As expected, the effects of fiscal devaluations on output, consumption, hours worked and the trade balance are positive but extensive margins provide additional transmission mechanisms. Endogenous tradability magnifies the effects on trade flows. Endogenous entry boosts variety creation in both countries, which amplifies the positive dynamics of domestic output, consumption and hours worked, and turns the response of foreign output from negative to positive.

In the third chapter, we study the impact of demographic factor and the growth of service sector in long run. Labor and production is reallocating from manufacturing to service sector in most developed countries. At the same time, the trend of population ageing in advanced economies calls for attention because this might change the way and speed of structural change in these countries. On one hand, population ageing may result to less labor supply for the service sector, and on the other hand, they may also provide more demand for the service goods. Moreover, population ageing may also have impact on sectoral productivity growth from innovative activities[14]. In the data of both OECD countries and US commuting zones, we find positive correlation between the percentage of young and the growth of service sector. We then establish a 2-sector 3-generation OLG model and find that as long as TFP growth is exogenous, the impact of demographic shock is positive but very limited (1pp annual growth of young generation would have increased employment share in services by 2pp within the last 60 years), and the positive effect comes from the labor supply side. With endogenous TFP growth, the effect is fourfoldly amplified.

In the fourth chapter, we study the effect of labor and capital mobility within a currency union. Due to fixed exchange rate, regions hit by negative shocks have limited capacity to adjust through currency depreciation. Factor mobility is considered as a potential cure to stabilize asymmetric shocks in the currency union. Factor mobility comprises labor mobility and capital mobility. Labor mobility helps releasing excess labor force in regions hit by negative demand shocks, and let them find new jobs in regions where labor market is relatively active. Capital mobility, also know as financial integration, helps diversifying investment choices of banks, and reduces the risk of default. Capital and labor mobility are thus expected to mitigate the impact of asymmetric shocks within a currency union. By establishing a two-country model, we study the potential interactions between financial integration and labor mobility facing asymmetric shocks. Our results show that while labor mobility reduces unemployment rates, financial mobility in contrast increases unemployment rates in both economies. Compared to labor mobility cost, the effect of financial mobility cost on labor market is secondary. Interestingly, factor mobility might not stimulate production due to the fall in employment. We also calibrate the model to the European Monetary Union and simulate the scenario in the aftermath of 2008 financial crisis. Our counterfactual experiments show that the divergence across member countries might not simply due to asymmetric TFP shocks, but rather their association with the increase of labor mobility costs. This finding also provides potential complements to answer Shimer's puzzle which states that the unemployment fluctuation generated by search and matching model is much smaller than what we observe in data.

[14] M.Romer (1990),Aghion and Howitt (2009),and Aksoy et al. (2015)

Chapitre 2

Banks, Sovereign Risk and Unconventional Monetary Policies

2.1 Introduction

In this paper, we analyze the interaction between interbank markets and default risk using a two-country dynamic general equilibrium model, with a focus on the transmission of the recent financial crisis and unconventional monetary policies. In particular, does the sovereign risk / interbank market feedback loop affect the transmission of a large negative shock? Does it alter the effectiveness of unconventional monetary policies and how? Interbank markets are at the crossroad of financial and real spheres, as they match creditor and debtor banks. Their dynamics crucially affect the amount of credit in the economy, with effects on investment and GDP. They are also critical in the conduct of monetary policy, as Central Banks implement open market operations to control the interest rate in the overnight interbank market to affect the yield curve. As such, they play a central role in the transmission of monetary policy decisions, as well as in the transmission of potential financial crises.

Following the introduction of euro, financial integration within the Euro Area opened the door for banks to hold sovereign debts from member countries. As shown by Guerrieri, Iacoviello and Minetti (2012), who use combined data from the Bank for International Settlements and the Bank of France, the ratio of French banks' holdings of Periphery's sovereign debt over their holdings of French government debt was 56% in the last quarter of 2009, up from 19% in the first quarter of 2005. As a consequence, European banks were increasingly exposed to the sovereign default risk of Periphery countries at that time. This vicious spiral of twin crisis between banks and sovereigns imposes potential losses for banks who invest massively in the sovereign market, and may result into a stop in credit growth.

The rising interdependence between interbank and sovereign bonds markets was at the heart of ECB's concerns about rising sovereign risk in the Euro Area. It was also partly exploited by ECB's unconventional monetary policies, to release tensions on both markets at the same time. To capture this interdependence, we develop a two-country model of a monetary union with sovereign default risk, an integrated interbank market and financial intermediaries. We particularly want to analyze the role of banks in the transmission of financial shocks to the economy. In the model, financial markets interact with the real economy through the balance sheet of banks. Saving banks collect deposits and optimize a portfolio made of domestic and foreign sovereign bonds and interbank loans. Commercial banks use interbank loans to grant loans to capital producers. The existence of an interbank market is ensured by assuming that both types of banks interact as suppliers and demanders of interbank liquidity. Both types of banks face agency problems *à la* Gertler and Karadi (2011), that introduces constraints on leverage ratios and leads to a financial accelerator mechanism and endogenous spreads among available assets. These features generate a strong relation between developments on sovereign bond markets, bank liquidity, and loans, and foster macroeconomic and financial interdependence between both regions.

Our model draws on Gertler and Karadi (2011), as the agency problem of both types of banks is derived from their contribution. It proposes a more complex representation of funding in the economy however, as we consider a larger number of assets in our economy (sovereign bonds, interbank loans) and heterogeneity in the banking system with two types of banks. In addition, the model features two countries, whose banks interact on an integrated interbank market. Both characteristics bring our model closer to the situation of banks in the Euro Area. The model also borrows from Corsetti, Kuester, Meier and Mueller (2014) for the sovereign risk channel. We assume that sovereign default risk is increasingly and positively related to a country's public debt-to-GDP ratio, and that default matters *ex-ante* for the pricing of assets, but not *ex-post*. We differ from Corsetti et al. (2014) however in that taxes used to stabilize the debt-to-GDP ratio bear on labor supply and are distortionary. Doing so is actually crucial to introduce a propagation mechanism from fiscal variables to the real economy. In our model, default risk has serious real consequences, even in absence of any actual default. Default risk raises equilibrium sovereign rates, lead debt to GDP and distortionary taxes to rise, with clear negative effects on output, consumption and investment.

First, the model is calibrated to the Euro Area and found to match key business cycle features quite well. Second, we proceed to the analysis of our model through the lens of a capital quality shock, as in Gertler and Karadi (2011). This analysis shows that our specific assumptions (two types of banks, an interbank market and sovereign default risk) play a crucial role in the quantitative response of the model after the shock. They act as strong amplifiers in comparison to Gertler and Karadi (2011) and increase the persistence of the response after the shock. Third, we mimic the effects of the Great Recession in the Euro Area differentiating Core and Periphery countries. We build on a joint capital quality shock, public spending shocks and default risk shocks. These ingredients are shown to reproduce particularly well the dynamics of output, debt to GDP and sovereign spreads in Core countries and in the Periphery. In particular, our simulations reproduce quite well the rise in public debt to GDP ratios at the beginning of the Great Recession, and the prolonged slump in countries of the Periphery. These countries are affected by a much larger default risk shock, which raises debt to GDP, labor income taxes and lowers output – or more precisely, delays output recovery. Fourth, we use this simulation as a benchmark, and investigate the effects of two alternative unconventional monetary policies in the spirit of Gertler and Karadi (2011): one that intermediates assets managed by saving banks – interbank loans and sovereign bonds – and one that intermediates assets managed by commercial banks – loans to capital producers. We find that the former is more efficient in stabilizing the economy than the latter, although both policies reduce significantly the welfare losses from the Great Recession.

The paper is organized as follows. Section 2 relates the paper to the literature. In Sections 3 and 4, we respectively describe the model and present the calibration. A business cycle matching exercise is proposed in Section 5. In Section 6, we perform simulation experiments, with or without unconventional monetary policies. Finally, Section 7 concludes.

2.2 Literature Review

There are very few studies on the joint frictions in the credit and sovereign markets. The existing studies about the role of banks in global economies pay little attention on sovereign debt problems. Devereux and Yetman (2010) study a two-country economy in which investors hold domestic and foreign assets but are exposed to leverage constraints. They find that if global financial markets are highly integrated, productivity shocks will be propagated through investors' financial portfolios, which will generate a strong output comovement. Mendoza and Quadrini (2010) build a two-country model with different degrees of financial development.

Their model analyzes the cross-country spillover effects of shocks to bank capital. Both Kollmann, Enders and Muller (2011) and Kalemli-Ozcan, Papaioannou and Perri (2013) consider a two-country environment with a global banking sector, their models generate synchronized business fluctuations across countries.

Our paper also relates to some of the recent literature on sovereign default or interbank markets.

For sovereign default risk, Guerrieri et al. (2012) build a two-country model calibrated to the Euro Area. They assume that partial sovereign default is exogenous and simulate the shock of partial sovereign default of 10% Periphery country's GDP. Their results show sizeable spillover effects of sovereign default from Periphery to the Core through the financial channel. Mendoza and Yue (2012) establish a general equilibrium model and explains the link between sovereign defaults and deep recessions which happened to small open economies. They show that sovereign default excludes the country from international credit market, which limits the country to get financing to buy imported intermediate goods from the international market. Bi (2012) implements sovereign default risk and bank runs into a baseline model derived from Gertler and Karadi (2011) and Gertler and Karadi (2013), and focuses on the interaction between sovereign default and domestic financial system. She finds that when bank run is possible, sovereign default risk is stagflationary and has dramatic and negative influence on domestic economy. van der Kwaak and van Wijnbergen (2014) integrate sovereign default risk and financial intermediaries building on Gertler and Karadi (2011), and study the interactions among bank rescues, sovereign risk, and financial fragility. They show that the maturity structure of government debt plays a crucial role in sovereign debt crisis. Bocola (2015) studies two channels through which sovereign default risk may hamper financial intermediaries: the liquidity channel and the risk channel. Calibrated to Italian data, his model shows that the risk channel is sizable. Due to the precautionary motive of banks, credit is actually not sensitive to Central Bank interventions.

Concerning the interbank market, Allen, Carletti and Gale (2009) build a theoretical model to analyze Central Bank's intervention on the interbank market. They show that there will be excessive price volatility on the interbank market when banks lack of opportunities to hedge liquidity shocks, and that the use of open market operations by the Central Bank helps stabilizing the short term interest rate. Dib (2010) proposes a micro-founded DSGE model that incorporates an interbank market. There are two banks that differ in terms of their liquidity requirement. The model is used to study the effects of conventional and unconventional monetary policies. Gertler and Kiyotaki (2010) develop a comprehensive model of the financial sector. They show that the net benefits from Central Bank's credit market interventions are increasing in the severity of the crisis. Focusing on systemic banking crisis, Boissay, Collard and Smets (2016) build a DSGE model with interbank market, explaining that moral hazard and asymmetric information may lead to financial crisis and deep recession during the period of credit boom.

On the policy side, Gertler and Karadi (2011) study the effect of unconventional monetary policy on the economy, where they assume that the Central Bank can lend directly to non-financial firms. They find that direct credit intervention can significantly mitigate the contraction caused by negative financial shocks. Stabilization may even be stronger when the Zero Lower Bound (ZLB) is binding. Gertler and Karadi (2013) extend the model developed in Gertler and Karadi (2011) to account for qualitative easing on the bond market. In this paper, they find that LSAPs (large-scale asset purchases) have more significant effects on the economy when the ZLB is binding. Dedola, Karadi and Lombardo (2012) build a two-country model with financial frictions as in Gertler and Karadi (2011). They show that under financial integration, unconventional policies aimed at stabilizing domestic conditions can have positive spillover effects on the foreign economy. Due to the lack of cooperation, in general, stabilization by one country will reduce the other country's incentive to intervene, which results in sub-optimal equilibrium credit policies. Takamura (2013) studies the influence of capital injections facing different shocks. He finds that capital injection is less efficient to counteract the effects of negative productivity shocks, but more efficient on financial shocks. Diniz and Guimaraes (2013) study the trade-off between sovereign debt restructuring and contractionary fiscal policy. By implementing government debt into a model based on Gertler and Karadi (2011) and calibrating it to the Euro Area, they show that losses from financial disruption caused by sovereign debt restructuring are offset by the benefits from less restrictive fiscal policies. Farhi and Tirole (2014) propose a "double-decker" bailout theory of the vicious spiral between sovereign debt and banking risks, that allows both for domestic banks bailouts by government and sovereign debt forgiveness by international lenders. Their theory provides implications for the sovereign debt re-nationalization, macro-prudential policies, as well as the rationale for a banking union.

So far, none of the mentioned contributions explores the impact of Central Bank's policy on sovereign default risk through the channel of the interbank market, which is the main focus of our analysis. Our paper integrates sovereign default risk, an integrated interbank market, and unconventional monetary policy interventions in an open-economy environment, and studies their joint interaction during a recession.

2.3 Model

Our model of financial intermediation is an extension of the Gertler and Karadi (2011) model with two types of banks: saving banks (s) that lend on the interbank market and borrowing banks (b) that borrow and grant loans to entrepreneurs. In addition to interbank loans, saving banks have access to additional assets (risky sovereign bonds) to compose their portfolios.

2.3.1 Saving Banks

There is a unit continuum of saving banks. The balance sheet of the representative saving banks is

a_t = Portfolio of assets	d_t = domestic deposits
	n_t^s = net worth

The portfolio of saving banks a_t is composed of interbank loans l_t^s, domestic debt b_t and foreign debt b_t^*, paying respectively r_t, the interbank market rate, $r_t^b(1-\chi_t)$ and $r_t^{b*}(1-\chi_t^*)$ the returns on government bonds between period $t-1$ and period t. Variables χ_t and χ_t^* are the potential hair-cuts applied by governments in cases of default. Following Coeurdacier and Martin (2009), the total amount of assets is obtained combining the three assets according to[1]

$$a_t = \left(\mu^{1/\varepsilon}\left(l_t^s\right)^{(\varepsilon-1)/\varepsilon} + \eta^{1/\varepsilon} b_t^{(\varepsilon-1)/\varepsilon} + (1-\mu-\eta)^{1/\varepsilon}\, b_t^{*(\varepsilon-1)/\varepsilon}\right)^{\varepsilon/(\varepsilon-1)} \tag{2.1}$$

The optimal allocation on the various assets is obtained minimizing total expenditure

$$a_t = E_t\left(q_{t+1}^s l_t^s + q_{t+1}^b b_t + q_{t+1}^{b*} b_t^*\right) \tag{2.2}$$

[1] Our approach is a quite simple attempt to rationalize the ad-hoc no-arbitrage conditions that would arise with a rougher approach to the bank balance sheet. Notice that with a very large value of the elasticity of substitution like the value that will be used in the calibration, both approaches deliver the same relation between the yields of the different assets according to which expected ex-ante returns are equalized.

for a given level of assets $\overline{a}$ subject to equation (2.1), where, defining r^a_{t+1} as the expected return on the portfolio, relative asset prices are given by

$$\begin{aligned} q^s_{t+1} &= r^a_{t+1}/r_{t+1} && (2.3)\\ q^b_{t+1} &= r^a_{t+1}/\left(r^b_{t+1}\left(1-\chi_{t+1}\right)\right) && (2.4)\\ q^{b*}_{t+1} &= r^a_{t+1}/\left(r^{b*}_{t+1}\left(1-\chi^*_{t+1}\right)\right) && (2.5)\end{aligned}$$

We get

$$\begin{aligned} l^s_t &= \mu E_t\left(r_{t+1}/r^a_{t+1}\right)^{\varepsilon} a_t && (2.6)\\ b_t &= \eta E_t\left(r^b_{t+1}\left(1-\chi_{t+1}\right)/r^a_{t+1}\right)^{\varepsilon} a_t && (2.7)\\ b^*_t &= \left(1-\mu-\eta\right) E_t\left(r^{b*}_{t+1}\left(1-\chi^*_{t+1}\right)/r^a_{t+1}\right)^{\varepsilon} a_t && (2.8)\end{aligned}$$

Once the asset-side of the balance sheet of savings bank has been determined, the balance sheet equation is

$$a_t = d_t + n^s_t \tag{2.9}$$

and savings banks' net worth evolves according to

$$n^s_{t+1} = r^a_{t+1}a_t - r^d_t d_t + T_t \tag{2.10}$$

where r^d_t is the deposit rate. In our model, as in Corsetti et al. (2014), default only matters *ex-ante* but not *ex-post*. Saving banks have access to insurance contracts and receive $T_t = r^b_{t+1}\chi_{t+1}b_t + r^{b*}_{t+1}\chi^*_{t+1}b^*_t$, covering their losses in case of sovereign default. Combining both equations gives the dynamics of the saving bank's net worth

$$n^s_{t+1} = \left(r^a_{t+1} - r^d_t\right)a_t + r^d_t n^s_t + T_t \tag{2.11}$$

The bank maximizes expected net worth given a fixed exit probability $(1-\sigma)$, in which event net worth is rebated to the households, and discounts future outcomes at the stochastic rate $\beta_{t+1} = \beta u_{c,t+1}/u_{c,t}$. We follow Gertler and Karadi (2011), conjecture v^s_t to be linear and assume

$$v^s_t = \gamma^a_t a_t + \gamma^s_t n^s_t \tag{2.12}$$

In addition, to prevent unlimited expansion of lending due to positive arbitrage opportunities, the representative saving bank may divert a fraction α^s of its assets. This possibility adds the following incentive constraint on saving bank's activities

$$v^s_t = \gamma^a_t a_t + \gamma^s_t n^s_t \geq \alpha^s a_t \tag{2.13}$$

which will be strictly binding in equilibrium. Let

$$\phi^s_t = a_t/n^s_t = \left(n^s_t + d_t\right)/n^s_t \tag{2.14}$$

be the leverage ratio of saving banks, the incentive constraint writes

$$v^s_t = \alpha^s\phi^s_t n^s_t \tag{2.15}$$

Saving banks optimization yields the following conditions for marginal values of arguments of the value function

$$\begin{aligned} \gamma^a_t &= E_t\left(\left(1-\sigma\right)\beta_{t+1}\left(r^a_{t+1} - r^d_t\right) + \sigma\beta_{t+1}\gamma^a_{t+1}\Omega^a_{t+1}\right) && (2.16)\\ \gamma^s_t &= E_t\left(\left(1-\sigma\right) + \sigma\beta_{t+1}\gamma^s_{t+1}\Omega^s_{t+1}\right) && (2.17)\end{aligned}$$

where $\Omega_t^s = n_t^s/n_{t-1}^s$ is the growth rate of net worth and $\Omega_t^a = a_t/a_{t-1}$ is the growth rate of intermediated assets, respectively evolving according to

$$\Omega_t^s = \left(r_t^a - r_{t-1}^d\right)\phi_{t-1}^s + r_{t-1}^d \tag{2.18}$$

$$\Omega_t^a = \left(\phi_t^s/\phi_{t-1}^s\right)\Omega_t^s \tag{2.19}$$

Using the expression of the value function finally allows to reformulate the binding incentive constraint as

$$\phi_t^s = \frac{\gamma_t^s}{\alpha^s - \gamma_t^a} \tag{2.20}$$

2.3.2 Commercial Banks

There is also a unit continuum of commercial banks. The representative bank borrows l_t^c from the interbank market, and accumulates net worth. On the asset side, it grants loans to the intermediate goods sector to purchase capital k_t at price q_t. Its balance sheet is thus

$q_t k_t$ = loans to the private sector	l_t^c = borrowing from the interbank market
	n_t^c = net worth

and the balance sheet equation is

$$q_t k_t = l_t^c + n_t^c \tag{2.21}$$

Net worth evolves according to

$$n_{t+1}^c = r_{t+1}^k q_t k_t - r_t l_t^c \tag{2.22}$$

where r_t^k is the return on capital. Combining both equations gives the dynamics of the representative commercial bank's net worth

$$n_{t+1}^c = \left(r_{t+1}^k - r_t\right) q_t k_t + r_t n_t^c \tag{2.23}$$

We also guess the form of its value function

$$v_t^c = \gamma_t^k q_t k_t + \gamma_t^c n_t^c \tag{2.24}$$

and let α^c be the fraction of the asset side that the commercial bank diverts. Its incentive constraint writes

$$v_t^c = \gamma_t^k q_t k_t + \gamma_t^c n_t^c \geq \alpha^c q_t k_t \tag{2.25}$$

and will be strictly binding in equilibrium. Letting

$$\phi_t^c = q_t k_t / n_t^c = \left(n_t^c + l_t^c\right)/n_t^c \tag{2.26}$$

be its leverage ratio, the incentive constraint writes

$$v_t^c = \alpha^c \phi_t^c n_t^c \tag{2.27}$$

Commercial banks optimization yields the following conditions for marginal values of arguments of the value function

$$\gamma_t^k = E_t\left(\left(1-\sigma\right)\beta_{t+1}\left(r_{t+1}^k - r_t\right) + \sigma\beta_{t+1}\gamma_{t+1}^k\Omega_{t+1}^k\right) \tag{2.28}$$

$$\gamma_t^c = E_t\left(\left(1-\sigma\right) + \sigma\beta_{t+1}\gamma_{t+1}^c\Omega_{t+1}^c\right) \tag{2.29}$$

where $\Omega_t^c = n_t^c/n_{t-1}^c$ is the growth rate of net worth and $\Omega_t^k = q_t k_t/q_{t-1}k_{t-1}$ is the growth rate of intermediated assets, respectively evolving according to

$$\Omega_t^c = \left(r_t^k - r_{t-1}\right)\phi_{t-1}^c + r_{t-1} \tag{2.30}$$

$$\Omega_t^k = \left(\phi_t^c/\phi_{t-1}^c\right)\Omega_t^c \tag{2.31}$$

reformulate the binding incentive constraint

$$\phi_t^c = \frac{\gamma_t^c}{\alpha^c - \gamma_t^k} \tag{2.32}$$

2.3.3 Intermediate and capital goods producers

Intermediate goods producers use effective capital $u_t k_{t-1}$ in the production process, where u_t is the variable utilization rate. They also hire labor in quantity n_t, that they combine to build the intermediate good, with the following production function

$$y_t^m = \varsigma_t \left(\xi_t u_t k_{t-1}\right)^{\iota} n_t^{1-\iota} \tag{2.33}$$

and sell intermediate goods at real relative price p_t^m. The installed (*i.e.* period $t-1$) effective capital stock can also be affected by a quality shock ξ_t as in Gertler and Karadi (2011). The optimizing conditions with respect to labor and utilization respectively give

$$p_t^m (1-\iota)\, y_t^m/n_t = w_t \tag{2.34}$$

$$p_t^m \iota y_t^m/u_t = \delta'(u_t)\,\xi_t k_{t-1} \tag{2.35}$$

where w_t is the real wage and where

$$\delta(u_t) = \delta + \overline{\delta}\left(u_t^{1+\kappa} - 1\right)/(1+\kappa) \tag{2.36}$$

is the time-varying depreciation rate. The zero-profit condition implies that intermediate goods producers pay the ex-post return on capital to the capital goods producers, *i.e.*

$$r_{t+1}^k = \left(p_{t+1}^m\left(\iota y_{t+1}^m/k_t\right) + q_{t+1}\xi_t\left(1-\delta(u_{t+1})\right)\right)/q_t \tag{2.37}$$

Capital goods producers buy the depreciated capital of intermediate goods producers and choose investment to accrue the total amount of available capital based on the evolution of its real price q_t.[2] Their profits write

$$E_t\sum_{s=0}^{\infty}\beta_{t+s}\left(q_{t+s}i_{t+s}\left(1-\left(\varphi^i/2\right)\left(i_{t+s}/i_{t+s-1}-1\right)^2\right) - i_{t+s}\right) \tag{2.40}$$

and optimization yields

$$q_t - 1 = q_t\varphi^i\left(x_t(1+x_t) + x_t^2/2\right) - E_t\left(\beta_{t+1}q_{t+1}\varphi^i x_{t+1}(1+x_{t+1})^2\right) \tag{2.41}$$

where $x_t = i_t/i_{t-1} - 1$. Given this optimizing condition for investment, the law of capital accumulation gives the dynamics of the capital stock

$$k_t - (1-\delta(u_t))\,\xi_t k_{t-1} = i_t\left(1-\left(\varphi^i/2\right)x_t^2\right) \tag{2.42}$$

[2] More formally, they maximize

$$E_t\sum_{s=0}^{\infty}\beta_{t+s,t+s+1}\left(q_{t+s}\left(k_{t+s} - (1-\delta(u_{t+s}))\,\xi_{t+s}k_{t+s-1}\right) - i_{t+s}\right) \tag{2.38}$$

subject to the law of motion of capital accumulation

$$k_t - (1-\delta(u_t))\,\xi_t k_{t-1} = i_t\left(1-\left(\varphi^i/2\right)\left(i_t/i_{t-1}-1\right)^2\right). \tag{2.39}$$

2.3.4 Final goods producers

Final goods producers j differentiate the intermediate good y_t^m in imperfectly substitutable varieties. The aggregate bundle of the final good and the corresponding aggregate price level are

$$y_t = \left[\int_0^1 y_t(j)^{\frac{\theta-1}{\theta}} dj\right]^{\frac{\theta}{\theta-1}}, \; p_t = \left[\int_0^1 p_t(j)^{1-\theta} dj\right]^{\frac{1}{1-\theta}} \tag{2.43}$$

Final goods producers take into account households demands $y_t(j) = (p_t(j)/p_t)^{-\theta} y_t$ when setting prices subject to Calvo price contracts of average length $1/(1-\gamma)$ with indexation to past inflation γ^p. The optimal pricing conditions are isomorphic to those found in Gertler and Karadi (2011).

2.3.5 Households

Households face a simple optimization problem as they choose consumption, labor supply and deposits maximizing lifetime welfare

$$E_t\left(\sum_{s=0}^{\infty} \beta^s u(c_{t+s}, n_{t+s})\right) \tag{2.44}$$

where $u_{n,t} \leq 0$ and $u_{c,t} \geq 0$ are the first-order partial derivatives with respect to hours worked and consumption, subject to the budget constraint

$$d_t + c_t = r_{t-1}^d d_{t-1} + (1-\tau_t) w_t n_t + \Pi_t \tag{2.45}$$

where d_t denote deposits to saving banks returning r_t^d between t and $t+1$, c_t is consumption, w_t denotes the real wage, τ_t a distortionary tax on labor income, n_t hours worked, and Π_t comprises monopolistic profits from final goods producers, and the net worth rebated by bankrupt banks, net from the starting fund allocated to new banks. First-order conditions give

$$E_t\left(\beta_{t+1} r_t^d\right) = 1 \tag{2.46}$$

$$u_{n,t} + (1-\tau_t) u_{c,t} w_t = 0 \tag{2.47}$$

2.3.6 Governments

We adopt the approach of sovereign default from Corsetti et al. (2014). Actual *ex post* default is neutral while the *ex ante* probability of default is the key for the pricing of government bonds, which has direct impacts on the interest rates, credit spreads, sustainability of the country's indebtedness, and GDP growth. As in the literature[3], we assume that the default risk follows a distribution that is non-linearly correlated to the country's debt-to-GDP ratio. Focusing on the domestic economy, the *ex ante* probability of default, p_t, at a certain level of sovereign indebtedness, $by_t = b_t^g/(4y_t)$, will be given by the cumulative distribution function of the beta distribution:

$$p_t = F_{beta}(by_t/by_{max}, \alpha_p, \beta_p) \tag{2.48}$$

where by_{max} denotes the upper end of the support for the debt to GDP ratio. Actual default occurs with probability p_t so that

$$\chi_t = \Delta \text{ if } \mathcal{B}(p_t) = 1 \tag{2.49}$$

$$\chi_t = 0 \text{ if } \mathcal{B}(p_t) = 0 \tag{2.50}$$

[3] For example, Eaton and Gersovitz (1981), Arellano (2008), Bi (2012), and Corsetti et al. (2014).

where $\mathcal{B}(p_t)$ is a Bernoulli. Given these assumptions, the budget constraint of the government writes

$$b_t^g = r_t^b (1 - \chi_t) b_{t-1}^g + g_t - \tau_t w_t n_t + T_t^b \tag{2.51}$$

Once again, potential losses from default are fully compensated, so that only *ex-ante* default risk matters. As a consequence

$$T_t^b = r_t^b \chi_t b_{t-1}^g \tag{2.52}$$

and the consolidated budget constraint writes

$$b_t^g = r_t^b b_{t-1}^g + g_t - \tau_t w_t n_t \tag{2.53}$$

The stability of public debt in the long run is granted by the following tax rule

$$\tau_t - \tau = \rho_\tau (\tau_{t-1} - \tau) + d_b (by_t - by) \tag{2.54}$$

Finally public spending evolve according to

$$\log(g_t) = \rho_g \log(g_{t-1}) + (1 - \rho_g)(log(g) - d_{gy} \log(y_t/y)) \tag{2.55}$$

Although actual default is not considered in our set-up, sovereign default risk has major real consequences. A rise in default risk raises the real sovereign rate r_t^b, leads to a rise in public debt that subsequently triggers a rise in the distortionary tax rate. As the latter goes up, hours worked, output, investment, asset prices and inflation collapse. So even in the absence of actual default, sovereign default risk can be a major driver of the dynamics of the economy.

2.3.7 Central bank

The Central Bank controls the nominal interest rate i_t^n. The relation between the nominal rate and national deposit rates is

$$i_t^n = r_t^d E_t(\pi_{t+1}) = r_t^{d*} E_t\left(\pi_{t+1}^*\right) \tag{2.56}$$

The Central Bank commits to the following policy rule

$$\log i_t^n = \rho_i \log i_{t-1}^n + (1 - \rho)(\log i^n + d_\pi \log \pi_t^u + d_y (\log y_t^u - \log \widetilde{y}_t^u)) \tag{2.57}$$

where π_t^u is the union-wide inflation rate and y_t^u the union-wide level of output, $\widetilde{y}_t^u$ being its natural level.[4]

2.3.8 Aggregation

Banking sector

At the end of the period, a fraction $1 - \sigma$ of each type of bankers will become households. Dividends are paid to households only when bankers exit. The net worth of continuing bankers is simply carried to the next period, so that aggregate continuing banks net worths evolve according to

$$n_t^{e,s} = \sigma \Omega_t^a n_{t-1}^s \tag{2.58}$$

$$n_t^{e,c} = \sigma \Omega_t^k n_{t-1}^c \tag{2.59}$$

[4] As in Gertler and Karadi (2011), variations in the union-wide mark-up will serve as a proxy for variations in the union-wide output gap.

In addition, households provide a starting net worth to new banks, equal to a fraction $\varphi^s/(1-\sigma)$ or $\varphi^c/(1-\sigma)$ of the total assets of old exiting bankers, so that the net worths of new banks are

$$n_t^{n,s} = \varphi^s a_{t-1} \tag{2.60}$$
$$n_t^{n,c} = \varphi^c \xi_t q_t k_{t-1} \tag{2.61}$$

Overall, aggregate net worths evolve according to

$$n_t^s = \sigma \Omega_t^a n_{t-1}^s + \varphi^s a_{t-1} \tag{2.62}$$
$$n_t^c = \sigma \Omega_t^k n_{t-1}^c + \varphi^c \xi_t q_t k_{t-1} \tag{2.63}$$

Goods markets

The clearing condition on the intermediate goods market is

$$y_t^m = \int_0^1 y_t(j)\,dj = y_t dp_t \tag{2.64}$$

where $dp_t = \int_0^1 (p_t(j)/p_t)^{-\theta} dj$ is the dispersion of prices. On the final goods market, the clearing condition simply writes

$$y_t = c_t + i_t + g_t \tag{2.65}$$

Financial markets

Given that the interbank market is unified within the monetary union, the market clearing condition is

$$l_t^s + \varrho l_t^{s*} = l_t^c + \varrho l_t^{c*} \tag{2.66}$$

where ϱ is the relative size of the foreign economy. This equation determines the interbank market rate. Finally, government bonds markets clearing conditions are

$$b_t^g = b_t + \varrho b_{*,t} \tag{2.67}$$
$$\varrho b_t^{g*} = \varrho b_t^* + b_{*,t}^* \tag{2.68}$$

where $b_{*,t}$ and $b_{*,t}^*$ are the holdings of domestic and foreign debt (respectively) from foreign savings banks.

2.4 Calibration

We calibrate the model to the Euro Area. The Periphery comprises Portugal, Italy, Greece and Spain while the Core is made of remaining members of the monetary union. The calibration follows Gertler and Karadi (2011) unless stated otherwise. The time unit is a quarter. The functional form of preferences is

$$u(c_t, n_t) = \log(c_t - hc_{t-1}) - \omega n_t^{1+\psi}/1+\psi$$

The discount factor is $\beta = 0.99$. The degree of habits in consumption is $h = 0.815$ and the inverse of the Frisch elasticity on labor supply is $\psi = 3$. This value is much larger than the value considered by Gertler and Karadi (2011) – they use 0.276 – but their calibration relates to the U.S. where the labor market is much more responsive than in the Euro Area.

On the production side, we follow Gertler and Karadi (2011). The share of effective capital is $\iota = 0.33$, the steady state depreciation rate is $\delta = 0.018$ (7% annually), and the elasticity of the marginal depreciation rate to utilization is $\kappa = 7.2$.[5] We impose a 1pp spread (in annual terms) over the risk-less rate for r^k in both regions, which pins down capital to output ratios. The investment adjustment cost parameter is $\varphi_i = 1.728$, Calvo parameters are $\gamma = 0.779$ and $\gamma^p = 0.241$ and the steady-state mark-up is 30%, implying $\theta = 4.33$.

On the monetary and fiscal policy side, we follow Corsetti et al. (2014) for the parameters of the default probability function and default size: $\alpha_p = 3.70$, $\beta_p = 0.54$, $by_{max} = 2.56$ and $\Delta = 0.55$. We assume standard Taylor rule parameters, *i.e.* $\rho_i = 0.8$, $d_\pi = 1.5$ and $d_y = 0.125$. We set the parameter in Equation (2.54) at $d_b = 0.05$ to ensure the stability of debt to GDP in the medium run. The persistence parameter in Equation (2.54) and parameters of the public spending rule (2.55) are set to match key business cycle moments (see next Section, Table 2.3). We obtain $\rho_\tau = 0.8789$, $\rho_g = 0.6757$ and $d_{gy} = 0.2182$ in the Core region, and $\rho_\tau = 0.8679$, $\rho_g = 0.8485$ and $d_{gy} = 0.1857$ in the Periphery.

In the banking sector, as explained in Appendix A, we impose steady-state leverage ratios $\phi^s = \phi^c = 2.5$ both for saving and commercial banks. This value is taken from ECB data for the aggregate balance sheet of Monetary and Financial Institutions (MFI excluding the Eurosystem). Assets that are not considered in the model are excluded from the data before computation. In addition, we choose not to impose heterogeneity in the banking sector, except for the home bias towards public debt in the portfolios of saving banks (see below for the calibration of these parameters). Further, still based on MFI data in 2008, we match the share of interbank loans over total assets of the banking system. The corresponding share of interbank loans in total assets of saving banks in the model is $\mu = 0.72$. Finally, we set the survival probability of bankers at $\sigma = 0.975$ and the elasticity of substitution between assets in the portfolio of saving banks at $\varepsilon = 1000$, implying that returns on interbank loans will almost perfectly follow returns on sovereign bonds net from expected losses due to default.

Remaining parameters are region-specific and are set based on computations from the data. Using OECD data for 2008, we build subgroup measures of hours worked and find $n = 0.2520$ for the Core region and $n = 0.3049$ for the Periphery. Proceeding similarly, we impose the share of public expenditure in GDP and the levels of public debt to GDP in each region: $s_g = 0.2080$ for the Core region and $s_g = 0.1924$ for the Periphery. Debt to GDP ratios are also imposed and we assume $b^g/(4y) = 0.6542$ in the Core area and $b^g/(4y) = 0.7718$ in the Periphery.[6] We also impose a higher productivity in the Core region, where we assume $\varsigma = 1.2$ while we set $\varsigma = 1$ in the Periphery. Steady-state labor income tax rates are adjusted to satisfy the budget balance of governments, implying $\tau = 0.4667$ in the Core region and $\tau = 0.4546$ in the Periphery. All variables are considered *per capita* but aggregate variables enter in the debt and interbank market clearing equations so we need to fix the relative size of regions. Based on relative GDPs, we normalize the relative size of the Periphery at $\varrho = 0.5959$.

In the banking sector, we apportion the steady-state holdings of government debt to Periphery and Core banks following Guerrieri et al. (2012). For the Core region, the share of domestic debt held by domestic agents reaches 81%, implying $\eta = 0.81\,(1-\mu) = 0.23$. The share of public debt issued in the Periphery that is held domestically is 60.5%, implying $\eta = 0.605\,(1-\mu) = 0.17$.

[5] Notice that $\overline{\delta}$ is adjusted for the steady-state optimal utilization rate equation to be consistent with the steady-state capital return equation.

[6] See Appendix B for details.

Table 2.1: Parameter values

Discount factor, β		0.99
Habit formation, h		0.815
Inverse of the Frisch elasticity, ψ		3
Steady state depreciation rate of capital, δ		0.018
Production function, capital parameter, ι		0.33
Steady state depreciation rate of capital, δ		0.018
Elasticity of the depreciation rate to utilization rate, κ		7.2
Private spreads, r^k/r^d		1.0025
Investment adjustment costs, φ_i		1.728
Calvo contracts parameter, γ		0.779
Indexation parameter, γ^p		0.241
Steady-state mark-up, $\theta/(\theta-1)$		1.3
Taylor rule parameter, ρ_i		0.8
Taylor rule parameter, d_π		1.5
Taylor rule parameter, d_y		0.125
Fiscal rule parameter, d_b		0.05
Default probability parameter, α_p		3.70
Default probability parameter, β_p		0.54
Default probability parameter, by_{max}		2.56
Default size, Δ		0.55
Savings banks leverage ratio, ϕ^s		2.5
Comm. banks leverage ratio, ϕ^s		2.5
Interbank lending to savings banks total assets, μ		0.72
Banker's survival probability, σ		0.975
Elasticity of subs. in the portfolio of saving banks, ε		1000
	Core	Peri.
Fraction of time spent working, n	0.2520	0.3049
Productivity scaling factor, ς	1.2000	1.0000
Government debt to annual GDP, $b^g/(4y)$	0.6542	0.7718
Labor income tax rate, τ	0.4667	0.4546
Tax rule persistence, ρ_τ	0.8789	0.8679
Public spending rule persistence, ρ_g	0.6757	0.8485
Public spending rule reaction to output, d_{gy}	0.2182	0.1857
Government spending to GDP, s_g	0.2080	0.1924
Relative size of the Periphery, ϱ	–	0.5492
Domestic debt to savings banks total assets, η	0.2300	0.1700

2.5 Business cycle moments

Before engaging in various simulation exercises, we first evaluate the ability of our model to generate realistic business cycle moments for a bunch of key variables. The model is fed with various shocks: productivity shocks, public spending shocks, capital quality shocks and monetary policy shocks. More precisely, we consider that ς_t and ξ_t follow AR(1) processes, and that the public spending rule (2.55) and the monetary policy rule (2.57) are affected by random shocks. The persistence and standard deviation of productivity shocks are set to 0.9 and 1% respectively in both countries. Other shock parameters (persistence and standard deviations) as well as parameters of the public spending rule (2.55) and persistence parameters of the tax rule (2.54) are estimated. We use the Simulated Method of Moments, where moments matched are those reported in Table 2.3 below. Table 2.2 reports the value of estimated parameters.

Table 2.2: Estimated parameter values for business cycle analysis

Persistence of productivity shocks, ρ_ς	0.9000	
Standard deviation of productivity shocks	0.0100	
Standard deviation of monetary policy shocks	0.0010	
	Core	Peri.
Tax rule persistence, ρ_τ	0.8789	0.8679
Public spending rule persistence, ρ_g	0.6757	0.8485
Public spending rule reaction to output, d_{gy}	0.2182	0.1857
Standard deviation of public spending shocks	0.0034	0.0068
Persistence of capital quality shocks, ρ_ξ	0.2019	0.9991
Standard deviation of capital quality shocks	0.0045	0.0005

Table 2.3 reports business cycle moments (standard deviations, autocorrelations and contemporaneous correlations with output) pertaining to quarterly GDP, private consumption, investment, public spending, private spreads (per quarter), loans, deposits, sovereign spreads (per quarter) and the debt to annual GDP ratio. Left panels report moments computed from the data and panels on the right report moments from our simulated model. Moments are calculated on HP-filtered time series from the data or generated by our (linearized) model with a smoothing parameter $\lambda = 1600$.[7]

Data suggest that output has a standard deviation around 1.3-1.4%, that consumption is less volatile than output, that investment is about two times more volatile than output and that public spending is less volatile than output. GDP components are quite persistent, with an average autocorrelation around 0.8-0.9. The main differences between the Core region and the Periphery are that consumption is smoother and public spending more countercyclical in the Core region. Private spreads exhibit little volatility, quite a large persistence and are countercyclical. They are more volatile and slightly more persistent in the Periphery than in the Core region. Loans and deposits are 2 to 3 times more volatile than output in both regions, moderately persistent (less than output, especially in the Periphery) and procyclical. Sovereign spreads exhibit very little volatility in the Core region, much more in the Periphery. They are persistent and countercyclical in both regions, and more persistent and countercyclical in the Periphery. Finally, debt to GDP ratios are quite volatile and strongly countercyclical.

Our model, driven by standard shocks, is able to reproduce almost all these features. In particular, public spending is more countercyclical in the Core region, owing to the larger

[7] Appendix B provides all the details about the data, how we treat them and how moments are computed.

Table 2.3: Business cycle moments

	Core region					
	Data			Model		
$x \downarrow$	$\sigma(x)$	$\rho(x)$	$\rho(x,y)$	$\sigma(x)$	$\rho(x)$	$\rho(x,y)$
Output	1.43	0.89	1.00	1.14	0.93	1.00
Consumption	0.37	0.77	0.78	0.67	0.95	0.70
Investment	2.07	0.90	0.94	5.26	0.94	0.92
Public spending	0.34	0.78	−0.41	0.38	0.62	−0.37
Private spread $\left(r^k_{t+1}/r^d_t\right)$	0.10	0.84	−0.25	0.17	0.72	−0.49
Loans $(q_t k_t)$	1.90	0.86	0.26	1.32	0.60	0.48
Deposits (d_t)	3.24	0.82	0.42	4.65	0.80	0.40
Sovereign spread (r^b_{t+1}/r_t)	0.03	0.84	−0.27	0.01	0.95	−0.61
Debt-to-GDP ratio (by_t)	2.86	0.88	−0.61	2.72	0.95	−0.60
	Periphery region					
	Data			Model		
$x \downarrow$	$\sigma(x)$	$\rho(x)$	$\rho(x,y)$	$\sigma(x)$	$\rho(x)$	$\rho(x,y)$
Output	1.31	0.88	1.00	1.40	0.93	1.00
Consumption	0.67	0.88	0.72	0.72	0.96	0.47
Investment	1.91	0.80	0.89	7.31	0.94	0.92
Public spending	0.62	0.54	−0.03	0.75	0.67	−0.02
Private spread $\left(r^k_{t+1}/r^d_t\right)$	0.17	0.88	−0.18	0.20	0.74	−0.60
Loans $(q_t k_t)$	1.78	0.79	0.41	1.23	0.48	0.41
Deposits (d_t)	1.89	0.54	0.03	3.94	0.83	0.04
Sovereign spread (r^b_{t+1}/r_t)	0.27	0.93	−0.58	0.03	0.95	−0.75
Debt-to-GDP ratio (by_t)	2.18	0.67	−0.53	3.05	0.95	−0.75

The standard deviations of output, private and sovereign spreads, and the debt to GDP ratio are in level, in percents. The standard deviations of consumption, investment, public spending, loans and deposits are expressed relative to the standard deviation of output. Core and Periphery aggregates are computed from the data as explained in Appendix B, which also contains details about data sources.

persistence of public spending in the Periphery, giving less weight to the countercyclical endogenous response of the public spending rule in this region. Investment is a bit too volatile. Private spreads are just a bit more volatile than in the data, almost as persistent and countercyclical. The business cycle behavior of loans and deposits is well matched, although persistence could be a bit higher, especially for loans. Sovereign spreads are countercyclical, and about three times more volatile in the Periphery than in the Core region. The level of sovereign spread volatility is relatively well matched in the Core region but should be larger in the Periphery. Last, the volatility of debt to GDP ratios generated by our model is well matched, the persistence is a bit too large and the correlation with GDP is a bit too negative.

Overall the model performs well in matching business cycle moments, and provides a good representation of the business cycle in the Euro Area.

2.6 Experiments

Various versions of the model are now simulated using a non-linear solution method over 500 periods under various assumptions. We first contrast the dynamics of the model (with constant public spending) after a capital quality shock with the dynamics produced by a standard two-country version of the Gertler and Karadi (2011) model. Then, we contrast the effects of the same capital quality shock on the Core and Periphery regions when public spending evolve as observed in the early quarters of the Great Recession. We also augment the dynamics with default risk shocks in both regions, calibrated to capture the rise in sovereign spreads observed in the data. We consider this simulation as our benchmark scenario, and produce two counterfactuals in which unconventional monetary policies (UMP) are conducted: (*i*) the Central Bank intermediates a fraction of the assets of saving banks and (*ii*) the Central Bank intermediates a fraction of the assets of commercial banks. Both cases are analyzed, compared to the benchmark, and the welfare effects of each type of UMPs are computed.

2.6.1 Capital quality shock

As in Gertler and Karadi (2011), we model the Great Recession as a negative and unexpected shock to the quality of the effective capital stock ξ_t. More precisely, we assume $\xi_t = (1 - \rho_\xi) + \rho_\xi \xi_{t-1} + s_{\xi,t}$ and feed the model with $s_{\xi,t} = -0.03$ assuming $\rho_\xi = 0.66$. The shock affects the quality of the capital stock of both regions, Core and Periphery. We compare our model with the one of Gertler and Karadi (2011), *i.e.* neglecting the saving banking sector and the default risk channel. In both cases, we assume $g_t = g$ instead of having the public spending rule (2.55) in place, hence restricting the reaction of governments to the implied economic downturn.

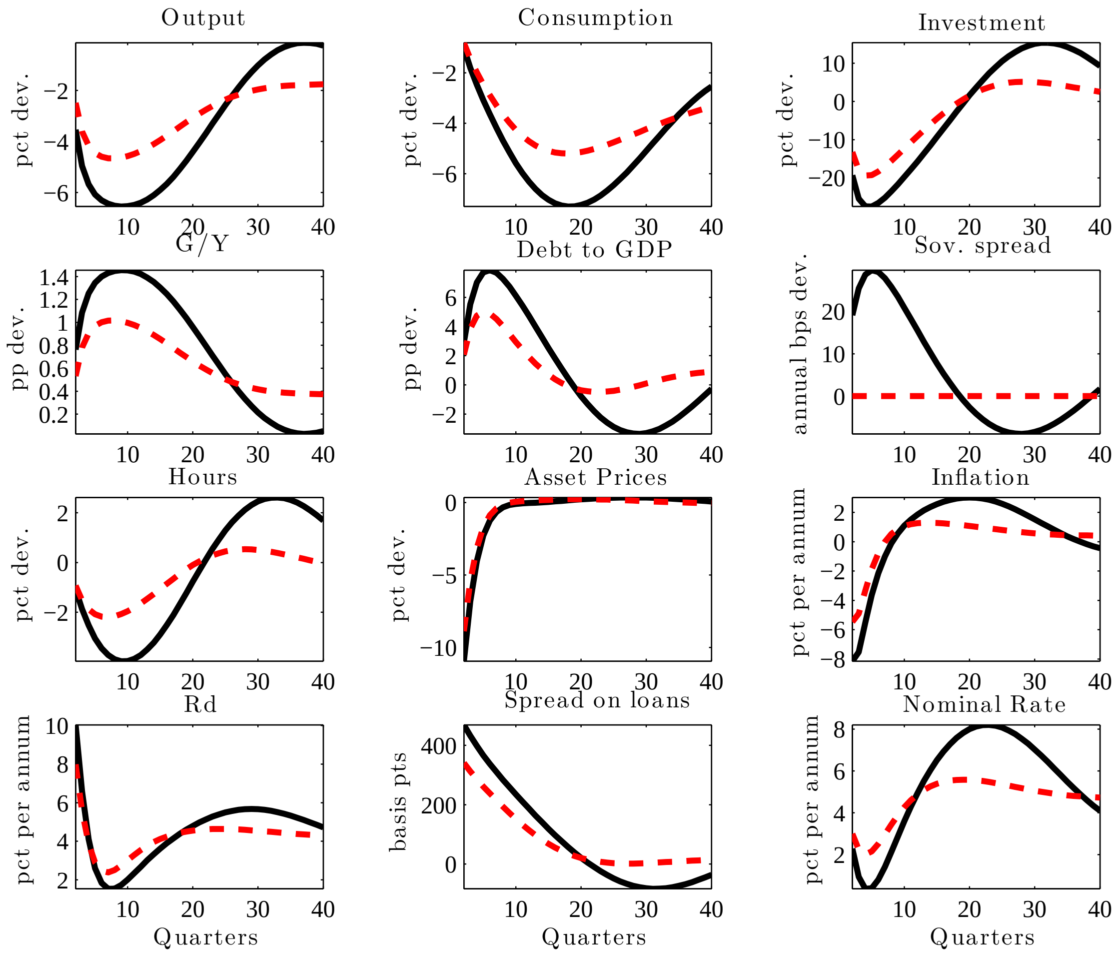
Basically, the two-country version of the model of Gertler and Karadi (2011) amounts to neglect equations that relate to saving banks and to consider that commercial banks use deposits directly – instead of interbank loans – to grant loans to capital producers. Consequently, the deposit rate enters in the first-order conditions of commercial banks and replaces the interbank rate. Further, the equilibrium of sovereign bonds markets is modified since savings banks do not buy them anymore. We thus assume that sovereign bonds are held by households and priced through a standard Euler equation. Finally, shutting down the sovereign default risk channel simply amounts to assume $p_t = \chi_t = 0$.

Figure 2.1 reports the dynamics of our baseline model and of the Gertler and Karadi (2011) model for the Core region.[8] Quantities are reported in percentage deviations from

[8] The dynamics for the Periphery region is qualitatively similar and therefore reported in Figure 2.5 in Appendix C.

their steady-state values, rates are reported in percent *per annum*, ratios in percentage point deviations and spreads in basis points deviations from their steady-state values.

Figure 2.1: Capital quality shock (Core region)



Black: baseline model, red: model of Gertler and Karadi (2011) with two-country

Figure 2.1 shows that our assumptions of heterogeneity in the banking sector (savings vs. commercial banks) and of sovereign default risk both act as amplifiers of the shock. As the shock generates a large economic downturn characterized by a large fall in GDP, debt to GDP rises, which in turn raises the default probability. Equilibrium on sovereign bonds markets requires that governments offer larger returns, which raises the interbank rate, and hence the rate at which commercial banks grant loans. The loan rate and the sovereign rate rise more than the deposit and the interbank rate respectively, leading private and sovereign spreads to increase significantly. Compared to Gertler and Karadi (2011), our model generates a much larger fall in GDP, consumption and private investment, hence a larger rise in public spending to GDP and debt to GDP. Private spreads are magnified due to the sovereign risk / banks feedback loop.

2.6.2 Great Recession

We investigate the dynamics of our model when both countries are hit by the same capital quality shock but feed the model with additional driving forces to replicate the Great Recession. We consider that time zero is the last quarter of 2007 and that the capital quality shock hits the economy in the first quarter of 2008. We then feed the model with the "observed" dynamics of public spending from 2008Q1 to 2013Q4 and with default risk shocks calibrated to match the observed sovereign spreads. What we have in mind is the differentiated effects of the Great Recession in countries of the Core region and in countries of the Periphery depending on the adjustment of public spending chosen by governments and on the default risk perceived by investors on financial markets.

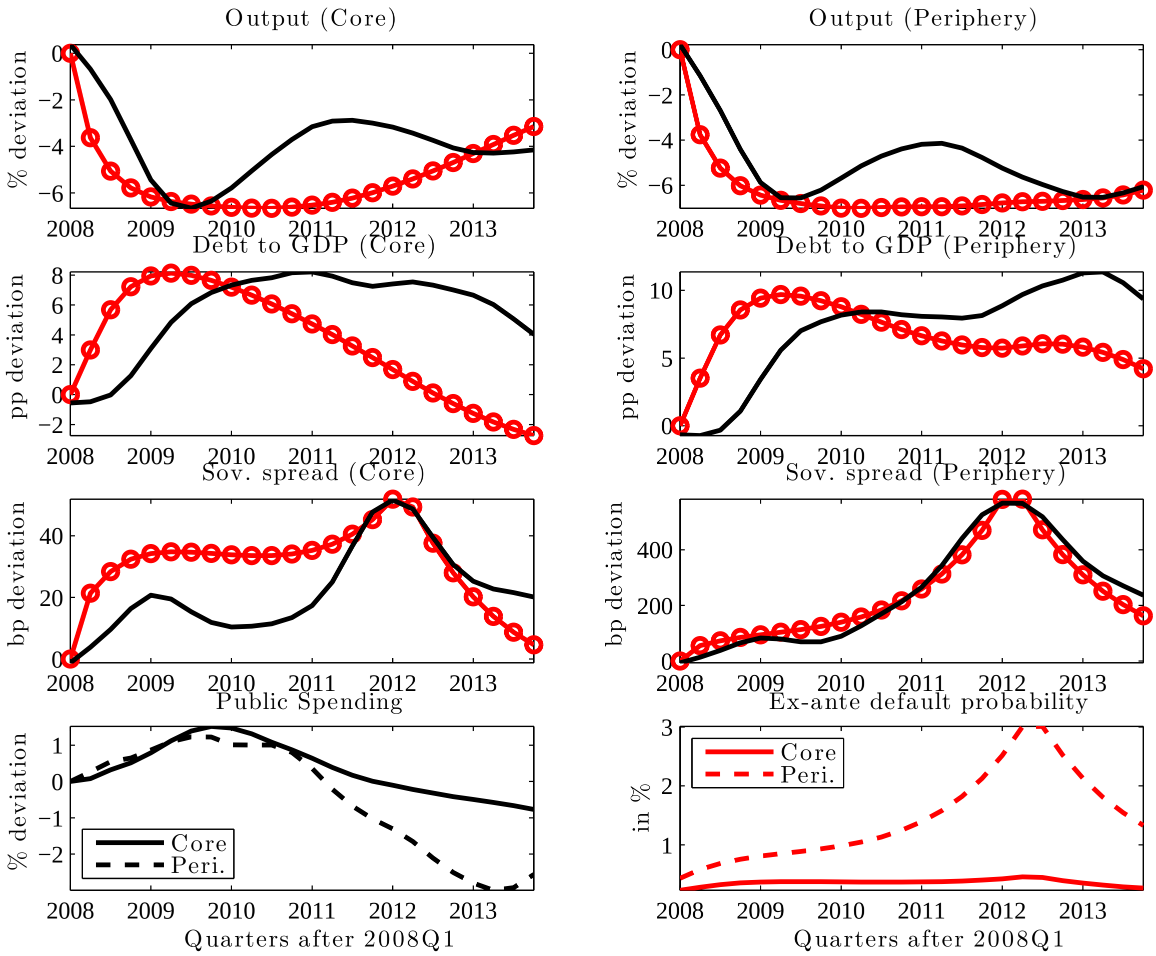
The "observed" path of public spending is computed from the data as follows. We take the log of public spending quarterly time series (for the Core and for the Periphery) and detrend them using an HP-filter with $\lambda = 10000$. We want to remove the trend, but we also want to prevent the filter from absorbing too much of the effects of the Great Recession. The resulting time series are then smoothed with an HP-filter with a very low value ($\lambda = 1.5$) to remove unimportant high frequency movements. Finally, series are normalized to express log-deviations from their 2008Q1 values until 2013Q4, and are assumed to return smoothly to the steady state after 2013Q4 – assuming an AR(1) process with a 0.75 autoregressive parameter.

Default risk shocks are designed to match the dynamics of sovereign spreads and are computed from the data in the very same way than public spending. Looking at Core and Periphery sovereign spreads reveals that they peaked at the end of 2012. Before they peaked however, default risk was also present and rose progressively. In addition, the decrease in default risk, although rapid, was not immediate. We thus feed the model with a joint default risk shock that shares the very same features. The magnitude of the shock in the Core and Periphery regions is adjusted to match the level of the peak in 2012Q4.

The model is thus simulated with those three different shocks. The resulting dynamics of output, public debt and sovereign spreads are reported in Figure 2.2, and compared to their observed dynamics. The dynamics of output, public debt to GDP and sovereign spreads are computed from the data using the same method that was used to compute observed public spending time series.

The model replicates particularly well the dynamics of sovereign spreads – default risk shocks are calibrated to target this time series – and the dynamics of output as well. The size of the recession and its first dip are particularly well matched. The dynamics of public debts are also captured correctly. The size of the initial rise of public debt to GDP ratios is nicely reproduced, although the model-based increase is a bit too early compared to the data. The persistence of public debt predicted by our model is also a bit low as debt starts falling after a few quarters according to our model while it remains high in the data. The effects of default risk shocks are coming into play after 8 to 10 quarters. The rise in the perceived probability of default leads sovereign rates to rise in equilibrium – even in absence of any actual default – which raises the debt to GDP ratio and forces governments to raise taxes through the tax rule, especially in the Periphery where the shock is much larger. This rise in distortionary taxes then depresses the economy and leads GDP to remain quite low for an additional bunch of quarters. The much larger rise of default risk in the Periphery significantly extends the length of the Great Recession, exactly as in the data. It also leads to an additional rise in the debt to GDP ratio, that is observed in the data as well. Overall, our model fed with a capital quality shock and country-specific public spending and default risk shocks performs well in replicating the macroeconomic dynamics observed during the Great Recession in European countries.

Figure 2.2: Great Recession experiment



Black: data, Red: model

2.6.3 Unconventional monetary policies

We investigate two counterfactual scenarios where the Central Bank of the monetary union implements UMPs. In the first scenario, the Central Bank intermediates a fraction of the assets held by saving banks, *i.e.* a fraction of their portfolios. This policy does more than just lowering interbank market rates by increasing the supply of interbank liquidity, and should also contribute to relieve sovereign default risk. In the second scenario, the Central Bank intermediates a fraction of the total assets of commercial banks, *i.e.* grants loans directly to the capital producers. In both cases, we follow Gertler and Karadi (2011) in their formulation of interventions. The Central Bank issues bonds to intermediate bank assets. These bonds are either purchased by households – and considered perfect substitutes to deposits when the policy intermediates saving banks assets – or by the Central Bank directly – and considered perfect substitutes to interbank loans when the policy intermediates commercial banks assets. Finally, UMPs induce a small efficiency loss expressed in units of output and proportional to the total amount of assets intermediated by the Central Bank (we set it to 0.1% of intermediated assets).

We consider a symmetric implementation of the policy in period 1 while asymmetric implementation is investigated in the welfare analysis. In the data, UMPs represented between 0.7% of Euro Area GDP in the form of interbank liquidity for the ECB after the default of Lehman Brothers to more than 9.4% of U.S. GDP in mortgage-backed securities when the FED implemented its QE1 program. We choose a figure somewhere in between and assume that the Central Bank intermediates an amount of assets that represents 5 percents of the pre-crisis annual GDP. This amount of intermediated assets then decreases slowly over time according to an AR(1) process with persistence 0.9. Consequently the total amount of assets intermediated is only 8% of the initial amount after 24 quarters. Figure 2.3 below reports the effects of each type of UMP in the Core region. It also plots the dynamics without these interventions for comparison. Figure 2.4 reports the dynamics of the Periphery.

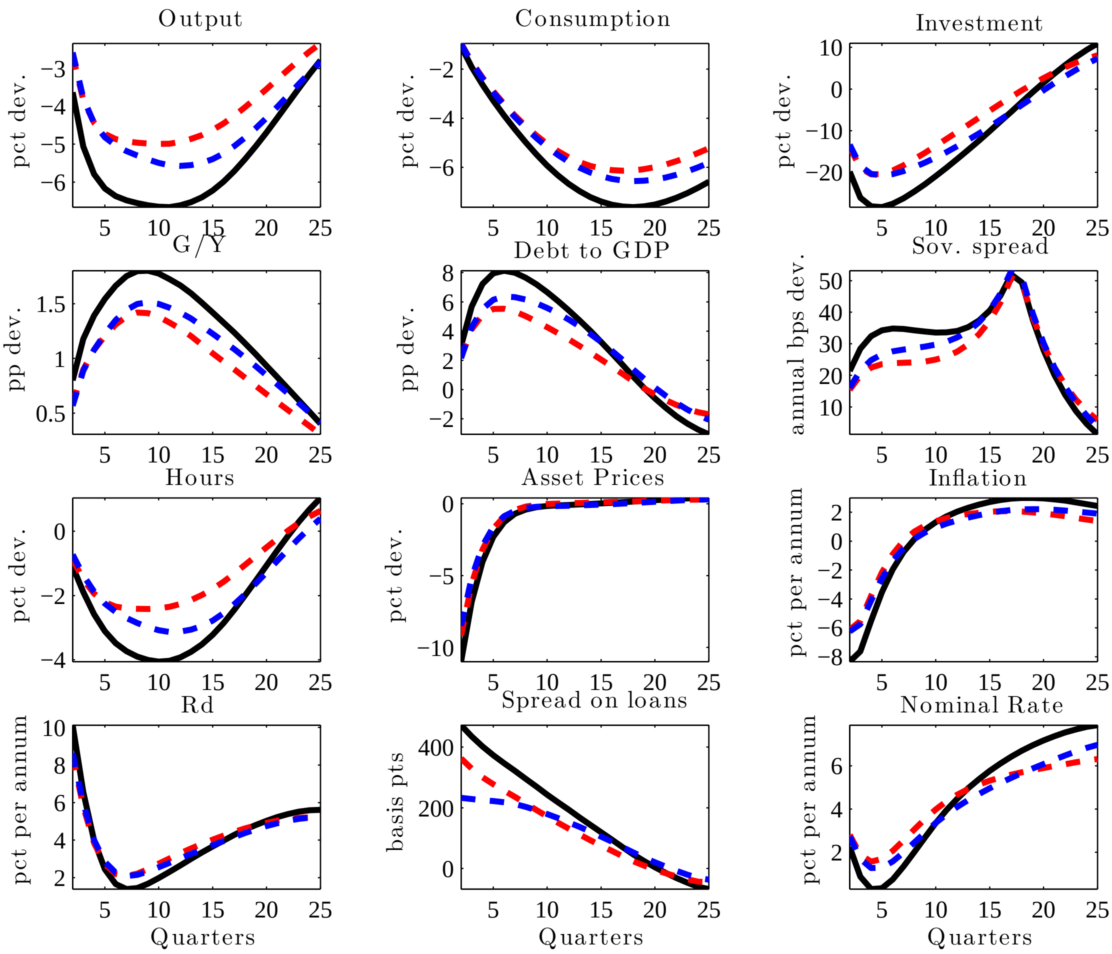
Figure 2.3 and 2.4 show that both policies limit the fall in output, consumption, investment, limit the rise in public spending to GDP and debt to GDP, the rise in sovereign and private spreads, and the fall of hours worked and asset prices. However, both policies are not fully equivalent. The most efficient intervention in terms of output stabilization is the UMP targeted at saving banks. It leads to a smoother path for almost all variables. Only asset prices and private spreads are better stabilized under the UMP targeted at commercial banks.

The reasons behind these differences are twofold. First, the UMP targeted at saving banks operates at an earlier stage of the supply of funds in the economy, thereby affecting jointly the returns on interbank loans and the returns on loans granted to capital producers. The reverse is not true, as interventions targeted at commercial banks do not feed back to saving banks directly. Second, distortionary taxes make interventions that stabilize sovereign spreads more desirable, as a stabilized sovereign spreads imply lower debt-to-GDP ratios, lower distortionary taxes and then higher levels of GDP, consumption and investment.

What are the welfare effects of these policies? To address this question, the specific welfare criterion is the constant percentage of consumption that the representative household would be ready to pay that leaves it indifferent between a particular path of the economy and the original path where the economy remains at its initial steady state, namely the value of ζ that solves:

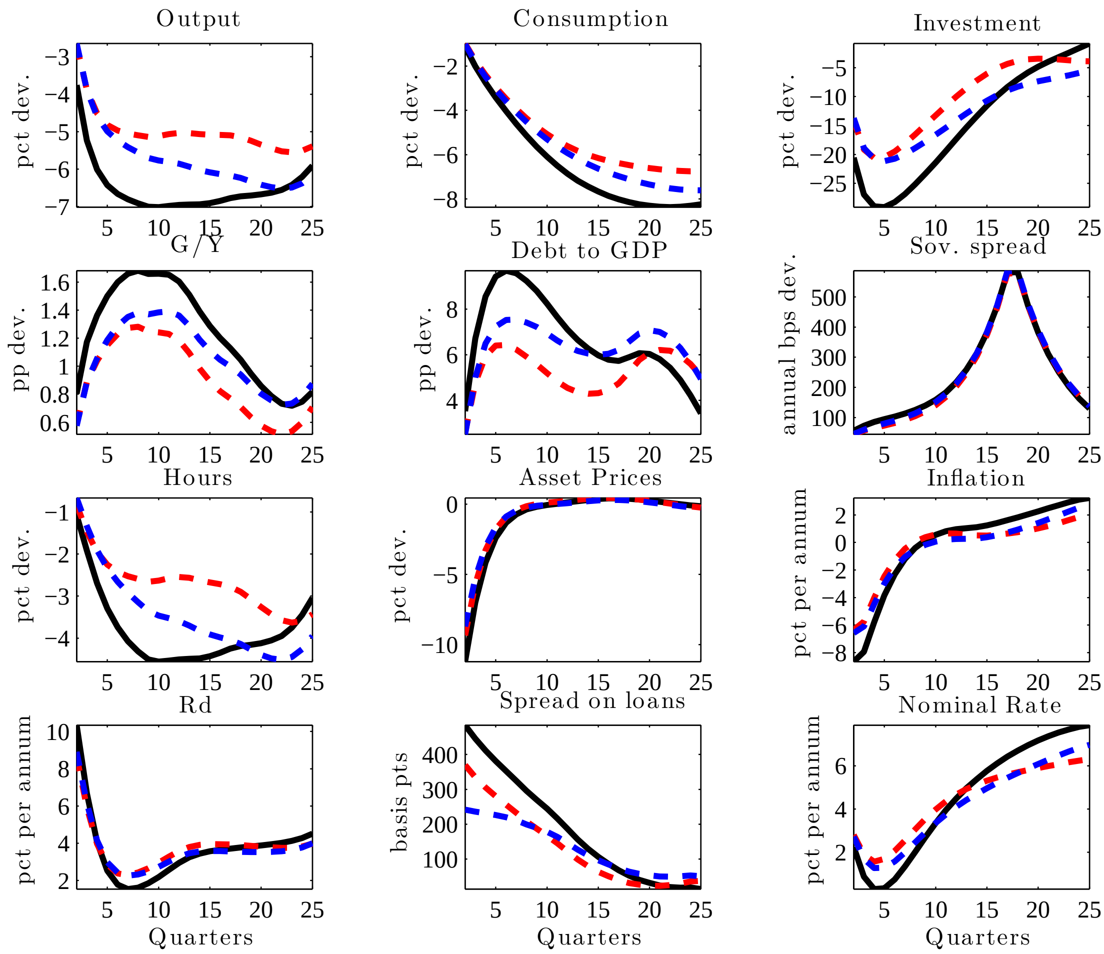
$$\sum_{t=0}^{J} \beta^t u\left(c_t\left(1-\zeta\right), n_t\right)\right) = u(c,n) \sum_{t=0}^{J} \beta^t. \tag{2.69}$$

Figure 2.3: Great Recession with UMP in the Core



Black: no UMP, Red: UMP targeted at savings banks, Blue: UMP targeted at commercial banks

Figure 2.4: Great Recession with UMP in the Periphery



Black: no UMP, Red: UMP targeted at savings banks, Blue: UMP targeted at commercial banks

Table 2.4 below provides a quantification of the welfare effects of the Great Recession at various horizons J, as well as an evaluation of what welfare losses would have been if UMPs had been implemented, at the same horizons. As a robustness check, we also contrast the effects of an asymmetric implementation of each type of policy, either in the Core region or in the Periphery.

Table 2.4: The welfare losses of the Great Recession without and with UMPs, in % of permanent consumption

	NO QE	QE Savings banks			QE Commercial banks		
		Joint	Core	Peri.	Joint	Core	Peri.
↓ Horizon				Core			
4	5.22	4.71	4.85	4.99	4.84	4.98	5.04
16	6.37	5.54	5.79	6.03	5.61	5.71	6.24
40	5.73	4.81	5.09	5.36	5.08	5.12	5.67
∞	2.45	2.15	2.24	2.33	2.23	2.26	2.42
↓ Horizon				Periphery			
4	5.47	4.84	5.00	5.20	5.07	5.10	5.37
16	6.48	5.53	5.80	6.09	5.72	6.15	5.98
40	6.37	5.36	5.66	5.97	5.81	6.18	5.95
∞	2.71	2.39	2.48	2.58	2.53	2.63	2.59

Joint means that the UMP is implemented in both countries at the same time. Core or Peri. means that the UMP is implemented asymmetrically in either the Core region or the Periphery.

Table 2.4 shows that the welfare losses from the Great Recession without UMPs are massive. At the horizon of 4 quarters, they reach 5.22% of consumption equivalent in the Core region and 5.47% in the Periphery. In general, whatever the horizon considered, losses are larger in the Periphery. It comes from the fact that, with or without UMPs, the Great Recession is both deeper and more persistent in this region. Losses grow at the 16 quarters horizon but then start to fall as the effects of the Great Recession slowly vanish. In the infinite horizon case, our economies return to the steady state.[9] The level of welfare losses thus stabilizes to 2.45% in the Core region and 2.71% in the Periphery.

UMPs produce the expected effects as they lower quite significantly the size of welfare losses, at all horizons. The effects of joint UMPs are larger than those of asymmetric UMPs, something that was also expected. Table 2.4 confirms that UMPs targeted at saving banks, *i.e.* that jointly affect sovereign spreads and the returns of interbank loans, are more efficient in stabilizing the economies and produce larger reductions in welfare losses. Interestingly, policies implemented in the Core region only are more efficient than policies implemented in the Periphery only, although this effects is probably related to the scale of interventions. Interventions are tailored to deliver a total amount of assets intermediated by the Central Bank that represents 5% of GDP: an asymmetric implementation in the Core region, that has a larger intial level of GDP, results in a larger amount of intermediated assets.

What is also interesting is that asymmetric UMPs yield reductions in welfare losses for both regions. Because interbank markets are fully integrated and because saving banks hold both types of sovereign bonds, this is not fully surprising but has to be stressed. Once again, the spillovers from asymmetric UMPs are larger when UMPs are implemented in the Core region, and larger when UMPs are targeted at saving banks. Notice that none of the UMPs

[9] This assumption may not be verified in practice. To date, countries from the Periphery did not start going back to their pre-2008 level of output.

considered in our experiments leads one of the two regions of the monetary union to be worse off with UMPs than without.

While the above policies are not intended to mimic any of the actual policies implemented by the European Central Bank, they shed some light on the impact that should be expected from these policies. In particular, because our model is able to capture both "business as usual" features of the economy – business cycle moments, and unusual episodes – the Great Recession, we think it imbeds key characteristics of the European economy. In particular, the sovereign debt / banks / loans loop featured in our model suggests that unconventional policies targeted at the reduction of sovereign spreads are potentially quite efficient in stabilizing the economy and preventing a deepening of the effects of the Great Recession, or a new recession that would be specific to European countries. In this perspective, the scale and design of the recent QE program promoted by the ECB goes in the right direction.

2.7 Conclusion

This paper builds a two-country model of a monetary union with sovereign default risk, two types of banks and an interbank market. Properly calibrated, the model is able to reproduce most features of the business cycle of European countries and provides a reliable representation of the European economy. Fed with an exogenous financial shock, with public spending data and a properly calibrated default risk shock, our model also reproduces the dynamics of European countries during the Great Recession and after. This framework is then used to assess the welfare losses from the Great Recession and the – positive – effects of unconventional monetary policies. Among the experiments that are conducted, policies that intermediate a large fraction of saving banks assets and that are implemented jointly, deliver the largest reduction in the welfare losses from the Great Recession. This result suggests that the recent QE program proposed by the European Central Bank could have a significant and positive impact in terms of macroeconomic stabilization.

2.8 Appendix

2.8.1 Steady state

At the country level, the zero-inflation condition implies that the steady state markup is

$$\mathcal{M} = \frac{\theta}{\theta - 1} = 1/p^m \tag{2.70}$$

In addition, $\pi = 1$ also implies

$$1 + i = r^d = 1/\beta \tag{2.71}$$

The price of capital is $q = 1$ and investment growth is $x = 0$. We also impose the steady state value of hours worked n and normalize the exogenous variables values to $\varsigma_t = \varsigma$ and $\xi_t = \xi = 1$. We impose the levels r^k and deduce the value of capital to output ratios

$$k/y^m = \frac{\iota\,(1/\mathcal{M})}{r^k - (1-\delta)} \tag{2.72}$$

From the intermediate goods producers first-order conditions, the following steady-state relation holds between factor prices

$$w = \left(\varsigma\iota^{\iota}\,(1-\iota)^{1-\iota}\,(1/\mathcal{M})\left(r^k - (1-\delta)\right)^{\iota}\right)^{\frac{1}{1-\iota}} \tag{2.73}$$

which determines w. Output $y^m = y$ is then given by

$$y = nw/(1-\iota) \tag{2.74}$$

k and i by

$$k = \frac{\iota(1/\mathcal{M})}{r^k - (1-\delta)} y \tag{2.75}$$

$$i = \delta k \tag{2.76}$$

Consumption is given by

$$c = y(1-s_g) - \delta k \tag{2.77}$$

where $s_g = g/y$ is the imposed share of public spending in output. Given the utility function considered, $u_n = -\omega n^\psi$, where ψ is the inverse of the Frisch elasticity on labor supply, and $u_c = (1-\beta h)/(c(1-h))$. The labor supply equation

$$\omega n^{1/\psi} = w(1-\beta h)/c(1-h) \tag{2.78}$$

is then used to compute the adjusted labor disutility parameter ω that makes hours worked match our target.

As in Gertler and Karadi (2011), we also fix the value of leverage ratios and the survival rates of bankers, and adjust relevant parameters. Commercial banks net worths are given by

$$n^c = k/\phi^c \tag{2.79}$$

which using the definition of leverage ratios also pins down demands for loans on the interbank market

$$l^c = (\phi^c - 1) n^c \tag{2.80}$$

On the government side, we have

$$p = F_{beta}(by/by_{max}, \alpha_{b^g}, \beta_{b^g}) \tag{2.81}$$

$$\chi = p\Delta \tag{2.82}$$

$$t_g = s_g - (by)\left(1 - r^b\right) \tag{2.83}$$

where by is the debt to annual output ratio.

Combining interbank loan supplies with demands pins down the interbank market rate

$$r = \left(\frac{l^c + \varrho l^{c*}}{\mu(r^a)^{-\varepsilon} a + \varrho\mu^*(r^{a*})^{-\varepsilon} a^*}\right)^{1/\varepsilon} \tag{2.84}$$

where a and a^* remain undetermined for now. Similarly, sovereign rates are given by sovereign bonds market clearing conditions

$$r^b(1-\chi) = \left(\frac{b^g}{\eta(r^a)^{-\varepsilon} a + \varrho(1-\mu^*-\eta^*)(r^{a*})^{-\varepsilon} a^*}\right)^{1/\varepsilon} \tag{2.85}$$

$$r^{b*}(1-\chi^*) = \left(\frac{\varrho b^{g*}}{(1-\mu-\eta)(r^a)^{-\varepsilon} a + \varrho\eta^*(r^{a*})^{-\varepsilon} a^*}\right)^{1/\varepsilon} \tag{2.86}$$

where, again, a and a^* remain undetermined. Using these expressions to substitute in asset demands

$$l^s = \frac{l^c + \varrho l^{c*}}{1 + (\varrho\mu^*/\mu)\left(r^a/r^{a*}\right)^{\varepsilon}(a^*/a)} \quad (2.87)$$

$$b = \frac{b^g}{1 + (\varrho(1-\mu^*-\eta^*)/\eta)\left(r^a/r^{a*}\right)^{\varepsilon}(a^*/a)} \quad (2.88)$$

$$b^* = \frac{\varrho b^{g*}}{1 + (\varrho\eta^*/(1-\mu-\eta))\left(r^a/r^{a*}\right)^{\varepsilon}(a^*/a)} \quad (2.89)$$

pins down the total value of savings banks assets a and a^* using the portfolio equations

$$a = \left(\mu^{1/\varepsilon}(l^s)^{(\varepsilon-1)/\varepsilon} + \eta^{1/\varepsilon}b^{(\varepsilon-1)/\varepsilon} + (1-\mu-\eta)^{1/\varepsilon}b^{*(\varepsilon-1)/\varepsilon}\right)^{\varepsilon/(\varepsilon-1)} \quad (2.90)$$

$$a^* = \left(\mu^{*1/\varepsilon}(l^{s*})^{(\varepsilon-1)/\varepsilon} + \eta^{*1/\varepsilon}b_*^{*(\varepsilon-1)/\varepsilon} + (1-\mu^*-\eta^*)^{1/\varepsilon}b_*^{(\varepsilon-1)/\varepsilon}\right)^{\varepsilon/(\varepsilon-1)} \quad (2.91)$$

and its foreign counterpart once an assumption has been made about relative weights, relative returns on portfolios and relative total assets. Equilibrium interbank and sovereign rates are also pinned down once r^a has been imposed. Notice that we consider values of the elasticity of substitution ε that guarantee $r^k > r$, *i.e.* large values of ε.[10] When total intermediated assets of savings banks a are known, their net worth is

$$n^s = a/\phi^s \quad (2.92)$$

Finally, the values of φ^s and φ^c are given by

$$\varphi^s = \frac{1-\sigma\Omega^a}{\phi^s} \quad (2.93)$$

$$\varphi^c = \frac{1-\sigma\Omega^k}{\phi^c} \quad (2.94)$$

and the values of α^s and α^c by

$$\alpha^s = \frac{\gamma^s + \gamma^a\phi^s}{\phi^s} \quad (2.95)$$

$$\alpha^c = \frac{\gamma^c + \gamma^k\phi^c}{\phi^c} \quad (2.96)$$

2.8.2 Data

Calibration

The calibration matches 2008 measures. Data are taken from the OECD Main Economic Indicators (MEI) database and from the OECD employment and labor market statistics database.

- Hours worked are obtained multiplying hours worked per employee and the total number of employed persons in each sub-region (Core and Periphery). Taking the sum and dividing by total employment gives an average measure of hours worked in each sub-region, that is finally expressed as a percentage of total time awake.
- Using debt to annual GDP ratios for each country of the region, we build a measure of public debt to annual GDP in each sub-region (Core and Periphery).
- Using government expenditure on final goods and GDP measures, we build sub-region measures of public spending to GDP.

[10] Perfect asset substitutability requires $\varepsilon \to \infty$.

Business cycle moments

- GDP, private consumption expenditure on final goods, total gross fixed capital formation government consumption expenditure on final goods are taken from the OECD Economic outlook database. Aggregates are volume measures at market prices and the data ranges from 1999Q1 to 2013Q4. Business cycle moments are computed as follows. Series are taken in logs, HP-filtered using a smoothing parameter $\lambda = 1600$ before moments are calculated. The standard deviation of GDP is expressed in absolute terms, the standard deviations of consumption, investment and public spending are expressed relative to the standard deviation of GDP.

- Private spreads are computed from CDS quotes on 5Y private bonds and are taken from Markit. The sample includes 51 firms from the Core region, and 8 firms from the periphery, on a monthly frequency from 2005M4 to 2015M4. We do not have monthly data for GDP (to compute the correlation of private spreads with GDP), and we use the industrial production index from the OECD MEI database. Sub-region indices for CDS are simply averaged. Sub-region industrial production indices are build using 2008 GDP weights. Since the dataset is monthly, we compute business cycle moments using a smoothing parameter $\lambda = 100000$. Standard deviations of private spreads are reported in absolute terms.

- Loans and deposits are taken from the OECD Non-consolidated financial balance sheets by economic sectors. We consider the sum of all sectors. Loans correspond to the items labelled "loans" reported at the asset side of balance sheets, and deposits correspond to the items labelled "deposits" reported at the liability side of balance sheets. The dataset is quarterly and ranges from 1999Q1 to 2013Q4. Amounts are expressed in nominal terms so GDP deflators are used to make them real. Loans and deposits are taken in logs before HP-filtering the series using a smoothing parameter $\lambda = 1600$. Standard deviations are expressed relative to the standard deviation of GDP.

- Sovereign rates per annum are taken from the International Financial Statistics database. We consider long-term rates, *i.e.* rates on 10-years government bonds. The dataset covers the period from 1999Q1 to 2013Q4. We build sub-region measures of sovereign rates using time-varying GDP weights, and compute the spread with the German rate before filtering the time series and computing business cycle moments. Standard deviations of sovereign spreads are reported in absolute terms.

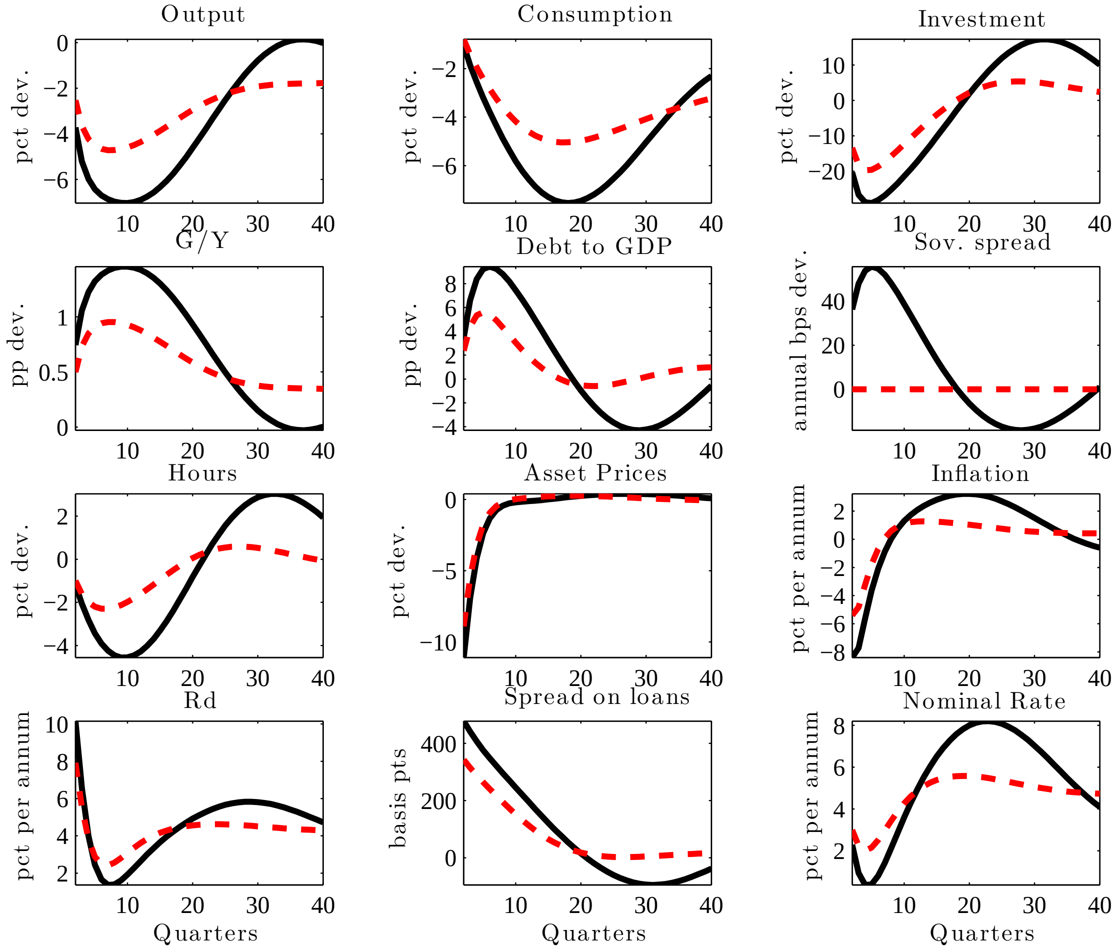
- Public debt to GDP ratios are taken from the OECD Public Sector Debt database. The ratios express general government gross debts, as percentages of annual GDPs. The series are quarterly and range from 2000Q1 to 2013Q4. Sub-region ratios are computed based on time-varying GDP weights before HP-filtering the data and computing business cycle moments. Standard deviations of the ratios are reported in absolute terms.

Simulations

Simulations use sub-region (Core and Periphery) measures of GDP, public spending, debt to annual GDP ratios and sovereign spreads. The dataset is build using the same methodology as in the business cycle section but data are filtered differently. Time series are detrended using an HP-filter with $\lambda = 10000$, a much higher value than in the business cycle section. We do not want the filter to absorb too much of the effects of the Great Recession. The resulting time series are then smoothed with an HP-filter with a very low value ($\lambda = 1.5$) to remove unimportant high frequency movements. Times series are then considered in deviation or log-deviation from their 2008Q1 values to capture the effects of the Great Recession. Hence data range from 2008Q1 to 2013Q4 in the simulations.

2.8.3 Additional figures

Figure 2.5: Capital quality shock (Periphery region). Solid: Baseline model, dotted red: model of Gertler and Karadi (2011).



Chapitre 3

Fiscal Devaluations in a Monetary Union with Endogenous Entry and Tradability

3.1 Introduction

Fiscal devaluations have recently attracted a lot of attention among policymakers of the Eurozone. The constraint on nominal exchange rates imposed by monetary unification makes the reduction of external imbalances more difficult, which has become more problematic since the 2008 Great Recession and the subsequent Eurozone crisis. Fiscal devaluations – a rise in tax rates affecting the consumption of goods (typically VAT) along with a fall in labor income tax or payroll tax rates – have appeared as a potential cure. Portugal recently announced that a fiscal devaluation would be implemented. Some countries such as Denmark (in 1987), Germany (in 2007) or France (2012) already proceeded to shifts in the tax burden from labor income to consumption taxation. The effects expected from such policies are a reduction in labor costs, production costs and a change in the relative price of tradable goods, leading to an expenditure switching effect towards domestic goods that improves the trade balance, with positive effects on output and employment.

In this paper, we investigate the effects of fiscal devaluations on key macroeconomic aggregates and welfare using a two-country monetary-union model with endogenous varieties and endogenous tradability.[1] The model derives from Auray, Eyquem and Poutineau (2012) and Cacciatore and Ghironi (2014). As usual, endogenous tradability is introduced by a threshold condition on export profits. However, endogenous entry is introduced in a more intuitive way than Auray et al. (2012) and Cacciatore and Ghironi (2014), as it derives directly from profitability conditions on the domestic market, providing a more straightforward interpretation of the effects at work.[2] Carefully calibrated to countries of the Euro Area and driven by standard productivity and monetary policy shocks, the model successfully replicates a large set of business cycle moments. We thus use the model to account for the effects of fiscal devaluations engineered through a temporary rise in VAT and a fall in the payroll tax rate that keeps the government budget balanced.

The theoretical channels through which fiscal devaluations can affect the economy were recently studied by Farhi, Gopinath and Itskhoki (2014). They show that allocations implied by nominal exchange rate devaluations may be replicated under an extensive set of assumptions regardless of the size of the targeted devaluation, and provided governments have access

[1] The paper thus belongs to the open-economy literature with heterogeneous firms and/or endogenous tradability along the lines of Bergin and Glick (2009), Bergin and Lin (2012), Naknoi (2008), or Roriguez-Lopez (2011) among others.

[2] Auray et al. (2012) borrow from Ghironi and Melitz (2005) and assume that entry depends on financial conditions, as the value of firms' equity is arbitraged by households. Cacciatore and Ghironi (2014) consider that entry is based on a cost minimization by final goods producers. Our entry condition only depends on the perspectives of profits on the domestic market.

to a sufficiently large number of tax instruments. Hence, changes in the tax mix can help governments affect the terms of trade and real exchange rates within a monetary union, and may generate external re-balancing effects and a rise in GDP through exports and the rise of hours worked.[3] In line with the literature, we find that a unilateral fiscal devaluation boosts output, consumption, hours worked and exports while imports are depressed. Net exports are significantly improved in the short run. Our results thus comforts existing studies about the overall effects of fiscal devaluations.[4]

However, most papers focusing on the effects of fiscal devaluations or fiscal policy in open economies disregard the potential effects that fiscal devaluations might have on the patterns of trade, limiting their scope to the effects on the intensive margin of trade, *i.e.* expenditure switching and international wealth effects (see Bosca et al. (2013), Lipinska and von Thadden (2012) or Langot and Lemoine (2014)). Since Ghironi and Melitz (2005) however, we know that changes in terms of trade not only induce expenditure-switching or wealth effects, but also impact the number of traded varieties, altering the overall degree of trade openness in the economy.[5] Hence, any change in the taxation of goods and labor that affects terms of trade should translate into significant effects on the number of produced varieties and on the number of exported varieties. In this paper, we show that endogenous tradability magnifies the trade effects of fiscal devaluations, and is therefore an important transmission channel of such tax reforms. The reason is that a fiscal devaluation not only lowers the relative price of domestic exports but also leads to a rise in the number of traded varieties, that contributes to raise exports. An opposite effect is at work for foreign exports (domestic imports) that lowers the number of imported varieties and deepens the fall in imports resulting from a fiscal devaluation.

In addition, we uncover an important and undocumented transmission channel of fiscal devaluations that relies on business creation. Endogenous business creation and the introduction of new varieties of products has long been identified as an important source of economic fluctuations.[6] We show that allowing for endogenously produced varieties enhances the response of domestic output, investment, consumption and hours worked to a fiscal devaluation. Most importantly, this channel leads to a much larger rise in private consumption and hours worked in the domestic economy, and amplifies the fall in the real wage. Further, this assumption induces a positive transmission to the foreign economy (output in particular) while the transmission is negative when the number of produced varieties is held constant. The mechanism at work is quite simple to grasp: the joint fall in domestic and foreign real wages lowers entry thresholds and triggers additional entries in both countries.

Our contribution to this literature is twofold. First, we show that endogenous tradability strengthens quite significantly the effects of fiscal devaluations on trade flows and on the resulting dynamics of the trade balance. Second, we show that fiscal devaluations boost business creation through the entry of new firms because they produce significant downward

[3] Relatedly, Langot, Patureau and Sopraseuth (2014) analyze the optimal taxation scheme in an open economy with search labor market frictions.

[4] A recent study by the European Commission (2013) uses general equilibrium models to quantify the effects of fiscal devaluations and concludes that fiscal devaluations induce an expansion of employment and GDP, while the trade balance reacts positively in the short-run. Bosca, Domenech and Ferri (2013) develop a general equilibrium model of a small open economy with search and matching frictions calibrated to Spain. They show that a fiscal devaluation may be effective in stimulating output, hours worked and the trade balance. Engler, Ganelli, Tervala and Voigts (2014) propose a New-Keynesian model with Ricardian and Non-Ricardian households and sticky wages and find similar results.

[5] See also the recent contribution of Imura (2016).

[6] See Bilbiie, Ghironi and Melitz (2012) and references therein for the importance of business creation in closed economies and Auray and Eyquem (2011) in open economies.

pressures in both domestic and foreign real wages, a key factor in the profitability condition that determines the creation of new business in our model. These additional transmission channels are absent form usual open-economy models and play an important role in the dynamics of key macroeconomic aggregates and welfare gains and losses that result from fiscal devaluations.

We perform two types of sensitivity analyzes. The first one investigates the effects of pre-announcement of the fiscal devaluation on the implied economic dynamics and welfare gains/losses. The resulting adjustment patterns change radically the short-run dynamics and welfare effects of fiscal devaluations compared to unexpected reforms. The timing of announcement thus matters for the way welfare gains/losses materialize over time, and can be manipulated by policymakers. The second one perform a more sensitivity analysis indicating that our results are fairly robust to changes in key parameters.

The paper is organized as follows. Section 2 presents the model used to analyze fiscal devaluations. Section 3 presents the calibration of the model. Section 4 comments on the dynamics implied by fiscal devaluations whether they are unexpected or pre-announced. The welfare effects are also reported and analyzed. Section 5 concludes.

3.2 Model

As in Auray et al. (2012), we consider a model of endogenously produced and traded varieties along the lines of Ghironi and Melitz (2005), and incorporate sticky prices in the retail sector. However, as in Cacciatore and Ghironi (2014), we consider an intermediate sector producing goods that serve as inputs in the production of final goods, and that are used to pay entry and export costs. We depart from all those contributions in assuming more intuitive entry conditions, based on intertemporal profitability conditions on domestic and export markets. Fiscal policy instruments are the VAT and payroll tax rates and thus alter the conditions of production in the intermediate and final sectors with strong implications on entry in domestic and export markets, and with general equilibrium consequences.

3.2.1 Households

Each country is populated with a representative household. In the home country, the representative household maximizes a welfare index:[7]

$$\mathcal{W}_t = \mathrm{E}_t \left[\sum_{s=t}^{\infty} \beta^{s-t} u\left(c_s, \ell_s\right) \right] \tag{3.1}$$

subject to the budget constraint:

$$b_t + p_t\left(c_t + ac_{b,t}\right) = r_{t-1}b_{t-1} + w_t\ell_t + p_t\left(\kappa_t + \upsilon_t\right) - tax_t \tag{3.2}$$

and to the appropriate transversality conditions. In the above expressions, β is the subjective discount factor, c_t is the aggregate consumption bundle, ℓ_t is the quantity of labor supplied. Domestic households have access to a nominal bond issued in the monetary union in quantity b_t, that pays a risk-free nominal interest rate r_{t-1} between periods $t-1$ and t. Trading bonds requires the payment of adjustment costs $ac_{b,t} = \phi^b \left(b_t/p_t - b/p\right)^2/2$. Further, p_t denotes the CPI in the domestic country in period t, κ_t is the total amount of real profit received

[7]We do not describe in details relations characterizing the foreign economy. However, similar conditions hold.

from monopolistic final goods producers and υ_t the amount of real profits received from the retail sector. Variable tax_t is a lump-sum tax. In period t, the household determines the optimal consumption c_t, labor supply ℓ_t, and the amount of bonds b_t. Combining first-order conditions yields:

$$\mathrm{E}_t\left[\beta_{t,t+1}\frac{r_t}{\pi_{t+1}\left(1+\phi^b\left(b_t/p_t-b/p\right)\right)}\right] = 1 \tag{3.3}$$

$$u_{\ell t}+u_{ct}w_t/p_t = 0 \tag{3.4}$$

where $\beta_{t,t+1}=\beta u_{ct+1}/u_{ct}$ is an adjusted discount factor and where $\pi_t=p_t/p_{t-1}$ is the CPI inflation rate. The first condition is the Euler condition on bonds and the second is the labor supply equation. Aggregate consumption is a bundle of the different local varieties ω of retail goods:

$$c_t=\left(\int_0^1 c_t\left(\omega\right)^{\frac{\eta-1}{\eta}}d\omega\right)^{\frac{\eta}{\eta-1}} \tag{3.5}$$

and the corresponding CPI is

$$p_t=\left(\int_0^1 p_t\left(\omega\right)^{1-\eta}d\omega\right)^{\frac{1}{1-\eta}} \tag{3.6}$$

which produces the following demand functions

$$c_t\left(\omega\right)=\left(\frac{p_t\left(\omega\right)}{p_t}\right)^{-\eta}c_t \tag{3.7}$$

Bond adjustment costs $ac_{b,t}$ and public spending g_t are also expressed in units of this bundle and add-up to total demand.

3.2.2 Firms

The retail sector aggregates n_t domestic varieties and $n_{x,t}^*$ foreign varieties according to

$$y_t\left(\omega\right)=\left(\int_0^{n_t} y_{d,t}\left(z,\omega\right)^{\frac{\theta-1}{\theta}}dz+\int_0^{n_{x,t}^*} y_{x,t}^*\left(z,\omega\right)^{\frac{\theta-1}{\theta}}dz\right)^{\frac{\theta}{\theta-1}} \tag{3.8}$$

where $\theta>1$ is the elasticity of substitution between different varieties.[8] The nominal marginal cost attached to this bundle is:

$$mc_t\left(\omega\right)=mc_t=\left(\int_0^{n_t} p_{d,t}\left(z\right)^{1-\theta}dz+\int_0^{n_{x,t}^*} p_{x,t}^*\left(z\right)^{1-\theta}dz\right)^{\frac{1}{1-\theta}} \tag{3.9}$$

where $p_{d,t}\left(z\right)$ is the price of domestic varieties and $p_{x,t}^*\left(z\right)$ the domestic price of imported varieties. Optimal good demands respectively from domestic and foreign retailers are

$$y_{d,t}\left(z,\omega\right) = \left(\frac{p_{d,t}\left(z\right)}{mc_t}\right)^{-\theta}y_t\left(\omega\right)\text{ and }y_{x,t}^*\left(z,\omega\right)=\left(\frac{p_{x,t}^*\left(z\right)}{mc_t}\right)^{-\theta}y_t\left(\omega\right) \tag{3.10}$$

$$y_{d,t}^*\left(z,\omega\right) = \left(\frac{p_{d,t}^*\left(z\right)}{mc_t^*}\right)^{-\theta}y_t^*\left(\omega\right)\text{ and }y_{x,t}\left(z,\omega\right)=\left(\frac{p_{x,t}\left(z\right)}{mc_t^*}\right)^{-\theta}y_t^*\left(\omega\right) \tag{3.11}$$

[8] As will become clear in the next section, n_t varieties are produced in the domestic (resp. n_t^* in the foreign economy) and only a subset $n_{x,t}$ (resp. $n_{x,t}^*$) of the total number of varieties is actually traded.

Each variety of retail good ω is sold at price $p_t(\omega)$ subject to Rotemberg adjustment costs. Optimal pricing thus solves

$$\underset{p_t(\omega)}{Max}\mathrm{E}_t \sum_{s=t}^{\infty} \beta_{t,s} \left(p_s(\omega) y_s(\omega) \left(1 - \phi \left(p_s(\omega)/p_{s-1}(\omega) - 1\right)^2/2\right) - mc_s y_s(\omega)\right), \phi \geq 0 \quad (3.12)$$

at time t to the demand functions given by Eq. (3.7), which gives

$$(\eta - 1)\left(1 - \phi(\pi_t - 1)^2/2\right) + \phi\left(\pi_t(\pi_t - 1) - \mathrm{E}_t\left[\beta_{t,t+1}\pi_{t+1}(\pi_{t+1} - 1) y_{t+1}/y_t\right]\right) = \eta mc_t^r \quad (3.13)$$

where $mc_t^r = mc_t/p_t$ is the real marginal cost in the retail sector.

The production sector is made of intermediate goods producers and final goods producers. In the intermediate sector, a unit mass of producers use labor to produce an intermediate input that they sell competitively. Their production function is

$$x_t = a_t \ell_t \quad (3.14)$$

where the total factor productivity a_t evolves as $\log a_t = \rho_a \log a_{t-1} + \epsilon_t^a$. The CPI-based real marginal cost φ_t at which intermediate output is sold is

$$\varphi_t = \frac{(1 + \tau_{\ell t})(w_t/p_t)}{a_t} \quad (3.15)$$

as hiring units of labor incurs the payment of a payroll tax $\tau_{\ell t}$.

In the final good sector, there is a continuum of heterogeneous firms that differentiate intermediate goods. The sector allows for endogenous entry and endogenous tradability. Over the entire space of potential varieties, only a subset will actually be created and commercialized. Firms have specific random productivity draws z that remain fixed once firms have been created. Variety creation incurs a once and for all sunk cost f_e, paid in units of intermediate goods. At each period t, there are two types of firms: n_t firms that are already productive at the beginning of the period and $n_{e,t}$ firms that are newly created – but nonproductive yet – within the period. At the end of the period a fraction $\delta \in [0, 1]$ of all existing firms is exogenously affected by an exit shock. The total number of varieties thus evolves according to:

$$n_t = (1 - \delta)(n_{t-1} + n_{e,t-1}) \quad (3.16)$$

Among the firms created, only the most productive address the export market. Entry in the export market is subject to a repeated payment of a cost f_x, also paid in units of intermediate goods, and incurs the payment of iceberg melting costs τ.[9] So firms need to be productive enough to cover the entry and transportation costs. Firm-specific productivity z has a Pareto distribution with lower bound $z_{\min}$ and shape parameter $\varepsilon > \theta - 1$. The probability density function of z is $g(z) = \varepsilon z_{\min}^{\varepsilon}/z^{\varepsilon+1}$ and the cumulative density function is $G(z) = 1 - (z_{\min}/z)^{\varepsilon}$. Over the total number of potential firms only a subset will actually be created and their number will be

$$n_t = (1 - G(z_{d,t})) = (z_{\min}/z_{d,t})^{\varepsilon} \quad (3.17)$$

where $z_{d,t}$ will be determined by a free-entry condition. In addition, among the total number of firms addressing the local market, the number of exporting firms $n_{x,t}$ will be those that are productive enough to cover the additional various export costs and their number is:

$$n_{x,t} = 1 - G(z_{x,t}) = (z_{\min}/z_{x,t})^{\varepsilon} \quad (3.18)$$

[9] Out of a quantity y produced and shipped, only $y/(1+\tau)$ actually arrive. Firms need to produce $(1+\tau)y$ to sell y.

where $z_{x,t}$ is the individual productivity of the cut-off exporting plant. Let $\kappa_t(z)$ denote the total current profits of a firm with productivity z and $\varphi_t(z)$ its specific production cost, defined as $\varphi_t(z) = \varphi_t/z$. Total current profits are composed of domestic profits $\kappa_{d,t}(z)$ and export profits $\kappa_{x,t}(z)$

$$\kappa_{d,t}(z) = \left(\frac{p_{d,t}(z)}{(1+\tau_{vt}) p_t} - \frac{\varphi_t}{z} \right) y_{d,t}(z) \tag{3.19}$$

$$\kappa_{x,t}(z) = \left(\frac{p_{x,t}(z)}{(1+\tau_{vt}^*) p_t} - \frac{(1+\tau)\varphi_t}{z} \right) y_{x,t}(z) - f_x \varphi_t \tag{3.20}$$

where τ_{vt} and τ_{vt}^* are respectively the domestic and foreign VAT rates.[10] Optimal pricing conditions are derived subject to the demand function given by Eqs. (3.10)-(3.11) and optimal prices imply

$$\rho_{d,t}(z) = \frac{p_{d,t}(z)}{p_t} = \mu(1+\tau_{vt}) \frac{\varphi_t}{z} \text{ and } \rho_{x,t}(z) = \frac{p_{x,t}(z)}{p_t^*} = (1+\tau)\mu(1+\tau_{vt}^*) \frac{\varphi_t}{q_t z} \tag{3.21}$$

where we have used the fact that $q_t = p_t^*/p_t$ is the real exchange rate and where $\mu = \theta/(\theta-1)$. Entry occurs one period before production can start and the productivity draw of the last firm is determined by a profitability condition. The entry productivity cut-off $z_{d,t}$ is obtained by equating the expected discounted sum of domestic profits (starting in $t+1$) of the last firm entering in period t, *i.e.* drawing its productivity level in t, to the initial entry cost paid in units of intermediate goods:

$$\mathrm{E}_t \left[\sum_{s=t+1}^{\infty} (\beta_{t,s}(1-\delta))^{s-t} \kappa_{d,s}(z_{d,t}) \right] = f_e \varphi_t \tag{3.22}$$

A recursive formulation combined with optimal pricing conditions gives

$$\mathrm{E}_t \left[\beta_{t,t+1}(1-\delta) \left(\left(\frac{1}{\theta(1+\tau_{vt+1})} \right)^{\theta} \left(\frac{\varphi_{t+1}}{(\theta-1) z_{d,t}} \right)^{1-\theta} y_{t+1} + f_e \varphi_{t+1} \right) \right] = f_e \varphi_t \tag{3.23}$$

This equation shows the determinants of firms entry. Higher entry (lower threshold $z_{d,t}$) occurs when current marginal costs are low, market size is large, when VAT is low and when current entry costs are low or expected discounted entry costs higher than current costs. Among the firms that produce, only the most productive can profitably enter the export market given that addressing the export market requires paying the iceberg melting cost and the repeated export costs. Hence the export productivity cut-off is $\kappa_{x,t}(z_{x,t}) = 0$ or, after using the optimal pricing conditions,

$$z_{x,t} = \frac{(1+\tau)}{(\theta-1)} \left(\frac{\theta(1+\tau_{vt}^*)\varphi_t}{q_t} \right)^{\frac{\theta}{\theta-1}} \left(\frac{f_x}{y_t^*} \right)^{\frac{1}{\theta-1}} \tag{3.24}$$

As in the case of firms' entry, the equation shed lights on the determinants of entry in the export market: low trade costs, low marginal costs, low fixed export costs, low foreign VAT and large foreign markets.

3.2.3 Aggregation, Governments and Monetary Policy

Let us first define the average productivity of firms addressing the domestic market as $\widetilde{z}_d = \nabla z_{d,t}$ where $\nabla = (\varepsilon/(\varepsilon-(\theta-1)))^{\frac{1}{\theta-1}}$ and the average productivity of firms addressing both markets as $\widetilde{z}_{x,t} = \triangledown z_{x,t}$.

[10] Notice that the foreign VAT rate applies to exports of domestic firms.

Average prices. Defining the average price of a domestic good as $\widetilde{\rho}_{d,t} = p_{d,t}\left(\widetilde{z}_{d,t}\right)/p_t$ and the average price of an exported good as $\widetilde{\rho}_{x,t} = p_{x,t}\left(\widetilde{z}_{x,t}\right)/p_t^*$, we obtain real average prices:

$$\widetilde{\rho}_{d,t} = \mu\left(1+\tau_{vt}\right)\varphi_t/\left(\bigtriangledown z_{d,t}\right) \text{ and } \widetilde{\rho}_{x,t} = \left(1+\tau\right)\mu\left(1+\tau_{vt}^*\right)\varphi_t/\left(q_t \bigtriangledown z_{x,t}\right) \tag{3.25}$$

where $q_t = p_t^*/p_t$ is the real exchange rate.

Variety effect. From the form of the marginal costs in the retail sector, we uncover the following variety effects:

$$n_t\widetilde{\rho}_{d,t}^{1-\theta} + n_{x,t}^*\widetilde{\rho}_{x,t}^{*1-\theta} = \left(mc_t^r\right)^{1-\theta}, \text{ and } n_t^*\widetilde{\rho}_{d,t}^{*1-\theta} + n_{x,t}\widetilde{\rho}_{x,t}^{1-\theta} = \left(mc_t^{r*}/p_t^*\right)^{1-\theta} \tag{3.26}$$

Goods market clearing. Intermediate goods serve as inputs of final goods producers. When final goods producers are more efficient they need less intermediate input to satisfy the demands from the domestic and foreign retail sectors. Further, the various entry costs are paid in intermediate goods. The market clearing condition is thus

$$a_t\ell_t = \left(\frac{mc_t^r}{\widetilde{\rho}_{d,t}}\right)^{\theta}\frac{n_t y_t}{\bigtriangledown z_{d,t}} + \left(1+\tau\right)\left(\frac{mc_t^{r*}}{\widetilde{\rho}_{x,t}}\right)^{\theta}\frac{n_{x,t}y_t^*}{\bigtriangledown z_{x,t}} + n_{e,t}f_e + n_{x,t}f_x \tag{3.27}$$

The market clearing condition for the final goods sector is

$$y_t^c = n_t\left(mc_t^r\right)^{\theta}\widetilde{\rho}_{d,t}^{1-\theta}y_t + n_{x,t}\left(mc_t^{r*}\right)^{\theta}\widetilde{\rho}_{x,t}^{1-\theta}y_t^* \tag{3.28}$$

Net foreign assets. Net foreign asset dynamics is obtained aggregating all budget constraints with market clearing conditions:

$$b_t^r - r_{t-1}b_{t-1}^r/\pi_t = q_t n_{x,t}\left(mc_t^{r*}\right)^{\theta}\widetilde{\rho}_{x,t}^{1-\theta}y_t^* - n_{x,t}^*\left(mc_t^r\right)^{\theta}\widetilde{\rho}_{x,t}^{*1-\theta}y_t \tag{3.29}$$

Inflation rates. Finally, using the definition of average prices, the dynamics of domestic and export goods inflation rates is given by

$$\pi_{d,t}/\pi_t = \widetilde{\rho}_{d,t}/\widetilde{\rho}_{d,t-1} \text{ and } \pi_{x,t}/\pi_t^* = \widetilde{\rho}_{x,t}/\widetilde{\rho}_{x,t-1} \tag{3.30}$$

Governments. Governments have a balanced budget every period. Distorsionary and lump-sum taxes exactly finance a constant provision of public expenditure $g_t = g$, expressed in units of final goods

$$\tau_{\ell t}\left(w_t/p_t\right)\ell_t + \left(\tau_{vt}/\left(1+\tau_{vt}\right)\right)\left(n_t\widetilde{\rho}_{d,t}^{1-\theta} + n_{x,t}^*\widetilde{\rho}_{x,t}^{*1-\theta}\right)\left(mc_t^r\right)^{\theta}y_t + tax_t = g \tag{3.31}$$

Monetary Policy. The common central bank controls the nominal interest rate, and commits to the following rule

$$\log\left(r_t/r\right) = \rho_r\log\left(r_{t-1}/r\right) + \left(1-\rho_r\right)\left(d_\pi\log\left(\widetilde{\pi}_t^u/\widetilde{\pi}^u\right) + d_y\log\left(\widetilde{y}_t^u/\widetilde{y}_{t-1}^u\right)\right) + \epsilon_t^r \tag{3.32}$$

where $\widetilde{\pi}_t^u = \widetilde{\pi}_t^{1/2}\widetilde{\pi}_t^{*1/2}$ is the union-wide average (data-consistent) inflation rate, $\widetilde{y}_t^u = \widetilde{y}_t^{1/2}\widetilde{y}_t^{*1/2}$ is the data-consistent output and ϵ_t^r is a monetary policy shock.[11]

3.3 Calibration

Table 3.1 reports the value of our calibrated parameters.

[11] In models with an extensive margin of activity and love for variety, the theoretical measures of price indices and macroeconomic aggregates do not have an empirical counterpart. They must therefore be adjusted to be consistent with the data. See Ghironi and Melitz (2005) and Appendix A for an extensive discussion.

Table 3.1: Parameter values.

Discount factor	$\beta = 0.99$
Risk-aversion	$\gamma = 2$
Consumption / leisure weight	χ adjusted to get $\overline{\ell} = 0.35$
Entry cost	f_e adjusted to get $n = 1$
Export cost	f_x adjusted to get $n_x/n = 0.2$
Exogenous death rate	$\delta = 0.025$
Elasticity of substitution between varieties of final goods	$\theta = 3.8$
Elasticity of substitution between varieties of retail goods	$\eta = 6$
Pareto curvature parameter	$\varepsilon = 4.87$
Price stickiness parameter	$\phi = 80$
Steady-state trade costs	$\tau = 0.10$
Portfolio adjustment costs on bonds	$\phi^b = 0.0007$
Steady-state VAT rate	$\tau_v = 0.15$
Steady-state payroll tax rate	$\tau_\ell = 0.3$
Nominal interest rate persistence	$\rho_r = 0.87$
Reaction to aggregate inflation	$d_\pi = 1.93$
Reaction to aggregate output growth	$d_y = 0.075$

Households. The calibration is identical in both countries. Target countries are those that belong to the Euro Area. The model is quarterly. The discount factor is $\beta = 0.99$. The utility function is:

$$u(c_t, \ell_t) = \frac{\left(c_t^\chi (1 - \ell_t)^{1-\chi}\right)^{1-\gamma}}{1 - \gamma} \tag{3.33}$$

The risk-aversion parameter is set to $\gamma = 2$ and the value of χ is adjusted to obtain a steady-state value of hours worked of $\overline{\ell} = 0.35$, in line with the share of hours worked in total awake time in Euro area countries according to OECD figures.

The production sector. The values of f_e and f_x are determined endogenously to match respectively the steady-state number of varieties n and the number of traded varieties n_x. Without loss of generality, we impose $n = 1$. Based on European data from the SDBS Database, firms' death rate is consistent with $\delta = 0.025$. Further, we follow Cacciatore, Fiori and Ghironi (2016) and calibrate the elasticity of substitution between varieties at $\theta = 3.8$. Incidentally, a value of $\theta = 3.8$ implies rather high steady state markups over marginal costs. However, given the presence of fixed costs, markups over average costs are in line with values found in the literature.[12] As in Cacciatore et al. (2016), the price stickiness parameter is set to $\phi = 80$.

The trade sector. Based on French data, Berman, Martin and Mayer (2012) report that the share of exporting firms is around 20%, implying $n_x/n = 0.2$. We impose this number in the steady state through an adjustment of the export cost f_x. Eaton, Kortum and Kramarz (2011) estimate Pareto parameters governing the distribution of french firms and their best estimate is $\varepsilon = 4.87$. We impose this precise value, and set $\tau = 0.1$, which yields a degree of intra-zone trade openness of 21%, close to the data. Our calibration implies that exporters are 39.16% more productive than non-exporters, and that domestic prices are 15.01% higher than export prices (including iceberg trade costs). Finally, as in Schmitt-Grohé and Uribe (2003), the international bond adjustment cost parameter is $\phi_b = 0.0007$.

Tax rates and monetary policy. Our analysis will be conducted through changes in the VAT rate and in the payroll tax rate. The steady-state VAT rate is $\tau_{vt} = 0.15$ and the

[12] See Bilbiie, Ghironi and Melitz (2008) for an extensive discussion.

steady-state payroll tax rate is $\tau_{\ell t} = 0.30$. Both figures match Euro Area averages. The share of public spending in final output is $s_g = 0.2$. Monetary policy parameters are calibrated after the values reported in Cacciatore et al. (2016): $\rho_r = 0.87$, $d_\pi = 1.93$ and $d_y = 0.075$.[13]

3.4 The effects of fiscal devaluations

3.4.1 Baseline case

We start our analysis with the effects of a temporary (8 quarters) unilateral increase in VAT $\Delta\tau_{vt} > 0$ raising fiscal revenues by 1 pp of ex-ante GDP together with a reduction in the payroll tax rate $\Delta\tau_{\ell t}$ that keeps the government budget balanced each period. The corresponding increase in VAT is 1.25 pp, that will translate into an approximate 2.5 pp fall in the payroll tax rate. As shown in Farhi et al. (2014), such a tax reform mimics the effects of a nominal exchange rate devaluation.

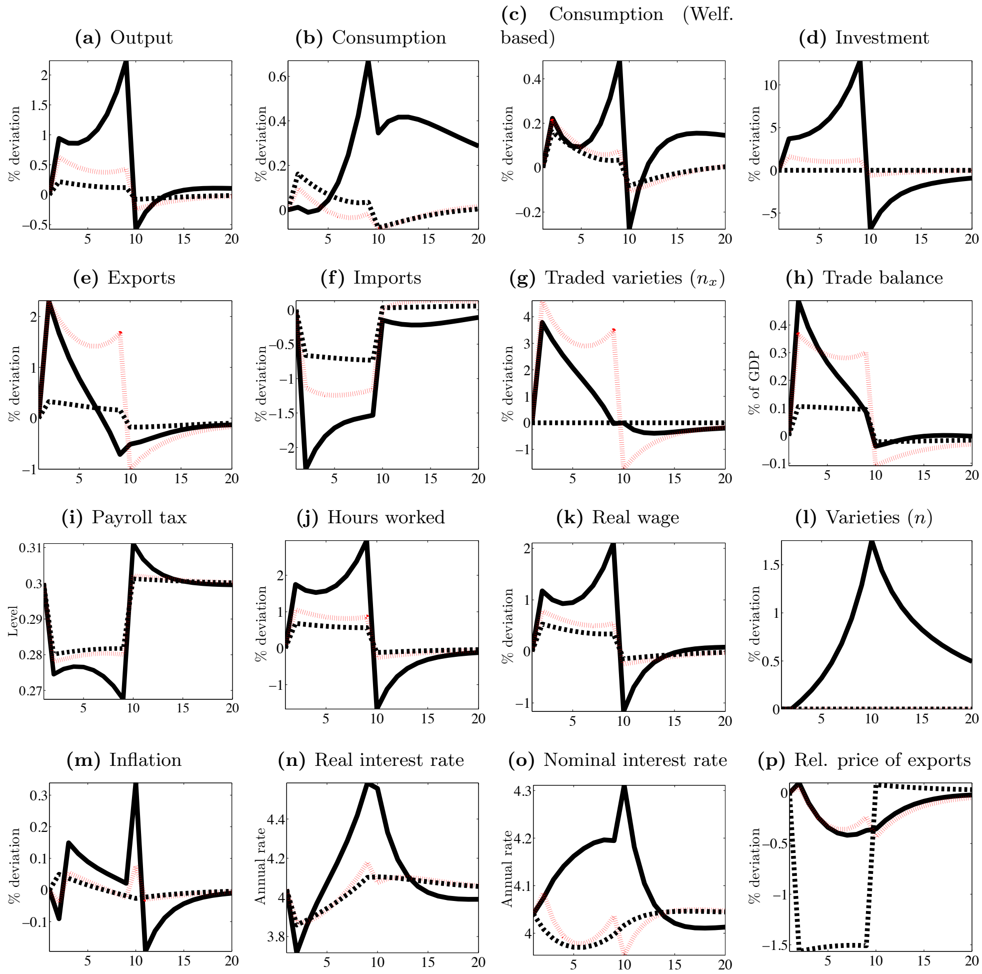
In Figures 3.1 and 3.2 below, we consider three alternative models: the baseline model, the model with a constant number of produced varieties and the model with constant produced and traded varieties. When the number of produced varieties is constant, Equation (3.23) and its foreign equivalent are replaced by $n_t = n_t^* = \overline{n} = 1$. When the number of traded varieties is constant, Equation (3.24) and its foreign equivalent are replaced by $n_{x,t} = n_{x,t}^* = \overline{n}_x = 0.2\overline{n}$.

In all cases, the model is solved under perfect foresight using a non-linear Newton-type algorithm with the set of parameter values reported in Table 3.1. We report mostly data-consistent variables in those graphs unless stated otherwise, as this is typically what policymakers would observe after such a policy change. Indeed, as explained in Ghironi and Melitz (2005), our simulated aggregates have to be deflated by a price index capturing the aggregate variety effect. Defining $p_t = (n_t + n_{x,t})^{\frac{1}{1-\theta}}\,\widetilde{p}_t$, real data-consistent variable x_t writes $x_t^r = p_t x_t / \widetilde{p}_t$, $\forall x$. In addition, average (data-consistent) inflation rates are defined as $\widetilde{\pi}_t = (p_t/p_{t-1})\,/\,(\widetilde{p}_t/\widetilde{p}_{t-1})$, and terms of trade as $\widetilde{q}_t = \widetilde{p}_t^*/\widetilde{p}_t$. However, the quantification of the impact on welfare will be conducted using welfare-based variables to capture accurately the potential benefits or losses from the perspective of households.

Let us start with the baseline model and focus on the domestic economy reported in Figure 3.1. The tax reform implies a rise in VAT and a fall in the payroll tax rate, with opposite effects on consumption. The rise in VAT increases the price of domestically produced goods as well as the price of imports, which tends to depress consumption. On the contrary, the fall in the payroll tax rate lowers the production cost which increases output and labor demand, pushing real wages up. The fall in the production cost fosters business creation (the extensive margin) while the rise of labor income potentially contributes to the intensive margin of consumption. Overall, welfare-based consumption goes up mostly due to the contribution of the extensive margin and data-consistent consumption (its intensive margin) is muted in the first periods before rising as well. The dynamics of varieties is interpreted through Equation (3.23). It shows that the reform has potentially opposite effects on firms' entry: the rise in VAT should depress business creation while the fall in the production cost and the rise in (welfare-based) domestic demand should push entries in the opposite direction. In equilibrium, after a fiscal devaluation, the second effect dominates and the total number of

[13] Appendix A shows that our calibration matches business cycle moments quite accurately. In particular, the volatility, persistence and cyclicality of gross and net trade flows at the business cycle frequency are remarkably well matched: the trade balance is counter-cyclical, imports are more strongly correlated with output than exports and both exports and imports are more volatile than output. The persistence of the real exchange rate is also well reproduced although as in Ghironi and Melitz (2005), its volatility is not correctly matched.

Figure 3.1: The home effects of a domestic fiscal devaluation



Solid black: baseline model, Dotted red: fixed n, Dashed black: fixed n and n_x. Variables are reported in a data-consistent manner unless specified otherwise.

varieties rises significantly, driving investment up as well. The net effect on output is positive because total demand (consumption plus investment in the creation of new firms) goes up.

Concerning the export sector, the trade reform has unambiguously positive effects. The relative price of exported goods falls and foreign demand grows, which boosts both the intensive margin and the extensive margin of exports. Imports fall dramatically because their relative price goes up very much and because the number of foreign exporters falls dramatically. The net effects on the trade balance are positive. The latter is improved by 0.5% of GDP on impact and tracks the dynamics of exports, that return to their steady-state value after 5 quarters. Quantitatively speaking, a fiscal devaluation raises output by 1% on impact, and by more than 2% after 8 quarters. It progressively increases (data-consistent) consumption from basically zero on impact to almost 0.7% after 8 quarters, and raises hours worked by 2% on impact and up to 2.5% after 8 quarters. The the real wage increases by 1% on impact and by around 2% after a few quarters. The number of firms goes up progressively and raises by more than 1.5%.

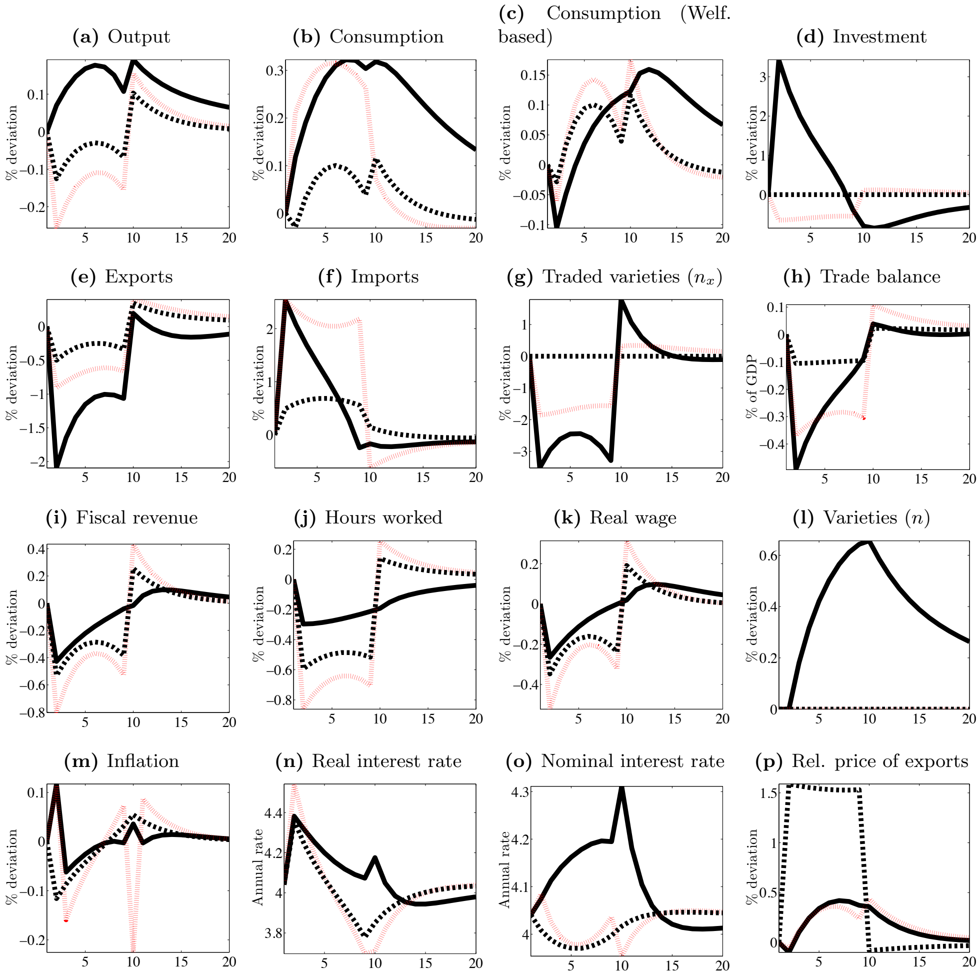
When the reform is undone after 8 quarters, there is a reversal in the dynamics of many variables. In particular, exports fall below their initial steady-state value – a 0.5% fall after the initial 2% rise – and imports return to the steady state. The trade surplus observed in the first periods thus turns into a trade deficit that represents less than 0.1% of GDP. The intensive margin of consumption slowly returns to the steady state after a gradual rise, and welfare-based consumption reverses down below its initial steady-state value. Varieties go back slowly to their steady-state value.

What are the differences with respect to alternative models? The most striking difference between the model with endogenous entry and models with constant varieties pertains to the dynamics of output, the real wage, hours worked, consumption and inflation. Allowing for endogenously produced varieties magnifies the response of these variables and leads, among other things, to a much larger rise in consumption and hours worked in the domestic economy. Allowing for endogenously traded varieties produces only minor differences in the key variables listed above but makes a significant difference in the dynamics of trade flows and trade balances. In particular, with a constant number of produced varieties and and endogenous tradability, the rise in exports and the associated improvement of the trade balance are both more persistent after a fiscal devaluation. However, the impact of this sustained improvement of the trade balance on GDP remains quite small compared to the contribution of consumption and investment when the number of produced varieties is endogenous. Overall, endogenously produced varieties make a much larger difference both quantitatively and qualitatively for the dynamics of key domestic variables after a fiscal devaluation. Endogenous tradability makes a smaller difference on those variables, but contributes to exaggerate the response of the trade sector.

In addition, the model with a constant number of produced varieties has radically different implications for the transmission to the foreign economy, in particular for the dynamics of GDP. The dynamics of foreign variables implied by our fiscal devaluation experiment are reported in Figure 3.2. Starting with our baseline model again, we find that a domestic fiscal devaluation generates a substantial and persistent increase in output (up to 0.2%). The relative price of foreign exports rises, which triggers an expenditure switching effect towards domestic goods in the short run. This negative supply shock is illustrated by a fall in foreign exports (that mimics the fall in domestic imports) and by a substantial fall in the number of exported varieties. In addition to these effects on trade, the negative supply shock reduces the foreign real wage along with foreign hours worked, inducing an indirect positive spillover: the entry threshold falls and tends to boost business creation. Hence, the domestic fiscal devaluation affects the foreign economy through a negative shock on the intensive margin but through a positive shock on the extensive margin. Indeed, while existing firms reduce the intensive margin, new firms enter the market, as shown by the rising dynamics of the total number of varieties. This rise is responsible for the persistent rise in output, consumption and of course investment. When the number of produced varieties is held constant, the dynamics of output are negative, the real wage falls more and drives hours worked further down. Consumption still goes up because the relative price of imports falls but a fiscal devaluation with a constant number of varieties has a negative effect on the productive sector of the foreign economy.

The above experiment shows that the assumptions of endogenous varieties and endogenous tradability crucially matter when investigating the effects of fiscal devaluations, as the domestic and foreign effects of such a tax reform are critically dependent on these assumptions.

Figure 3.2: The foreign effects of a domestic fiscal devaluation



Solid black: baseline model, Dotted red: fixed n, Dashed black: fixed n and n_x. Variables are reported in a data-consistent manner unless specified otherwise.

3.4.2 Welfare analysis

Given the above dynamics, what will be the welfare implications of the tax reform analyzed? We quantify the welfare gains by computing the Hicksian consumption equivalent that makes households indifferent between experiencing the reform and remaining at the initial steady state. This Hicksian equivalent is computed at different horizons, for the three models, whether the reform is implemented unilaterally or jointly. Its calculation is made using the utility function with simulated paths for welfare-based consumption and hours worked. The most relevant computation is the one that is made over an infinite horizon but the associated numbers should be small in all cases, since the reform is temporary and lasts only 8 quarters. In the short run, in the domestic economy, the tax reform raises hours worked and welfare-based consumption, a combination that yields unclear welfare effects. In the longer run, consumption remains above its steady-state value for quite some time while hours worked fall below their steady-state value, so the reform should generate welfare gains. In the foreign economy, the short-run and long-run welfare effects should be positive given the joint increase in consumption and fall in hours worked. How big are these welfare gains/losses? Do alternative models produce different welfare effects? What are the welfare effects of a joint reform?

Figure 3.3: Welfare effects of fiscal devaluations, in percents

	Baseline			Cst. n			Cst. n and n_x		
Horizon	H	F	Joint	H	F	Joint	H	F	Joint
1	−0.37	0.03	−0.24	−0.19	0.21	0.01	−0.11	0.15	0.02
4	−0.60	0.10	−0.39	−0.30	0.37	0.03	−0.19	0.27	0.04
8	−0.76	0.15	−0.55	−0.34	0.42	0.04	−0.23	0.31	0.04
32	−0.06	0.12	0.05	−0.08	0.10	0.02	−0.06	0.08	0.01
60	−0.01	0.06	0.05	−0.04	0.05	0.01	−0.03	0.04	0.01
∞	0.01	0.02	0.02	−0.01	0.02	0.00	−0.01	0.01	0.00

Note: A negative sign indicates a welfare loss.

Table 3.3 shows that a fiscal devaluation generates a 0.37% welfare loss for domestic households on impact and a small 0.03% gain for foreign households in our baseline model. After 8 quarters, the welfare effects are amplified both for domestic and foreign households. Over the medium run (32 quarters), the reform has long been undone – remember, in quarter 8 – but still affects households welfare. Undoing the reform generates an instantaneous welfare gain that contributes to lower the intertemporal contribution of the initial loss. Domestic households still endure a 0.06% welfare *loss* and foreign households experience a 0.12% welfare *gain* at this horizon. Taking into account the full transition path (∞ line of Table 3.3) delivers the true lifetime welfare impact of the reform. Its positive effects that go through the extensive margin of output and trade generate small welfare gains for everyone (0.01% in the home economy and 0.02% in the foreign economy). While these numbers might seem small, it should be recalled that the total welfare losses from business cycle fluctuations in this kind of models is rarely larger than 0.01% or 0.02% of consumption equivalent. So the welfare benefits from an 8-quarters temporary tax reform might be as large as the total welfare costs from business cycles.

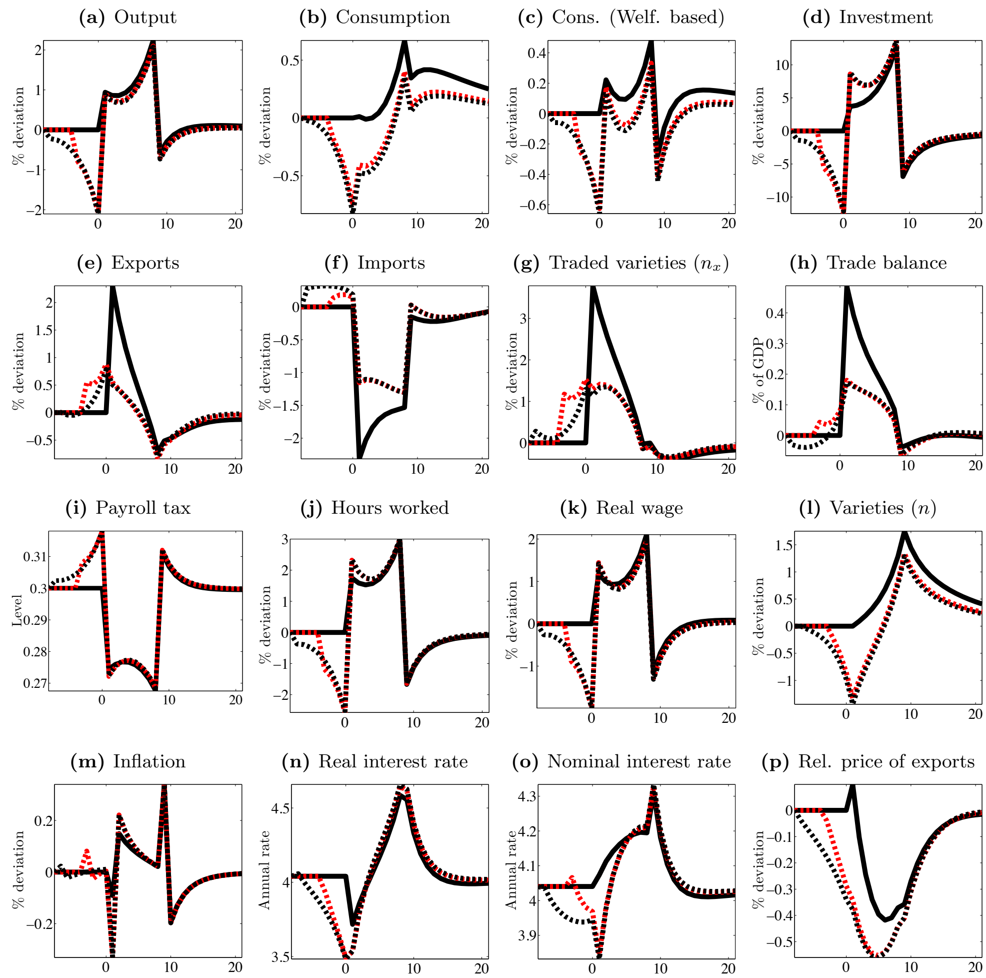
The effects of joint reforms roughly average welfare gains and losses of unilateral reforms. When the number of produced varieties is held constant, the model with endogenous tradability and the model with constant tradability produce very similar results: welfare losses at all horizons for domestic households and welfare gains of a similar magnitude at all horizons for foreign households. Only the model with endogenously produced and traded varieties generates different results: losses in the short and medium run for domestic households and small welfare gains over the same horizons for foreign households, and small welfare gains for everyone in the long run. In a nutshell, when used to assess the welfare gains from fiscal devaluations, alternative models tend to under-estimate the welfare losses in the short-run while they suggest that fiscal devaluations are zero-sum games. Our baseline model concludes that fiscal devaluations produce relatively larger welfare losses in the short-run with long term gains.

3.4.3 Unexpected vs. expected fiscal devaluations

We now investigate the extent to which the timing of announcement matters when implementing fiscal devaluations, given that most fiscal reforms are pre-announced. From the literature, we know that news shocks have very different implications than unexpected immediate shocks and this should also be the case here. Figure 3.4 to 3.5 below report the effects of a domestic unilateral fiscal devaluation effective in period 1 announced 4 or 8 quarters ahead. It also reports the effects of an immediate, unexpected, fiscal devaluation, as in Section 4.1.

Let us first focus on the domestic effects of pre-announced reforms. Within the quarter

Figure 3.4: The home effects of a domestic fiscal devaluation - Announced vs. Unexpected

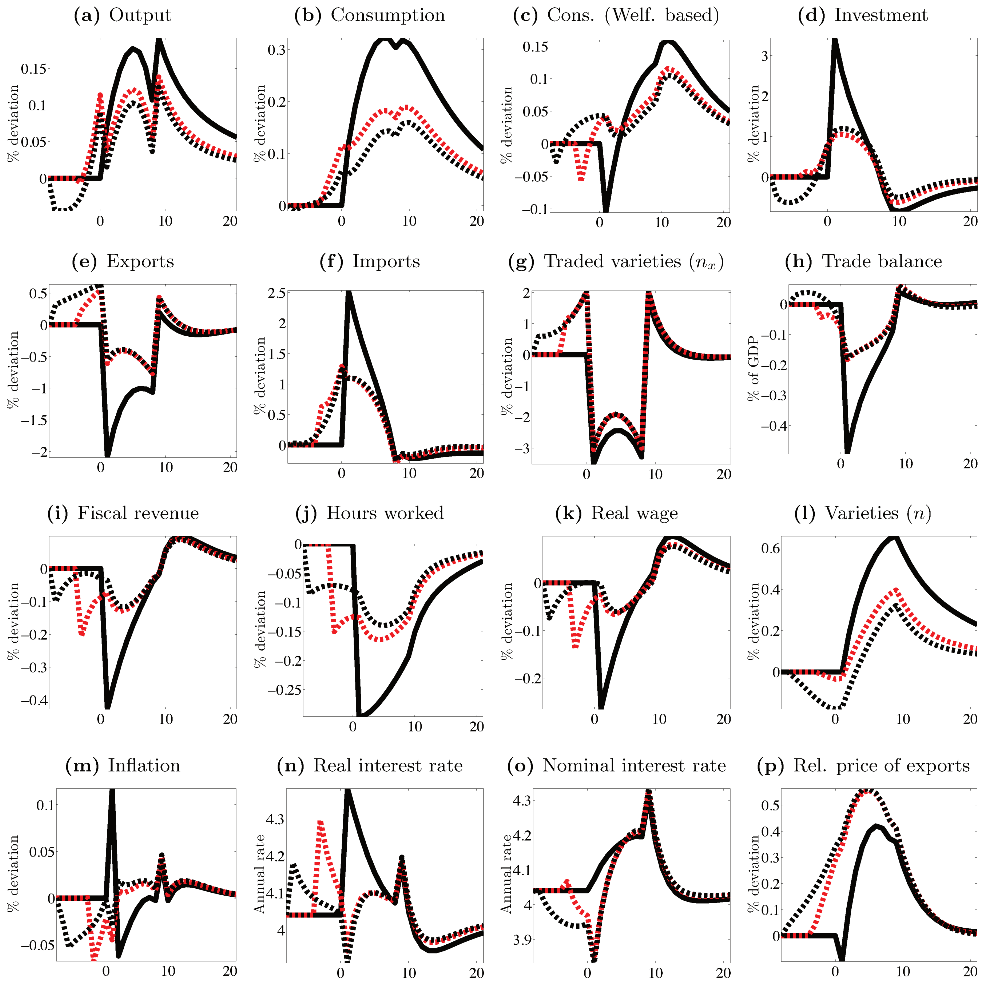


Solid black: baseline model unexpected, Circled red: announced 4 quarters ahead, Dashed black: announced 8 quarters ahead. Variables are reported in a data-consistent manner unless specified otherwise.

of the announcement, households and firms know for certain that VAT will rise and that the payroll tax will fall in 4 and 8 quarters respectively. The expected fall in the payroll tax lowers the future cost of building varieties – through the effect on the real wage – leading firms to postpone entry. Produced varieties thus fall immediately, leading the demand for intermediate goods to drop as well, lowering labor demand (hours and the real wage both drop when the reform is pre-announced). This movement is large enough to lower consumption. The relative price of exported goods falls but this is due to internal real wage deflation. Transmission to the foreign economy occurs through this fall in the relative price imported goods, foreign imports increase, but the foreign productive sector is depressed by the fall in hours worked. Real wages fall but not as much as when the reform is unexpected and the movements in consumption and hours worked are dampened.

This analysis reveals that the timing of announcement and implementation of fiscal devaluations crucially affects the resulting short-run dynamics. Because pre-announced fiscal devaluations may lead to very different adjustment paths they should also result in very different welfare effects in the short run. Overall, announced fiscal devaluations should have positive welfare effects in the short run for domestic households and unclear effects on for-

Figure 3.5: The foreign effects of a domestic fiscal devaluation - Announced vs. Unexpected



Solid black: baseline model unexpected, Circled red: announced 4 quarters ahead, Dashed black: announced 8 quarters ahead. Variables are reported in a data-consistent manner unless specified otherwise.

eign households' welfare, as hours worked fall (positive effects on welfare) but welfare-based consumption falls (negative effects on welfare).

Figure 3.6: Welfare effects of unilateral fiscal devaluations (Expected vs. %unexpected), in percents

	Unexpected		Expected (4Q)		Expected (8Q)	
Horizon	H	F	H	F	H	F
1	−0.37	0.03	0.20	0.01	0.07	0.01
4	−0.60	0.10	0.45	0.05	0.14	0.04
8	−0.76	0.15	−0.20	0.08	0.29	0.05
32	−0.06	0.12	−0.11	0.09	−0.12	0.08
60	−0.01	0.06	−0.05	0.05	−0.06	0.05
∞	0.01	0.02	−0.02	0.02	−0.02	0.02

Note: A negative sign indicates a welfare loss.

Table 3.6 confirms that the long run effects of fiscal devaluations are almost independent of the announcement scheme. In the short run however, pre-announced unilateral fiscal devaluations produce substantial welfare gains for the domestic economy in the first periods, up to 0.20% of consumption equivalent, that must be compared to the 0.37% short run welfare loss when the fiscal devaluation is unexpected. In the medium and long run, welfare gains and losses are less sensitive to the announcement scheme. Pre-announcement is thus crucial for the way welfare gains or losses attached to fiscal devaluations materialize over time. In addition, the timing of fiscal devaluations can be manipulated by governments to produce non-negligible short-run welfare gains instead of welfare losses. Announcing fiscal devaluations might produce large welfare gains in the short-run while postponing the welfare losses (for instance after re-election).

3.4.4 Robustness

We finally conduct a series of robustness checks and sensitivity analyzes. First, we investigate the effects of permanent fiscal devaluations. Contrary to nominal exchange rate devaluations, fiscal devaluations can be permanent and have permanent effects. Second, we analyze the sensitivity of the welfare gains and losses from fiscal devaluations to changes in the calibrated steady-state value of hours worked, that determines the Frisch elasticity of labor supply. This should matter because the response of labor supply tailors the size of equilibrium responses of hours worked and the real wage, two variables that are crucial in the above analysis. Third, we also check the sensitivity of our results to setting a much higher degree of risk-aversion $\gamma = 5$. Last, we inspect the effects of using the consumption tax rate τ_c instead of the VAT rate to implement the tax reform. This is what many papers do, even though the consumption tax rate (excise tax for instance) is clearly not the most obvious policy variable that governments may use to engineer fiscal devaluations, as opposed to VAT. In this last case, the rise in the consumption tax rate should be 1.25 pp to generate an equivalent transfer of fiscal revenue for the consumption tax to the payroll tax (that is 1pp of ex-ante GDP). In each of these cases, we simply report the attached welfare gains or losses, computed with our baseline model with flexible export prices. The results can be found in Table 3.7 below.

Figure 3.7: Welfare effects of unilateral fiscal devaluations (Robustness), in percents

	Baseline		Permanent		$\ell = 0.25$		$\gamma = 5$		Using τ_c	
Horizon	H	F	H	F	H	F	H	F	H	F
1	−0.37	0.03	−0.62	0.08	−0.66	0.05	−0.16	0.03	−0.83	0.09
4	−0.60	0.10	−1.00	0.19	−0.99	0.16	−0.26	0.07	−1.36	0.21
8	−0.76	0.15	−1.14	0.26	−1.35	0.23	−0.32	0.09	−1.59	0.27
32	−0.06	0.12	−1.37	0.26	−0.08	0.14	−0.02	0.08	−0.04	0.16
60	−0.01	0.06	−1.45	0.23	−0.01	0.07	0.00	0.05	0.04	0.05
∞	0.01	0.02	−1.55	0.22	0.01	0.02	0.01	0.02	0.06	−0.01

Note: A negative sign indicates a welfare loss.

A permanent reform yields welfare losses at all horizons for the domestic households, between 0.62% on impact and 1.55% in the long run. Welfare gains are observed for the foreign households, ranging from 0.08% on impact to 0.22% in the long run. In this case, the reform reduces consumption at the intensive margin since the price of domestic consumption goods raises permanently. It also decreases the production cost while hours worked increase. Foreign households enjoy positive spillovers from the reform as hours worked fall, inducing a fall in the real wage that triggers entries and an increase in the total number of varieties.

Assuming a lower level of steady-state hours worked ($\bar{\ell} = 0.25$) or a larger degree of risk-aversion ($\gamma = 5$) only affects the quantitative implications of the exercise. Welfare gains and losses increase for higher degrees of risk-aversion while welfare gains and losses decrease for less elastic labor supply. Qualitatively, the pattern highlighted in the previous sections remains the same: welfare losses for domestic households and welfare gains for the foreign households in the short run, small welfare gains both for domestic and foreign households in the long run. Finally, using the consumption tax rate instead of the VAT rate to engineer the fiscal devaluation yields quite similar welfare patterns, although the short run dynamics are somewhat different (not reported). The main difference with respect to our baseline model is that welfare losses are larger in the short run and that welfare gains materialize earlier in the medium run for domestic households. Finally, positive spillovers (welfare gains) for foreign households are larger in the short run than in our baseline model using VAT.

3.5 Conclusion

This paper is, to our knowledge, the first attempt to quantify the effect of fiscal devaluations in a monetary union characterized by both endogenous entry and tradability. Countries that decide to follow these types of policies unilaterally experience positive outcome on output, consumption, hours worked and the trade balance. For trade partners of the monetary union, they generate positive output and consumption spillovers.

Our results suggest that endogenous tradability amplifies the size of the trade effects of the reform. Further, the assumption of endogenous business formation also alters the effects of fiscal devaluation. In this environment, fiscal devaluations boost business creation both for the country that implements the reform and for other members of the monetary union. Our results also indicate that the pre-announcement scheme of fiscal devaluations crucially alters the resulting dynamics. Taking into account the dynamics of produced and exported varieties, two realistic features of the data, thus proves to be essential in accounting for the effects of fiscal devaluations.

3.6 Appendix

3.6.1 Business cycle properties of the model

In this paragraph, business cycles are generated by productivity and monetary policy shocks. We follow the estimates of Smets and Wouters (2005) and impose $std(\epsilon^r) = 0.25\%$. In addition, as in Smets and Wouters (2005), we set the persistence of productivity shocks at $\rho_a = 0.99$. Finally we adjust $std(\epsilon^a) = 0.99\%$ to match the standard deviation of GDP, with a cross-country correlation of innovations $\rho\left(\epsilon^a, \epsilon^{a^*}\right) = 0.5$. Using those numbers and the calibration reported in Table 3.1, we solve the model using a first-order approximation around the deterministic steady state, and compare the business cycle moments computed on simulated HP-filtered time series – using $\lambda = 1600$ – to the business cycle moments computed on observed HP-filtered time series. As explained in Ghironi and Melitz (2005), our artificial time series have to be deflated by a price index capturing the aggregate variety effect. Defining $p_t = (n_t + n_{x,t})^{\frac{1}{1-\theta}} \widetilde{p}_t$, real data-consistent variable x_t writes $x_t^r = p_t x_t / \widetilde{p}_t$, $\forall x$. In addition, average (data-consistent) inflation rates are defined as $\widetilde{\pi}_t = (p_t/p_{t-1}) / (\widetilde{p}_t/\widetilde{p}_{t-1})$, and terms of trade as $\widetilde{q}_t = \widetilde{p}_t^* / \widetilde{p}_t$.

For the data, we use time series for GDP, consumption, investment, exports, imports, and CPIs for Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Spain and Portugal. These series are taken from the OECD Economic Outlook database, and range from 1981Q1 to 2012Q4. GDP, consumption, investment, exports and imports are volume chained, seasonally adjusted, millions of PPP 2005 US dollars. Inflation is the quarterly growth rate of the CPI. CPIs are previously filtered to remove high-frequency movements, and capture "core" movements in price levels. Consumption is the total expenditure of households on consumption goods. Investment is the gross fixed capital formation. Each macroeconomic variable is also computed at the aggregate (euro) level. GDP, consumption, investment, exports and imports are taken in log. Net exports over GDP are computed as exports minus imports divided by GDP. No correction is necessary as quarterly national account variables (GDP, consumption, investment, exports and imports) are all expressed in annualized levels. Terms of trade are computed using CPIs. For each country, terms of trade is the ratio of the aggregate (euro) CPI and the national CPI level. The aggregate CPI is a GDP-weighted average of national CPIs – with time-varying weights. Terms of trade are then taken in log. Time series are all HP-filtered with $\lambda = 1600$ before computing the business cycle moments. Business cycle moments are computed for each country and averaged. The cross-country correlation is the correlation of a macroeconomic variable with the same aggregate (euro) variable. Cross-country correlations are computed for each country and then averaged.

Table 3.8 below presents the standard deviations or relative standard deviations of data-consistent key macroeconomic aggregates, their first-order auto-correlation, their correlation with GDP and their cross-country correlation.

Figure 3.8: Business cycle moments

	Data				Model			
$x \downarrow$	σ_x	ρ_x	$\rho_{x,y}$	ρ_{x,x^*}	σ_x	ρ_x	$\rho_{x,y}$	ρ_{x,x^*}
GDP (y_t^r)	1.48	0.84	–	0.83	1.48	0.73	–	0.45
Consumption (c_t^r)	0.85	0.78	0.67	0.66	0.93	0.73	0.90	0.65
Investment (i_t^r)	3.07	0.81	0.78	0.73	3.97	0.64	0.82	0.20
Exports	2.58	0.78	0.69	0.82	1.79	0.61	0.50	0.83
Imports	2.72	0.80	0.77	0.81	1.78	0.60	0.61	0.85
Net exports / GDP	0.23	0.58	−0.01	–	0.16	0.74	−0.19	–
Inflation ($\widetilde{\pi}_t$)	0.33	0.56	0.37	0.70	0.31	0.20	0.01	0.99
Terms of trade ($\widetilde{q}_t$)	0.65	0.68	0.04	–	0.04	0.78	−0.41	–

Note: σ_x is the standard deviation (for GDP, net exports to GDP and terms of trade) or the standard deviation relative to GDP (for consumption, investment, export, and imports). ρ_x is the first-order correlation. $\rho_{x,y}$ is the contemporaneous correlation with GDP. ρ_{x,x^*} is the correlation of a variable with the same variable in the other country of the monetary union.

Table 3.8 shows that the model correctly reproduces many features of the data. As in the data, consumption is less volatile than GDP while investment is more volatile. Exports and imports are more volatile than GDP, but a little less than in the data. The volatility of net exports to GDP is almost perfectly matched. The volatility of terms of trade is much lower than in the data: as in Ghironi and Melitz (2005), the model does not fully reproduce the volatility of relative prices observed in the data. Other moments are qualitatively well matched: persistences are a bit too low compared to the data and cyclical patterns are broadly correctly matched. In particular exports and imports are positively correlated with output but imports are more strongly correlated which produces counter-cyclical net exports, as in the data. The cross-country correlation of consumption is almost perfectly matched and remains higher than that of GDP, and the cross-country correlation of investment is too low compared to the data. The cross-country correlation of trade flows is almost perfectly matched.

Our model of endogenous business creation and tradability performs quite well in matching the business cycle moments of gross and net trade flows while producing reasonable figures for business cycle moments pertaining to GDP, consumption, investment or inflation. Overall, given its relative simplicity with respect to medium-scale business cycle models – we abstract from habits in consumption, price indexation, variable capital utilization, and focus on a much scarcer number of driving shocks – the model performs rather well and correctly matches a wide range of business cycle moments. We thus consider the model as providing a reliable business cycle representation of countries of the Eurozone, that we wish to consider in the analysis of fiscal devaluations.

Chapitre 4

Demographic Factor and the Rise of Services

4.1 Introduction

Structural change is one of the most prominent phenomenon for modern economic growth. When the economy develops, its labor force first shifts from agriculture into industry, and then from industry toward services[1]. In most of the developed countries, the portion of labor force working in service sector exceeds 70% of their overall working population.

At the same time, population have been aging during the past decades. On one hand, since the young are driving forces for new sectors, aged population may result to the slowdown of structural change. On the other hand, economies with aged population are likely to be wealthier and have more demand for service goods. So far, the potential effect of population age on the growth of service sector remains unclear.

To investigate the correlation between age and structural change, we apply data of 10 OECD countries. Data are from Groningen Growth and Development Centre, which starts from 1950 and ends in 2011. We average dataset within every 5-year interval to avoid the short term cyclical effect. Figure (4.1) suggests a positive co-movement between the proportion of young male of 15 to 29 years old and the speed of structural change. This pattern might prevail in US, Western Europe, Japan, and South Korea. The downward trend suggests simultaneity between rising services and population aging. Figure (4.2) and (4.3) also suggest that a higher percentage of middle-aged and retired population is associated with lower speed of structural change across times within each country. We find similar correlation using Integrated Public Use Microdata Series (IPUMS) for US commuting zones (CZ).

This correlation between population's age profile and the growth of service sector seems intriguing. By assumption, there are three mechanisms behind it: (1) Young generation are more mobile across sectors, who supply labor and promote structural change toward services. (2) Middle-aged population are the group of people who are less mobile and who save and invest. They may raise the demand for investment/manufacturing goods, thus slow down the rise of service sector. (3) Retired generation, although they supply no labor to the rising service sector, they are likely to provide demand for services consumption such as health care and personal services. To test these underlying assumptions, especially young generation's mobility and retired generation's consumption profile, we work on two microdatasets: the first dataset is SIPP (Survey of Income and Program Participation) microdata. In SIPP data, each individual's employment history is tracked during 4 years, by which we can observe the individual's mobility records. The SIPP data confirms negative correlation between sectoral mobility and age profile, which provides evidence for labor supply from the young. The second

[1]Kuznets (1971), Kongsamut, Rebelo and Xie (2001), Ngai and Pissarides (2007), and Herrendorf, Rogerson and Valentinyi (2014)

Figure 4.1: Percentage men of 15-29 year-old and the growth of services in 10 OECD countries

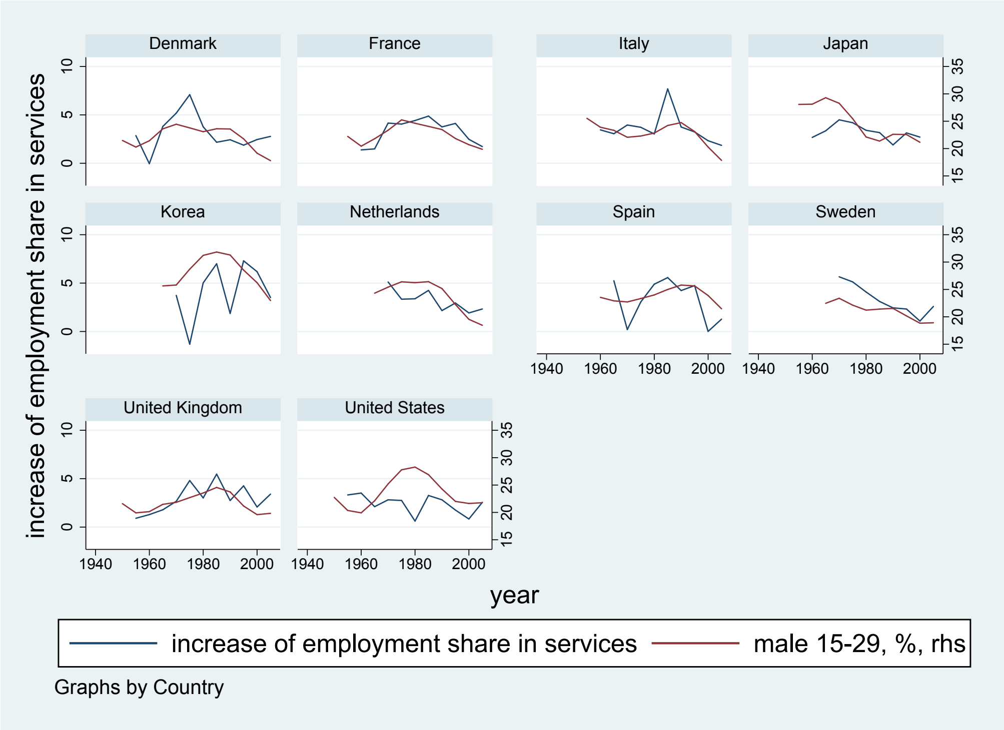


Figure 4.2: Percentage men of 30-59 year-old and the growth of services in 10 OECD countries

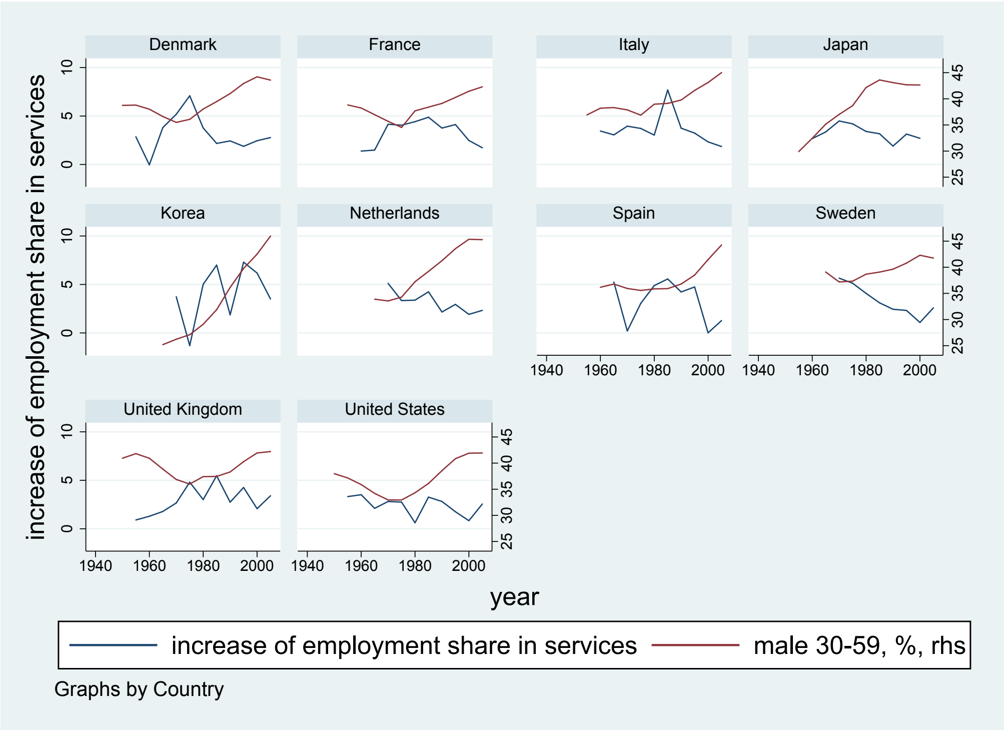
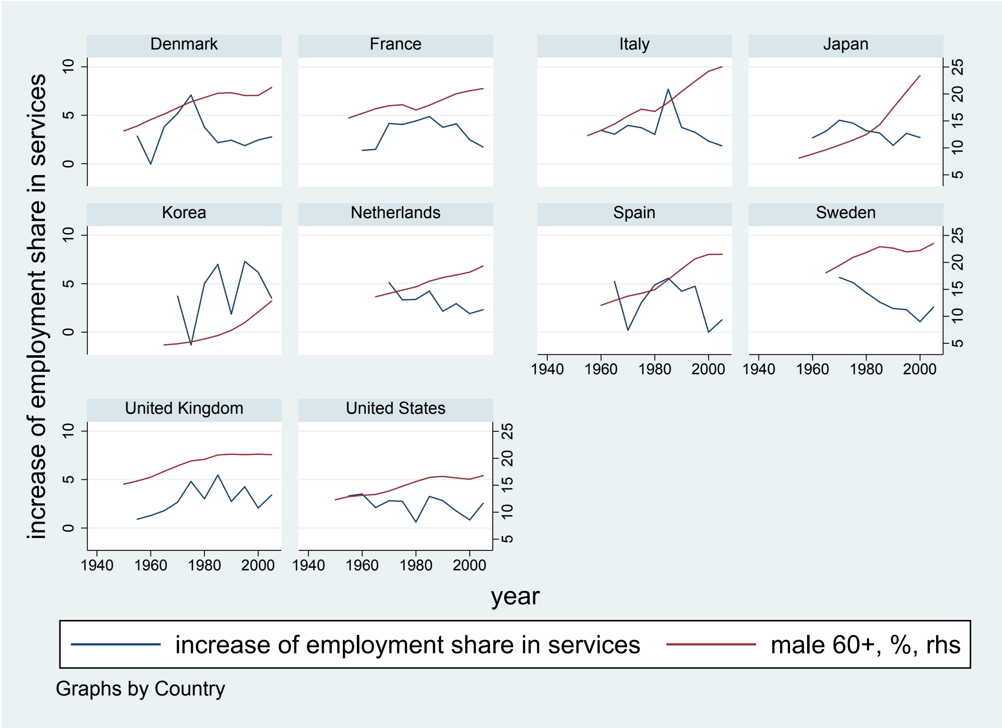


Figure 4.3: Percentage men of 60+ year-old and the growth of services in 10 OECD countries



dataset is CE PUMD[2] microdata. In CE PUMD data, we have information of consumer unit's expenditure choice and their demographic characters, by which we observe the correlation between expenditure share in services and consumer unit's age profile. The CE PUMD data confirms positive correlation between expenditure share in services and consumer unit's age profile, but negative interaction between age and income level. Overall, the net effect of age on expenditure share in service goods is slightly negative but not significant, due to the weak income effect from aged population.

To further investigate the impact of demographic shock on the rise of service sector, we build a 3-period 2-sector OLG framework and implement both factors *i.e.* labor supply from the young and capital supply from the middle-aged, inside the model. The 2 sectors, *i.e.* manufacturing and service sector, capture the modern structural shifting from manufacturing to service sector. The 3-period OLG model captures the impact of demographic structure since young, middle-aged and retired people have different functions and preferences for the economy: the young borrow, consume, and easy to mobilise between sectors; middle-aged people consume, save, and hard to mobilise; retired people consume and do not work. Calibrating to US data, we find that a positive demographic shock has positive but very limited impact on the growth of service sector when TFP growth is exogeneous.

However, as discussed in many literatures, demographic shock may affect the sectoral TFP growth through its impact on the innovative activities and input resources [3], thus influence the procedure of structural change. For this reason, we extend our basic model to endogenous growth, and find that the new mechanism amplifies the impact of demographic shock by four

[2]Beginning in 2012, the Consumer Expenditure Survey (CE) was given clearance to make CE public-use microdata (PUMD) available for free electronic download. In the past, PUMD was only available from the CE for purchase. All PUMD data from 1996 through 2014 are now available online.

[3]M.Romer (1990),Aghion and Howitt (2009),and Aksoy, Basso, Grasl and Smith (2015)

times.

In the remaining part of this section, we will make a brief review of relative literatures. According to the recent survey by Herrendorf et al. (2014), there are two classical causes for structural change. One is income effect, the other is heterogenous TFP growth across sectors. The income effect, *i.e.* Engel's law, indicates that as income grows, people's demand for manufactured goods is limited. Therefore, the demand of services is more elastic to income growth than the demand of manufactured goods. Heterogenous productivity growth across sectors, *i.e.* Baumol's effect, means that sectors with higher productivity growth may shed off labor force toward sectors with lower productivity growth.

Kuznets is probably the first to study structural change in a systematical way. In his book (Kuznets (1971)), Kuznets enumerated three potential causes for structural change: 1) the income effect that reflects the basic structure of consumer demand; 2) international trade that helps a country to shift toward its comparative advantages; and 3)heterogeneous productivity growth and innovation across industries. Baumol (1967) also emphasized the importance of heterogeneous productivity growth, and argued that sectors with higher productivity growth will shed off labor force to sectors with lower productivity growth.

The cause of structural change has been largely studied during the last decade. Kongsamut et al. (2001) proves the importance of income growth by adopting non-homothetic preference in their model. Later, Ngai and Pissarides (2007) use a multi-sector model to show that as long as the elasticity of substitution between final goods is less than unity, labor force would move to the sector with the lowest productivity growth. Matsuyama (2009) analyzed the role of international trade in a simple two-country model with Stone-Geary preferences. His results suggest that there is a hump-shaped relationship between technology progress and labor reallocation in the country which experiences stronger technological progress in manufacturing.

Some contributions to the recent literature on structural transformation suggest that sectoral differences in the capital share and the substitutability between capital and labor also have important implications for structural transformation. Acemoglu and Guerrieri (2008) present study the effect of capital deepening on structural transformation. They establish a two-sector general equilibrium model and find that capital deepening induces faster employment growth in less capital-intensive sector. Alvarez-Cuadrado, Long and Poschke (2015) study the channel of capital-labor substitutability for structural change. They show that capital-labor ratio influences the relative returns on capital and labor. In the more flexible sector where capital and labor are more substitutable (the manufacturing sector, for example), when capital becomes more abundant, this sector will shed off labor and apply more capital in the production.

Herrendorf, Herrington and Valentinyi (2015) assess how the properties of technology affect structural transformation, *i.e.* the reallocation of production factors across the broad sectors of agriculture, manufacturing, and services. To this end, they estimate sectoral constant elasticity of substitution (CES) and Cobb-Douglas production functions on postwar US data. They find that differences in technical progress across the three sectors are the dominant force behind structural transformation whereas other differences across sectoral technology are of second- order importance. Their findings imply that Cobb-Douglas sectoral production functions that differ only in technical progress capture the main technological forces behind the postwar US structural transformation.

In terms of labor mobility, Kuznets (1966) states the importance of having a younger population:

"... It is the younger groups in the labor force who are most mobile - in space and within the productive system - since, unlike older workers, they are not committed to family and housing or to established positions. This greater mobility is particularly true of new entrants into the labor force, who naturally veer toward those sectors that are likely to spearhead the country's economic growth and who are oriented toward these sectors even in their training within the educational system."

In their empirical work, Kim and Topel (1995) and Autor and Dorn (2009) also find that sectoral employment is especially adjusted among new cohorts, with expanding sectors bringing in more young workers, and declining sectors bringing in fewer young. Kim and Topel (1995) show that the labor reallocation during the period of industrialization of Korea took place mostly thanks to the new entrants. Autor and Dorn (2009) apply the IPUMS microdata and integrate it by commuting zones. They find negative correlation between the employment of shrinking "routine" occupations and workers' age profiles. Moreover, Kambourov and Manovskii (2008) by studying data from the Panel Study of Income Dynamics (PSID), they find that occupational and industry mobility rates decline with workers age and education. Auray, Fuller, Lkhagvasuren and Terracol (2015) find from PSID data that lifetime earnings is negatively correlated with mobility. They build a dynamic multi-sector model with net and excess mobility, and find that sector-specific skill accumulation and dynamic mismatch shocks play an important role to explain this wage-mobility relationship. Lee and Wolpin (2006) build a general equilibrium model and quantify the mobility cost for workers to change sectors. They find that the mobility cost is large, and labor supply from young cohorts plays a minor role for the trend of structural change.

On the demand side, empirical studies on households' expenditure allocation confirmed that older households spend more on basic needs than do younger households. Compared with the nonelderly, the elderly spend more on housing, food, and healthcare - and less on clothing, transportation, and household furnishings. (Chen and Chu (1982), Chung and Magrabi (1990), Lee, Hanna, Mok and Wang (1997), Harris and Blisard (2002), Hong and Kim (2000) and Lee, Sohn, Rhee, Lee and Zan (2014)).

The paper is organised as follows. In Section 2 we propose several empirical evidence to show the weak but positive correlation between percentage of young and the growth of service sector. We also provide evidences for our assumption that sectoral labor mobility decreases with age. Section 3 presents a toy model to illustrate the mechanism behind the positive correlation between the percentage of young people and economy's employment share in services. Section 4 shows the complete model and simulation with frictions from labor mobility, non-homothetic preferences, and heterogenous labor-capital substitutability across sectors. In Section 5, we extend the model to endogenous growth and simulate it. Section 6 concludes and discusses open questions for future research.

4.2 Empirical Evidence

We have two datasets to show the correlation between age structure and the speed of structural change: the Groningen data for OECD countries and the IPUMS US data for the commuting zones (CZ) in the US. We first look at the cross countries case for OECD economies (1950-2011), then cross US commuting zones (CZ) (1970-2000). Both datasets exhibit weak but positive correlations between young generation and the growth of service sector.

By assumption, there are three mechanisms behind it: (1) Young generation are more mobile across sectors, who promote the structural change toward services. (2) Middle-aged population are the group of people who are less mobile and who save and invest. They may raise the demand for investment/manufacturing goods, thus slow down the rise of service sector. (3) Retired generation, although they supply no labor to the rising service sector, they are likely to provide demand for service gods such as health care and personal services.

To test these underlying assumptions, especially young generation's mobility and retired generation's consumption profile, we work on two microdatasets: the first dataset is SIPP (Survey of Income and Program Participation) microdata. In SIPP data, each individual's employment history is tracked during 4 years, by which we can observe the individual's mobility records. The SIPP data confirms negative correlation between sectoral mobility and age profile, which provides evidence for labor supply from the young. The second dataset is CE PUMD[4] microdata. In CE PUMD data, we have information of the expenditure choice and their demographic characters for each consumer unit (CU), i.e. an unit in which people live together, by which we observe the correlation between expenditure share in services and consumers' age profile. The CE PUMD data confirms positive correlation between expenditure share in services and consumer unit's age profile, but negative interaction between age and income level. Overall, the net effect of age on expenditure share in service goods is slightly negative, due to the weak income effect from aged population.

4.2.1 Macrodata: Correlation

OECD Countries

We apply the Groningen dataset for 10 OECD countries from 1950 to 2011. The dataset is provided by Groningen Growth and Development Centre, which was founded in 1992 by a group of researchers working on comparative analysis of levels of economic performance and differences in growth rates.

We investigate correlation between the proportion of young male and the speed of structural change toward services. The speed of structural change is measured by the difference of labor growth rates between service and manufacturing sector. Our model is explained by equation (4.1). In this part, each t represent 5-year period from 1950 to 2011. The dependent variable ser_{jt} is the share of employment in services. Explanatory variable$agegroup_{jt}$ is the percentage of male between 15-29 ($p1529_{it}$), 30-59 ($p3059_{it}$), and 60+ ($p60+_{it}$) years old over the total male population; α_j and $year_t$ capture the country fixed effect and the time effect. Our control variables include share of female employment, education, and trade openness. $(\gamma_{im,t}-\gamma_{is,t})$ is the difference of productivity growth between manufacturing and services, and $gdppc_{jt-1}$ is the lagged log of gdp per capita in country j. All growth rates are expressed in percentage points. Our results (Table (4.1)) confirm the positive correlation between service growth and the percentage of young generation.

$$\begin{aligned}\Delta ser_{jt} &= \beta_0 + \beta_2 * agegroup_{jt} + \beta_3 * (\gamma_{im,t} - \gamma_{is,t}) + \beta_4 * gdppc_{jt-1} \\ &\quad + \beta_5 * control_{jt} + \beta_6 * year_t + \alpha_j + \epsilon_{jt}, \end{aligned} \tag{4.1}$$

In Table (4.1), the coefficient for the percentage of young generation ($p1529_t$) is positive and significant both with (0.23) and without control variables (0.26). It seems that young generation's positive effect on structural change is dominant. Coefficients of GDP per capita ($gdppc_{t-1}$) and difference of TFP growth in manufacturing and service sector ($\gamma_{m,t} - \gamma_{s,t}$) confirm the income effect and Baumol's effect on the structural change.

[4]Beginning in 2012, the Consumer Expenditure Survey (CE) was given clearance to make CE public-use microdata (PUMD) available for free electronic download. In the past, PUMD was only available from the CE for purchase. All PUMD data from 1996 through 2014 are now available online.

Table 4.1: OECD: correlation between service growth and age group

variable	(1)	(2)	(3)	(4)	(5)	(6)
$p1529_t$	0.26^{***}	–	–	0.23^{**}	–	–
$p3059_t$	–	-0.14^{**}	–	–	-0.11	–
$p60+_t$	–	–	-0.22	–	–	-0.28^{**}
$gdppc_{t-1}$	5.31^{***}	5.32^{***}	6.44^{***}	4.59^{**}	4.76^{**}	5.83^{***}
$\gamma_{m,t}-\gamma_{s,t}$	0.09^{***}	0.08^{***}	0.09^{***}	0.09^{***}	0.10^{***}	0.10^{***}
$year_t$	-0.13^{***}	-0.12^{***}	-0.14^{***}	-0.12	-0.14^{*}	-0.14^{*}
$control_t$	no	no	no	yes	yes	yes
fe	yes	yes	yes	yes	yes	yes
r^2	0.40	0.33	0.32	0.48	0.44	0.46
$obs.$	85	85	85	80	80	80

Column (1) - (3) are regressions without control variables. Column (1) tests the correlation between the growth of service sector and the percentage of young population. The result shows that the increase of 1pp of young generation promotes the rise of employment share in services by 0.26pp. Column (2) tests the correlation between the growth of service sector and the percentage of middle-aged population. The result shows that the increase of 1pp of middle-aged generation decreases the growth of employment share in services by 0.14pp. Column (3) tests the correlation between the growth of service sector and the percentage of retired population. The coefficient is not significant, but shows negative correlation between retired population and the growth of service sector (0.22).

Column (4) - (6) are regressions with control variables. Similar to the cases without control variables, column (4) tests the correlation between the growth of service sector and the percentage of young population with control variables. The result shows that the increase of 1pp of young generation promotes the rise of employment share in services by 0.23pp. Column (5) shows that the increase of 1pp of middle-aged generation decreases the growth of employment share in services by 0.11pp, although not significant. Column (6) shows that with control variables the increase of 1pp of middle-aged generation decreases the growth of employment share in services by 0.28pp. The coefficient is significant this time.

In general, the correlation between proportions of each generation and the growth of service sector in our experiment are consistent with Figure (4.1) - (4.3) for OECD countries. The proportion of young generation catalyses structural change toward services. The proportions of middle-aged and retired population reduce the speed of structural change.

IPUMS Decennial Data

We then test the relationship between age groups and service growth in the United states by using the IPUMS[5] USA microdata. We integrate data by Commuting Zones (CZ) as in Autor and Dorn (2009). The method of CZ was first developed by Tolbert and Sizer (1996), who clustered counties that exhibit high commuting ties but weak between clusters. The 741 CZs we use cover both urban and rural areas across the mainland of United States.

We investigate correlation between the change of employment share in services, and the percentage of of each age group. Our model is explained by equation (4.2). The model is very similar to previous sections, except that we do not have interaction terms due to lack of data on CZ-specific sectoral productivities. In this part, each t represent 10-year period from 1970

[5]Integrated Public Use Microdata Series

to 2000. The dependent variable ser_{jt} is the share of employment in services. Explanatory variable$agegroup_{jt}$ is the percentage of male between 15-29 ($p1529_{it}$), 30-59 ($p3059_{it}$), and 60+ ($p60+_{it}$) years old over the total male population; α_j and $year_t$ capture the CZ fixed effect and time effect. Our control variables include female employment, education, marital status, number of kids under 5-year old, and income level. Our results (Table (4.2)) confirm the positive correlation between service growth and the percentage of young generation.

$$\begin{aligned}\Delta ser_{jt} &= \beta_0 + \beta_2 * agegroup_{jt} + \beta_3 * income_{jt-1} + \beta_4 * control_{jt} \\ &\quad + \beta_5 * year_t + \alpha_j + \epsilon_{jt},\end{aligned} \tag{4.2}$$

According to Table (4.2), the coefficient of young generation is non-significant without control variables, but positive and significant with control variables (0.30). The non-significance of the former is not representative, since R-square in the former case is merely 11% compared to 43% in the latter case [6]. Income effect is also confirmed in the latter case, although not significant. Another remarkable result is that middle-aged people seem to have negative and significant impact on the structural change (-0.62–0.70).

Column (1) - (3) are regressions without control variables. Column (1) tests the correlation between the growth of service sector and the percentage of young population. The result shows that there is a positive correlation between the proportion of young generation and the growth of service sector, although not significant (0.03). Column (2) tests the correlation between the growth of service sector and the percentage of middle-aged population. The result shows that the increase of 1pp of middle-aged generation decreases the growth of employment share in services by 0.70pp, which is more than twice as large as the case of OECD countries. Column (3) tests the correlation between the growth of service sector and the percentage of retired population. The coefficient is not significant, shows positive correlation between retired population and the growth of service sector (0.13).

Column (4) - (6) are regressions with control variables. Similar to the cases without control variables, column (4) tests the correlation between the growth of service sector and the percentage of young population with control variables. The result shows that the increase of 1pp of young generation promotes the rise of employment share in services by 0.30pp, which is significant and slightly larger than in OECD countries. Column (5) shows that the increase of 1pp of middle-aged generation decreases the growth of employment share in services by 0.62pp, which is still much larger than that in OECD countries. Column (6) shows that the correlation between the growth of service sector and the percentage of retired population is positive but still not significant (0.15).

In general, the correlation between proportions of each generation and the growth of service sector in our experiment are consistent with that in OECD countries, except that the effect is stronger when counting the control variables. The proportion of young generation catalyses structural change toward services. The proportion of middle-aged population reduces the speed of structural change.

4.2.2 Microdata: Evidence for the Mechanism

Having the correlation evidence provided in previous sections, we want to build a theoretical mechanism to test and explain this interesting fact. To establish our mechanism, we need to first find evidence to show that the young are more mobile, thus supply more labor to

[6] The small R-square without control variables is partly because that we do not have data on sectoral TFP growth rates for commuting zones

Table 4.2: US: correlation between service growth and age group across CZs

variable	(1)	(2)	(3)	(4)	(5)	(6)
$p1529_t$	0.03	–	–	0.30^{**}	–	–
$p3059_t$	–	-0.70^{***}	–	–	-0.62^{***}	–
$p60+_t$	–	–	0.13	–	–	0.15
$income_{t-1}$	−3.87	−2.79	−3.66	4.35	5.72^{*}	3.54
$year_t$	-0.11^{**}	0.13	-0.13^{***}	0.28^{***}	0.38^{***}	0.19^{**}
$control_t$	no	no	no	yes	yes	yes
fe	yes	yes	yes	yes	yes	yes
r^2	0.11	0.12	0.11	0.43	0.43	0.42
$obs.$	1482	1482	1482	1482	1482	1482

the rising sector; and we want to see in the data whether the middle-aged and retired have more demand for service goods compared to the young. To provide evidence for the labor supply side, *i.e.* young people supply more labor to the rising service sector than middle-aged/retired, we have SIPP microdata, in which each individual's mobility records are well documented. Then, we use the CE PUMD microdata [7] to test the demand effect, *i.e.* whether middle-aged and retired people spend more on service consumption. The SIPP data supports our assumption that young people are more mobile across sectors. The CE PUMD data confirms positive correlation between expenditure share in services and consumer unit's age profile, but negative interaction between age and income level. Overall, the net effect of age on expenditure share in service goods is slightly negative but not significant, due to the weak income effect from aged population.

Supply Side: SIPP Microdata

We have SIPP data from 1996 to 2013, and for each individual tracked, we investigate his/her mobility from non-service sector into service sector within a span of 6-month. The dependent variable is a dummy that records whether an individual changed sectors within the past 6 months. Explanatory variables are: on-job dummy that records whether the individual had a job 6 months ago and also in period t; interactions between on-job dummy and age profile of the individual; dummy that records whether the individual was a job market entrant 6 month ago. The model is described by equation (4.4). $toser_{jt}$ is a dummy variable, which equals to 1 if individual j worked in non-service sector or at school (who did not look for jobs) at the beginning of each period, and who moved into the service sector after 6 months. $onjob_{jt}$ is a dummy variable, which equals to 1 if individual was employed both 6 months ago and in period t. $entrant_{jt}$ is a dummy variable, which equals to 1 if individual was at school (not working) at the beginning, and who find a job after 6 months. Control variables include interactions between on-job dummy ($onjob_{jt}$) and sex, races, marital status, home ownership, and employment history in the past 12 to 18 months. α_s and η_t capture the state and time fixed effect. Age groups are 15-19 ($p1519_{jt}$), 20-29 ($p2029_{jt}$), 30-39 ($p3039_{jt}$), 40-49 ($p4049_{jt}$), 50-59 ($p5059_{jt}$), and 60+ ($p60+_{jt}$). We expect that coefficients of interaction terms between on-job dummy and age profile to decrease with individual's age profile. This leads to

$$\begin{aligned} toser_{jt} &= \beta_0 + \beta_1 onjob_{jt} * agegroup_{jt} + \beta_2 entrant_{jt} \\ &+ \beta_3 control_{jt} + \alpha_s + \eta_t + \epsilon_{jt}. \end{aligned} \tag{4.3}$$

[7] The CE PUMD provides a continuous and comprehensive flow of data on the buying habits of American consumers. These data are used widely in economic research and analysis, and in support of revisions of the Consumer Price Index.

We also built a similar model for those who move out of the service sector:

$$outser_{jt} = \beta_0 + \beta_1 onjob_{jt} * agegroup_{jt} + \beta_2 control_{jt} + \alpha_s + \eta_t + \epsilon_{jt}. \tag{4.4}$$

Table (4.3) and (4.4) reports our results. These results show that labor mobility declines with age.

In Table (4.3), we run the simple OLS regression. Column (1) is the results for mobility toward service sector. It tests the correlation between the individual's age profile and his/her on-job sectoral mobility. The result shows that for people who worked in non-service sector 6 months ago, their on-job mobility toward service sector after 6 months decreases with age profile. The relative probability compared to 60+ is 11.8% for 15-19, 3.8% for 20-29, 1.3% for 30-39, 0.9% for 40-49, and 0.5% for 50-59. Compared to workers with experiences, job market entrants' probability to enter the service sector is 65pp higher.

Column (2) is the results for mobility out of service sector. It tests the correlation between the individual's age profile and his/her on-job sectoral mobility out of services. The result shows that for people who worked in service sector 6 months ago, their on-job mobility toward non-service sector after 6 months decreases with age profile. The relative probability compared to 60+ is 0.5% for 15-19, 1.4% for 20-29, 0.9% for 30-39, 0.7% for 40-49, and 0.5% for 50-59.

Table (4.3) test the same relationship, but with probit model. The results are consistent with those in OLS regression. The negative correlation between age profile and sectoral mobility provides supports for our assumption that young generation are more mobile thus supply more labor to the rising service sector.

Table 4.3: US: age group's probability to move to/out of services (OLS)

variable	to services	out of services
$onjob_t * p1519_t$	0.118***	0.005***
$onjob_t * p2029_t$	0.038***	0.014***
$onjob_t * p3039_t$	0.013***	0.009***
$onjob_t * p4049_t$	0.009***	0.007***
$onjob_t * p5059_t$	0.005**	0.005***
$entrant_t$	0.650***	–
$control_t$	yes	yes
$obs.$	135553	357775

Table 4.4: US: age group's probability to move to/out of services (probit)

variable	to services	out of services
$onjob * 15-19$	0.79***	0.26***
$onjob * 20-29$	0.44***	0.45***
$onjob * 30-39$	0.21***	0.34***
$onjob * 40-49$	0.14***	0.28***
$onjob * 50-59$	0.07**	0.21***
$entrant$	1.30***	–
$control_t$	yes	yes
$obs.$	135553	357775

Demand Side: CE PUMD Microdata

We then investigate the correlation between expenditure share in services and age profile by applying microdata from CE PUMD[8]. In our regression, dependent variable is expenditure share in services of a consumer unit. According to dataset documentation, A consumer unit consists of any of the following:

(1) All members of a particular household who are related by blood, marriage, adoption, or other legal arrangements;

(2) a person living alone or sharing a household with others or living as a roomer in a private home or lodging house or in permanent living quarters in a hotel or motel, but who is financially independent; or

(3) two or more persons living together who use their incomes to make joint expenditure decisions.

Explanatory variables include age, annual total income of the consumer unit, and their interaction. Age of the consumer unit is defined as average age of reference person and his/her spouse if the person is married or live with someone. Otherwise it is age of the reference person. Control variables include number of kids under 18, race and education of the reference person, and geographical states [9]. Equation (4.5) describes our model. For each consumer unit i, expenditure share in services $ser_{i,t}$ is defined as aggregated consumption in food away from home, education, entertainment, housing loans, domestic services, vehicle finance, vehicle insurance, vehicle maintenance and repairs, vehicle rental, leases, licenses, and other charges, public transportation, health insurance, medical services, personal care and personal insurances. Income level ($income_{i,t}$) is the log of total after tax income for the past 12 months within a consumer unit.

$$ser_{i,t} = \beta_0 + \beta_1 age_{i,t} + \beta_2 age_{i,t} * income_{i,t} + \beta_3 income_{i,t} + \beta_4 control_{i,t} \tag{4.5}$$

Table (4.5) shows the results of our regression. Expenditure share in services is positively and significantly correlated with age profile, around 0.52 on average. The correlation with income level is positive, consistent with Engel's law. The interaction term between age and income level is negative, meaning that the income effect is weaker for aged people.

Table 4.5: US: expenditure share in services and age profile

variable	1996Q4	2000Q4	2004Q4	2008Q4	2012Q4	1996Q4-2012Q4
age_t	0.51^{***}	0.43^{***}	0.91^{***}	0.36^{***}	0.40^{**}	0.49^{***}
$age_t * income_t$	-0.06^{***}	-0.05^{***}	-0.10^{***}	-0.04^{***}	-0.04^{**}	-0.06^{***}
$income_t$	6.10^{***}	5.04^{***}	8.61^{***}	6.08^{***}	4.93^{***}	5.54^{***}
$control_t$	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
obs.	3122	4217	5103	4575	4406	18342

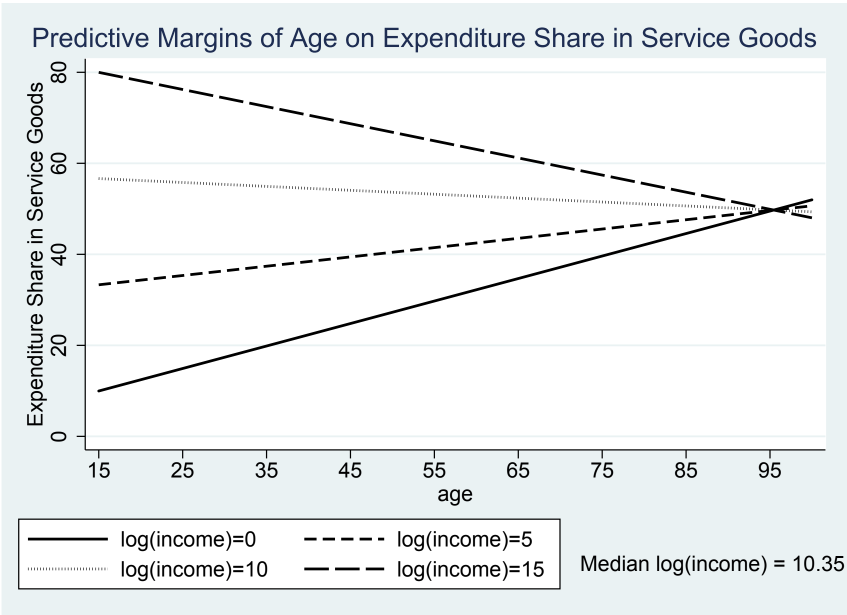
Column (1) - (5) are the results of regressions for the 4th quarter of year 1996, 2000, 2004, 2008, and 2012. Column (6) shows the regression results on these five years (1996, 2000, 2004, 2008 and 2012). Results show that there is a positive correlation between the consumer unit's expenditure share in services and the average age profile. Quantitatively, 1 year older in the

[8] Beginning in 2012, the Consumer Expenditure Survey (CE) was given clearance to make CE public-use microdata (PUMD) available for free electronic download.

[9] In the case of 1996Q4-2012Q4 of Table (4.5), control variables also include geographical states and reference year.

consumer unit's average age increases expenditure share in services by 0.36pp-0.91pp. The fourth line is the regression of income effect on the rise of service sector, *i.e.* 1% more income increases expenditure share in services by 4.93pp - 8.61pp. The third line examines the interaction between income effect and the consumer unit's age profile. The results show that 1 year older in the consumer unit's average age decreases income effect by 0.04pp-0.10pp. Intuitively, although aged population expend more in services, their expenditure share in services is less sensitive to income growth. In Figure (4.4), it shows the marginal effects of age on expenditure share in service goods depending on different income levels. The net effect of age on expenditure share in service goods is slightly negative, due to the weak income effect from aged population.

Figure 4.4: Predictive Margins of Age on Expenditure Share in Service Goods



4.3 Model

The data part provides evidences for the positive correlation between the growth of service sector and the percentage of young people in an economy. We now need a model to understand the mechanism behind. For example, which effect is dominant in explaining this correlation? Labor mobility, capital supply, or other factors?

In the model, we assume small open economy, and the OLG model have three generations: young, middle-aged, and old. There are 2 consumption goods: manufacturing and services, the investment good can be derived 1 to 1 from manufacturing good. Only manufacturing goods are tradable. Capital is freely mobile across sectors. We make the assumption of SOM, *i.e.* constant interest rate, because although interest rate may exhibit short-term fluctuations, it does not show a long-term trend. This is also one of the Kaldor's facts, indicating that the capital return rate is roughly constant in long run.

According to the model, a young person works, earns wages, and borrows for consumption. In middle-age, he/she works, earns wages, saves, and repays his/her debt of the previous period. When he/she retires, he/she simply consumes savings. We assume that each individual is endowed with 1 unit of labor when he/she is young/middle-aged, and he/she can allocate this unit of labor to work in both manufacturing for a fraction and service sector for the remaining fraction.

To better understand the mechanism, we begin a simple version with free mobility, homothetic preferences, full capital depreciation, and Cobb-Douglas production function, and that the young cannot borrow. We will add frictions one by one in the next section.

The household's program is:

Household:

$$\max \log C_{y,t} + \beta \log C_{m,t+1} + \beta^2 \log C_{o,t+2}$$

where $C_{i,t}, i \in \{y, m, o\}$ is the composite (CES) of consumption in manufacturing and service goods:

$$C_{i,t} = [\omega_s^{\frac{1}{\epsilon}} c_{i,st}^{\frac{\epsilon-1}{\epsilon}} + \omega_m^{\frac{1}{\epsilon}} c_{i,mt}^{\frac{\epsilon-1}{\epsilon}}]^{\frac{\epsilon}{\epsilon-1}}, \tag{4.6}$$

with $c_{i,st}$ and $c_{i,mt}$ the consumption in services and in manufacturing goods, and ω_s, ω_m the relative weights of service goods and manufacturing goods consumption. Budget constraints are:

$$p_{st}c_{y,st} + c_{y,mt} + a_{y,t+1} = w_{y,t}, \tag{4.7}$$
$$p_{st+1}c_{m,st+1} + c_{m,mt+1} + a_{m,t+2} = w_{m,t+1} + ra_{y,t+1}, \tag{4.8}$$
$$p_{st+2}c_{o,st+2} + c_{o,mt+2} = ra_{m,t+2}, \tag{4.9}$$

where p_{st} is the relative price of service goods; $w_{y,t}$ and $w_{m,t}$ are wages for young and middle-aged workers, respectively; r is the interest rate and return rate of capital; $a_{y,t}$ and $a_{m,t}$ are assets for the young and the middle-age. The holdings of these assets are pre-determined.

By combining F.O.Cs of each generation, we have:

$$\left(\frac{\omega_s}{\omega_m}\right)^{\frac{1}{\epsilon}} \left(\frac{c_{j,st}}{c_{j,mt}}\right)^{-\frac{1}{\epsilon}} = p_{st}, j \in \{y, m, o\}. \tag{4.10}$$

which interprets the relationship between demand and relative price p_{st}.

Firms In each sector, firms combine labor and capital to produce manufacturing/service goods. The production functions are Cobb-Douglas:

$$Y_{jt} = (A_{jt}N_{jt})^{1-\alpha}K_{jt}^{\alpha}, \tag{4.11}$$
$$j \in \{s, m\}.$$

with

$$N_{jt} = e_t n_{y,jt} L_{y,t} + n_{m,jt} L_{m,t}$$

the total effective labor in sector j, and K_{jt} is the capital used in sector j's production. $L_{y,t}$ and $L_{m,t}$ are the size of young and middle-aged population in period t. $e_t < 1$ is the relative productivity of young workers as in Coeurdacier, Guibaud and Jin (2015).

Population grows at rate $g_{L,t}$:

$$L_{y,t} = (1 + g_{L,t})L_{y,t-1}, \tag{4.12}$$

Implementing the market clearing conditions into Equation (4.10), we get[10]:

$$\left(\frac{\omega_s}{\omega_m}\right)^{\frac{1}{\epsilon}}\left(\frac{Y_{st}}{Y_{mt}-a_{m,t+1}L_{m,t}}\right)^{-\frac{1}{\epsilon}}=p_{st}. \tag{4.13}$$

From the condition of wage equality, we have:

$$p_{st}=\left(\frac{A_{mt}}{A_{st}}\right)^{1-\alpha}. \tag{4.14}$$

Combining Equation (4.13) and (4.14), expressing sectoral labor in terms of employment shares, we obtain the final equilibrium condition (see Appendix for more details):

$$\left(\frac{\omega_s}{\omega_m}\right)^{\frac{1}{\epsilon}}\left[\frac{n_{st}}{1-n_{st}-\frac{\beta}{1+\beta}(1-\alpha)\frac{1}{g_{L,t}+2}}\left(\frac{A_{mt}}{A_{st}}\right)^{\alpha-1}\right]^{-\frac{1}{\epsilon}}=\left(\frac{A_{mt}}{A_{st}}\right)^{1-\alpha}, \tag{4.15}$$

where n_{st} and $1-n_{st}$ are shares of labor working in service and manufacturing sector, respectively [11].

The LHS of Equation (4.15) is the demand of service goods relative to manufacturing goods, and its RHS is the relative supply side. Whenever there is a positive shock on relative productivity[12], the supply curve moves up while the demand curve moves to the right (left one of Figure (4.5)). When ϵ is inferior to 1, demand side is dominant and employment share in services n_{st} rises[13]. That is the structural change we see in most of the developed countries in the past decades. If ϵ is superior to 1, then price effect becomes dominant and the direction of structural change will be reversed. Calibration of other parameters is identical to Table (4.6).

After a few manipulation for Equation (4.15), we get:

$$\frac{n_{st}}{1-n_{st}-\frac{\beta}{1+\beta}(1-\alpha)\frac{1}{g_{L,t}+2}}=\frac{\omega_s}{\omega_m}\left(\frac{A_{mt}}{A_{st}}\right)^{(1-\epsilon)(1-\alpha)}, \tag{4.16}$$

where $\frac{\beta}{1+\beta}(1-\alpha_m)\frac{1}{g_{L,t}+2}$ is the employment share working for investment/capital good. When population grows at a constant rate, this will be a constant share of total labor force; otherwise there will be an effect of population growth on structural change. We have the following propositions :

Proposition 1 Labor share in services rises with population growth.

Proof Given the sectoral productivity level, the LHS of Equation (4.16) decreases with higher population growth rate $g_{L,t}$. In order to make equilibrium condition hold, n_{st} rises. That is, when population growth accelerates, there is relatively less demand for investment goods[14]),

---

[10]The denominator in the LHS, i.e. the domestic consumption of manufacturing goods comes from the annulation between current acount(CA_t) and capital account (KA_t):

$$Y_{mt}-a_{m,t+1}L_{m,t}=(Y_{mt}-CA_t)-(a_{m,t+1}L_{m,t}+KA_t),$$

in which the first parenthesis represents the total supply of manufacturing goods in domestic country, and the second parenthesis represents total investment in domestic country. Since investment goods are assumed to be produced domestically, difference between the first and the second parenthesis represent domestic consumption in manufacturing goods.

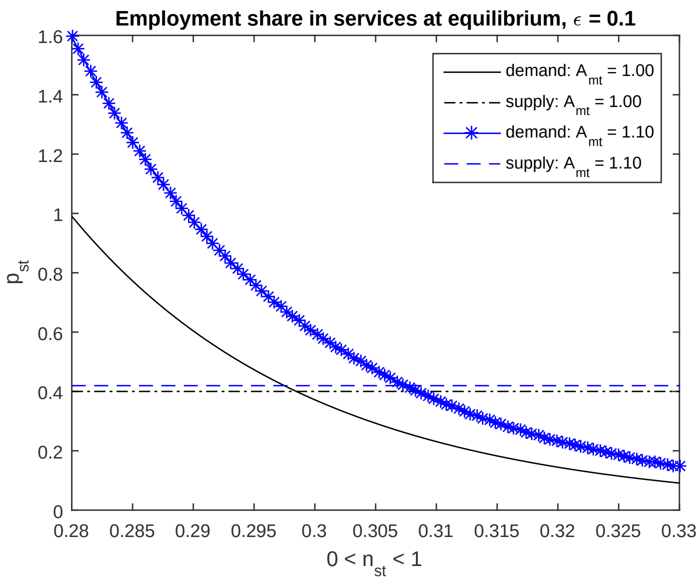
[11]$n_{st}\equiv\frac{N_{st}}{L_{y,t}+L_{m,t}}$ and $1-n_{st}\equiv\frac{N_{mt}}{L_{y,t}+L_{m,t}}$

[12]equivalent to a positive shock on relative price p_{st}

[13]We derive the threshold of ϵ from Equation (4.16).

[14]by knowing that in a small open economy, the current account and capital account cancel out each other

Figure 4.5: Equilibrium value of n_{st}, with TFP shock in manufacturing sector



which reduces the share of labor in investment (manufacturing) goods. As a result, labor in services grow. In our numerical experiment, we come back to Equation (4.15) whose LHS explains consumer demand and RHS explains relative price caused by sectoral supply. The impact of $g_{L,t}$ on n_{st} is positive but limited as in the left one of Figure (4.6). □

Proposition 2 Labor share in services rises with relaxed financial constraint θ.

Proof When $\theta \neq 0$, Equation (4.16) becomes:

$$\frac{n_{st}}{1 - n_{st} - \frac{\beta}{1+\beta}(1-\alpha)(1-\theta)\frac{1}{g_{L,t}+2}} = \frac{\omega_s}{\omega_m}\left(\frac{A_{mt}}{A_{st}}\right)^{(1-\epsilon)(1-\alpha)}, \tag{4.17}$$

Given the sectoral productivity level and population growth, the LHS decreases with θ. In order to hold the equilibrium condition, n_{st} rises. That is, when credit constraint for young is relaxed, there is less demand for investment goods because middle-aged workers lend part of their savings to the young instead of buying investment goods - which reduces labor share in the manufacturing sector[15]). As a result, labor in services grow. Quantitatively, this effect is fairly small according to our simulation in the right one of Figure (4.6). □

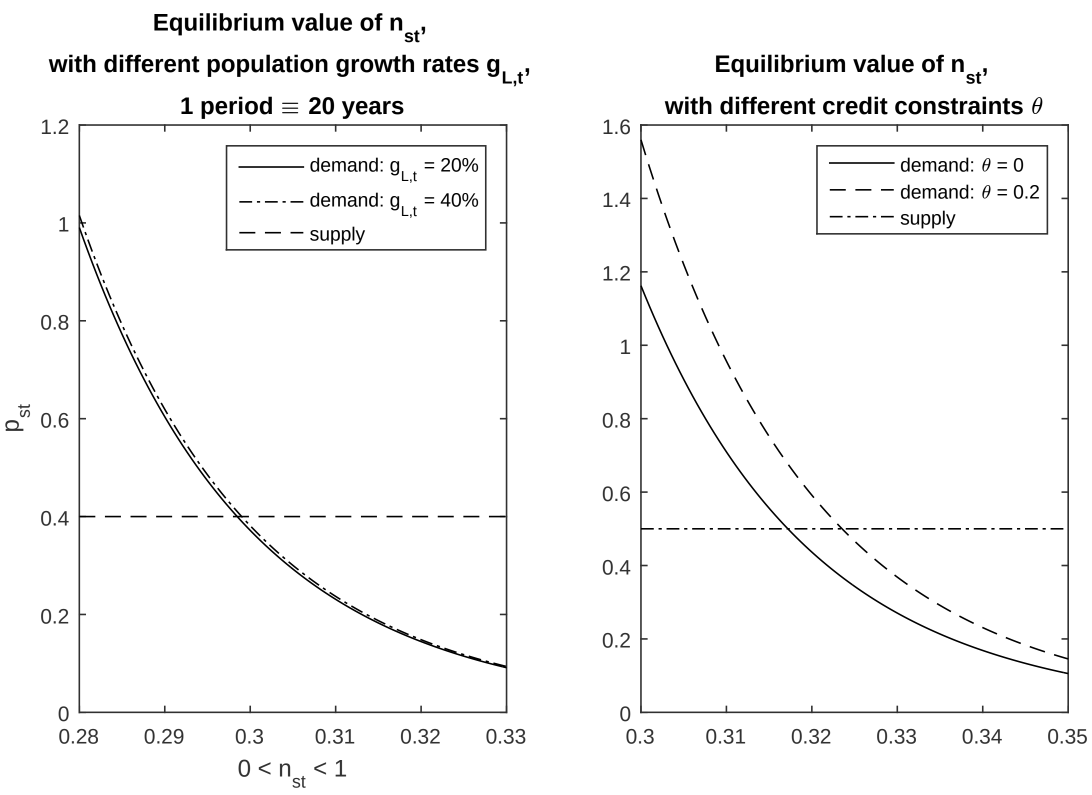
As long as growth is exogenous, the effect of demographic/financial shock is independent to the value of ϵ. In our model, even though the direction of structural change may be reversed when $\epsilon > 1$, demographic/financial shock may still have positive effect on the rise of services by reducing demand for investment/capital goods.

The question is: how big is the effect of demographic shock on service sector? According to our simulation (left subfigure of Figure (4.6) and upper-left of Figure (4.7)), with this simplified model of free labor mobility, demographic shock has positive but actually very little - almost no effect compared to the influence from TFP growth. In the following section, we add frictions like immobile middle-aged workers, non-homothetic preference functions, and

[15]by considering that in a small open economy, the current account and capital account cancel out each other

heterogenous labor-capital substitutability across sectors, and see whether they can amplify the effect of demographic shock on structural changes.

Figure 4.6: Equilibrium value of n_{st}



4.4 Complete Model

In this part, we include immobility of middle-aged workers, non-homothetic preferences, and heterogenous labor-capital elasticities of substitution into the model. Since price is flexible, whenever there are heterogenous TFP growth across sectors, p_{st} is always there to balance wages between sectors. Therefore, a very small mobility cost can demotivate middle-age workers from switching from one sector to the other. Hence, we assume that middle-age are immobile and do not write down the mobility cost explicitly in our model. The immobility of middle-aged workers is an extreme assumption basing on the fact that sectoral mobility decreases with age profile (SIPP data, Table (4.4)). Non-homothetic preferences account for the demand side, that expenditure share of service goods increases with income, and different generations have heterogenous preference for service consumption (CE PUMD data, Table (4.5)).

Furthermore, middle-aged people are the main resource of capital, because they are the only generation who save. Therefore, demographic shock in long term may influence the economy's aggregated capital stock. Since the elasticity of labor-capital substitution is heterogenous across sectors, changes in demographic structure may have important impact on the economy's sectoral structure. We capture this channel by assuming different elasticities of labor-capital substitution in manufacturing and service goods production.

The complete model has similar notations as in the toy model. Each individual maximizes his/her lifetime utility:

$$\max \log C_{y,t} + \beta \log C_{m,t+1} + \beta^2 \log C_{o,t+2} \tag{4.18}$$

with

$$C_{i,t} = [\omega_s^{\frac{1}{\epsilon}}(c_{i,st} + \bar{c_{i,s}})^{\frac{\epsilon-1}{\epsilon}} + \omega_m^{\frac{1}{\epsilon}} c_{i,mt}^{\frac{\epsilon-1}{\epsilon}}]^{\frac{\epsilon}{\epsilon-1}}. \tag{4.19}$$

The presence of $\bar{c_{i,s}}$ (Stone-Geary preference function) makes utility function non-homothetic and allows expenditure shares in services grows with income as in Kongsamut et al. (2001).

Budget constraints are:

$$\begin{aligned}
p_{st}c_{y,st} + c_{y,mt} + a_{y,t+1} &= n_{y,st}w_{y,st} + (1 - n_{y,st})w_{y,mt} && (4.20)\\
p_{st+1}c_{m,st+1} + c_{m,mt+1} + a_{m,t+2} &= n_{m,st+1}w_{m,st+1} + (1 - n_{m,st+1})w_{m,mt+1} + ra_{y,t+1} && (4.21)\\
p_{st+2}c_{o,st+2} + c_{o,mt+2} &= ra_{m,t+2} && (4.22)\\
a_{y,t} &= -\frac{\theta}{r}\{n_{m,st+1}w_{m,st+1} + (1 - n_{m,st+1})w_{m,mt+1}\}. && (4.23)
\end{aligned}$$

where $n_{i,st}, i \in \{y, m\}$ is the fraction of labor that individual of generation i allocates to the service sector.

Firms The production function is no longer Cobb-Douglas, but in CES form with different labor-capital substitutability ($\sigma_j, j \in \{s, m\}$) across sectors:

$$\begin{aligned}
Y_{jt} &= [(1-\alpha)(A_{jt}N_{jt})^{\frac{\sigma_j-1}{\sigma_j}} + \alpha K_{jt}^{\frac{\sigma_j-1}{\sigma_j}}]^{\frac{\sigma_j}{\sigma_j-1}}, && (4.24)\\
j &\in \{s, m\}.
\end{aligned}$$

4.4.1 Simulations

In this section, we would see how frictions like immobility, non-homothetic preference, and heterogenous labor-capital substitutability influence the structural change toward services. We first simulate the case of immobile middle-aged workers with homothetic preferences ($\bar{c_{j,s}} = 0, j \in \{y, m, o\}$) and Cobb-Douglas production function ($\sigma_i = 1, i \in \{s, m\}$). In the second step, we add non-homothetic preferences and heterogenous capital-labor substitutability across sectors to check the model's robustness. The simulation starts from a long run steady-state, where the economy has zero growth in both technology and population.

We set our sectoral productivity growth as $g_s = 0.21, g_m = 0.84$, which is from Groningen data for United States, where each period t represents 20 years. Results (Figure (4.7)) show that with exogenous growth, the impact of demographic shock on service sector is amplified by immobility of middle-aged workers, but remain limited (1pp population growth causes employment share in services increasing by 2pp in the past 60 years). It is the demand side, *i.e.* heterogenous sectoral productivity growth that contributes mainly to structural change in the period of 1950-2010.

Homothetic preference and immobile middle-aged workers

In this part, we have immobile middle-aged workers, homothetic preferences ($\bar{c_{j,s}} = 0, j \in \{y, m, o\}$), and Cobb-Douglas production function ($\sigma_i = 1, i \in \{s, m\}$). We assume full capital depreciation ($\delta = 1$). For the 20-year interval, we set discount factor β to 0.1, credit constraint for young to $\theta = 0.1$, and effective labor of each young to $e = 0.3$ in steady-state[16], which are not far from Coeurdacier et al. (2015). We assume that service and manufacturing goods are gross complements, and set $\epsilon = 0.1$, which is in the range of calibration of Ngai and Pissarides (2007). We choose values for interest rate r, and initial value of labor share in services n_s according to US data in 1950s. Relative price for service goods p_s is set so that market clears for manufacturing goods. Productivity of manufacturing sector A_m is normalised to 1, and we derive productivity of service sector A_s from Equation (4.14). From Equation (4.49) in Appendix, we derive the value of k_s and k_m. Then we can easily get the values of wages and consumptions from F.O.Cs of firms and households. We set capital share $\alpha = 0.5$, higher than the standard value 0.3, because we want to have the relative price level close to data ($p_s \approx 0.4$).

Table 4.6: Parameter and steady-state values, homothetic preference

Parameter		Steady-state	
β	0.10	A_m	1.00
σ_s	1.00	p_s	0.3004
σ_m	1.00	r	3.00
ω_s	0.50	g_s	0.00
ω_m	0.50	g_m	0.00
θ	0.10	g_L	0.00
ϵ	0.10	n_s	0.58
$\bar{c_{ys}}$	0.00	L_y	1.00
$\bar{c_{ms}}$	0.00	e	0.30
$\bar{c_{os}}$	0.00		
α	0.50		

Reminding that relative price is flexible which makes sectoral wages almost equivalent across time, middle-aged workers have little incentive to move between sectors. Therefore, immobile middle-aged workers have the potential to amplify the positive effect of demographic growth on the structural change [17]. Calibrating to US data, our quantitative experiment shows that the effect of demographic shock is indeed amplified by immobility of middle-aged workers(subfigure (1,1) vs. subfigure (1,2) of Figure (4.7)). Nevertheless, the effect is fairly limited: 1pp more population growth rate makes 2pp difference for labor share in services during 60 years.

Non-homothetic preferences

We apply non-homothetic preference (Stone-Geary in our case) to capture the income effect, *i.e.* Engel's law - and heterogenous demand for service goods from different age groups. Since middle-aged people earn more than the young, they are likely to consume more service goods. Therefore, this effect may neutralize the positive effects of demographic growth on service sector as shown in the previous case.

We first assume identical preference functions for young, middle-aged, and retired people, *i.e.* identical values for $\bar{c_{is}}, i \in \{y, m, o\}$. We set this parameter to match the historical rise of labor share in services from US data. Table (4.7) reports calibration of parameters and variable value, where boldfaced values are those different from in the model with homothetic

[16] We drop time index for steady-state variables.
[17] compared to the simplified model with free mobility

preferences (Table (4.6)). Our simulation shows that service sector grows faster with non-homothetic preferences, but the impact of demographic shock remains limited and close to the case with homothetic preference functions (subfigure (2,2) of Figure (4.7)).

Table 4.7: Parameter and steady-state values, non-homothetic preference

Parameter		Steady-state	
β	0.10	A_m	1.00
σ_s	1.00	r	3.00
σ_m	1.00	g_s	0.00
ω_s	0.50	g_m	0.00
ω_m	0.50	g_L	0.00
θ	0.10	e	0.30
ϵ	0.10	n_{ys}	0.58
$\bar{c_{ys}}$	**0.01**	n_{ms}	0.58
$\bar{c_{ms}}$	**0.01**	L_y	1.00
$\bar{c_{os}}$	**0.01**	p_s	**0.4065**
α	0.50		

In the second step, we test heterogenous preference functions among different age groups. We set $\bar{c_{os}} < \bar{c_{ms}} < \bar{c_{ys}}$ to match the fact that the income effect is weaker for aged population, as well as the hump-shaped expenditure share in service goods with the consumer unit's age-profile. New calibration is in Table (4.8). Our results (subfigure (3,1) of Figure (4.7)) show that the effect of demographic growth is not amplified comparing to identical preference functions (subfigure (2,2) of Figure (4.7)).

Table 4.8: Parameter and steady-state values, non-homothetic preference

Parameter		Steady-state	
β	0.10	A_m	1.00
σ_s	1.00	r	3.00
σ_m	1.00	g_s	0.00
ω_s	0.50	g_m	0.00
ω_m	0.50	g_L	0.00
θ	0.10	e	0.30
ϵ	0.10	n_{ys}	0.58
$\bar{c_{ys}}$	**0.02**	n_{ms}	0.58
$\bar{c_{ms}}$	**0.005**	L_y	1.00
$\bar{c_{os}}$	**0.002**	p_s	**0.4327**
α	0.50		

Heterogenous capital-labor substitutability

What will happen if we have heterogenous labor-capital substitutability across sectors? As middle-aged people bring more capital to the economy, sector with higher labor-capital substitutability (manufacturing sector in our case) should be able to apply more capital and shed off labor into the other sector. In this channel, the positive effect of demographic growth to structural change should be neutralized.

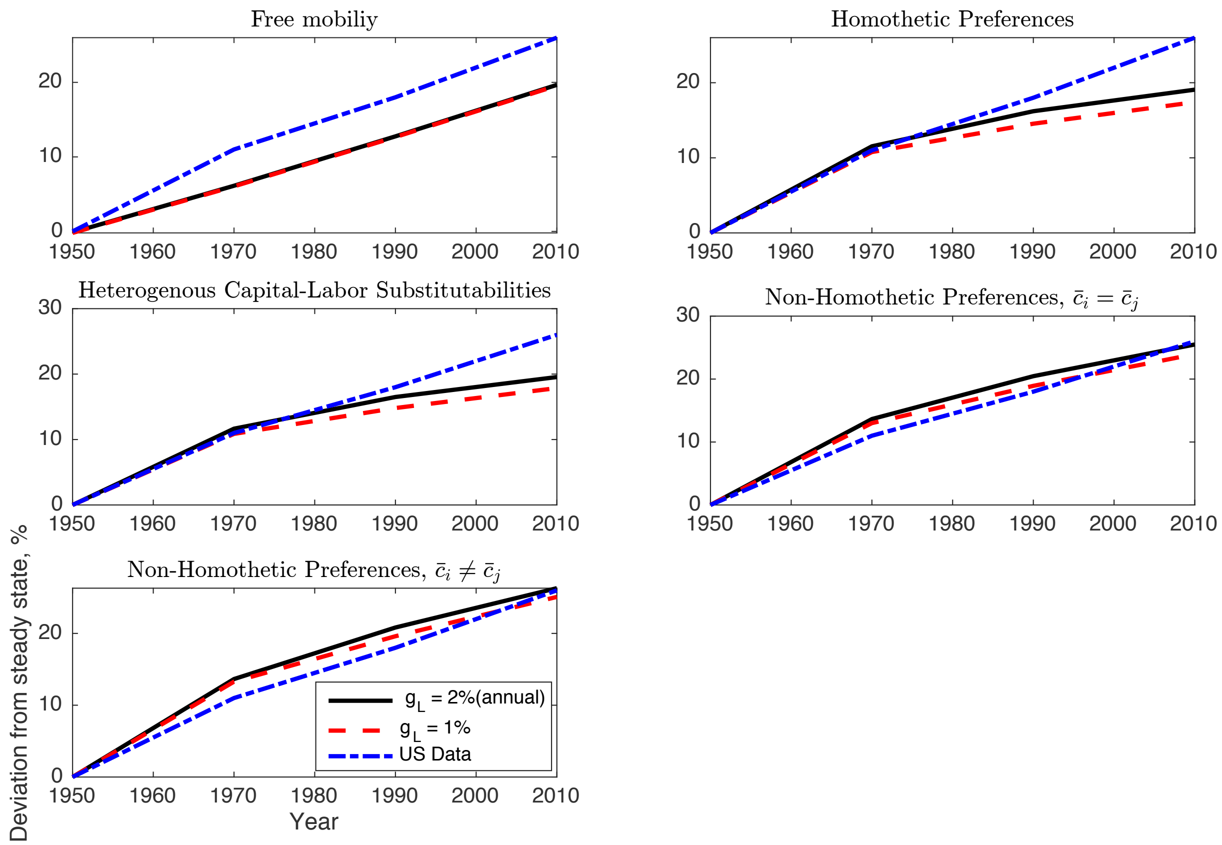
In our calibration, we take the elasticities of capital-labor substitution around Cobb-

Douglas, which is within the range of sectoral elasticities estimated by Herrendorf et al. (2015). The result is in the lower-right of Figure (4.7). The effect becomes slightly smaller than in the two previous cases, and remains very limited.

Table 4.9: Parameter and steady-state values, heterogenous capital-labor substitutability

Parameter		Steady-state	
β	0.50	A_m	1.00
σ_s	**0.95**	r	3.00
σ_m	**1.05**	g_s	0.00
ω_s	0.50	g_m	0.00
ω_m	0.50	g_L	0.00
θ	0.10	e	0.30
ϵ	0.10	n_{ys}	0.30
$\bar{c}_{ys}$	0	n_{ms}	0.30
$\bar{c}_{ms}$	0	L_y	1.00
$\bar{c}_{os}$	0	p_s	**0.4212**
α	0.50		

Figure 4.7: RFs (response functions) of employment share in services n_{st} to population growth rates and exogenous TFP shocks



Over all, frictions like non-homothetic preferences and heterogenous labor-capital substitutability have little effect on the impact of demographic shock on the rise of services.

The mobility of young and immobility of middle-aged people explain most of the effect. We then extend our model to endogenous TFP growth, and try to see whether the effect of demographic shock can be again amplified.

4.5 Endogenous Growth

We are interested in endogenous growth, because when innovation depends on labor/capital inputs, more young generation may have an impact on heterogenous TFP growth across sectors thus change the pattern of structural change. Besides, investment in innovation may be influenced by capital supply from middle-aged generation, and sensitivity of demand to demographic shocks may also be different. Endogenous growth part is the classical Schumpeterian Model from Aghion and Howitt (2009). We analyse the endogenous growth by applying Schumpeter's approach. Assuming that capital is invested merely in R&D activities. In each sector, firms are perfectly competitive, and they use two inputs - labor and a single intermediate product - according to Cobb-Douglas production function:

$$Y_{it} = (A_{it}N_{it})^{1-\alpha}x_{it}^{\alpha} \tag{4.25}$$

Growth results from innovations that raise the productivity parameter A_{it} by improving the quality of the intermediate product. The monopolist at t maximizes expected consumption by maximizing her profit Π_{it}, measured in units of manufacturing good:

$$\Pi_{xit} = p_{xit}x_{it} - x_{it} \tag{4.26}$$

where p_{xit} is the price of the intermediate good in sector i relative to the price of manufacturing good.

The representative firm in sector i maximizes her profit:

$$\Pi_{it} = p_{it}(A_{it}N_{it})^{1-\alpha}x_{it}^{\alpha} - p_{xit}x_{it} - w_{it}N_{it}. \tag{4.27}$$

Therefore, we have:

$$p_{xit} = \alpha(A_{it}N_{it})^{1-\alpha}x_{it}^{\alpha-1}. \tag{4.28}$$

According to Equation (4.26), we obtain:

$$x_{it} = \alpha^{\frac{2}{1-\alpha}}A_{it}N_{it}. \tag{4.29}$$

The equilibrium profit is:

$$\Pi_{xit} = \pi A_{it}N_{it}, \tag{4.30}$$

with

$$\pi \equiv (1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}}. \tag{4.31}$$

Then we have sector i's output function:

$$Y_{it} \quad = \quad \alpha^{\frac{2\alpha}{1-\alpha}}A_{it}N_{it}. \tag{4.32}$$

Innovation

In each sector, there is an entrepreneur who has an opportunity to innovate. If she succeeds, the innovation will create a new version of the intermediate good, which is more productive than previous versions. More specifically, the productivity of the intermediate good in use will go from last period's value A_{it-1} up to $A_{it} = \gamma_i A_{it-1}$, with $\gamma_i > 1$. If she fails, there will be no innovation, and the productivity remains the same $A_{it} = A_{it-1}$.

In order to innovate, the entrepreneur needs to conduct a costly research activity that uses manufacturing goods as its input. As indicated earlier, the research is uncertain, which may fail and generate no innovation. However, the more the entrepreneur spends on research, the more likely she is to innovate. Specifically, the probability μ_{it} that an innovation occurs in period t depends positively on the amount R_{it} spent on research, according to the innovation function:

$$\mu_{it} = \phi\Big(\frac{R_{it}}{\gamma_i A_{it-1}}\Big). \tag{4.33}$$

By denoting $m_{it} = \frac{R_{it}}{\gamma_i A_{it-1}}$, we assume

$$\phi(m_{it}) = \lambda_i m_{it}^{\sigma}, \sigma \in (0, 1). \tag{4.34}$$

Research Arbitrage

If the entrepreneur at t successfully innovates, she will become the intermediate monopolist in that period, because she will be able to produce a better (more productive) product than anyone else. Otherwise, the monopoly will pass to someone else chosen randomly who is able to produce last period's product. Therefore, the reward to a successful innovator is the profit Π_{it} that she will earn as a result. Her expected reward is thus

$$\phi(m_{it})\Pi_{it},$$

and her net benefit from research is

$$\phi\Big(\frac{R_{it}}{\gamma_i A_{it-1}}\Big)\Pi_{it} - r_t R_{it}. \tag{4.35}$$

The entrepreneur will choose the research expenditure R_{it} that maximizes this net benefit, which implies that:

$$\phi'(m_{it})\pi N_{it} = r_t. \tag{4.36}$$

We thus have:

$$m_{it} = \Big(\frac{\sigma\lambda_i \pi N_{it}}{r_t}\Big)^{\frac{1}{1-\sigma}} \tag{4.37}$$

and

$$\mu_{it} = \lambda_i^{\frac{1}{1-\sigma}}\Big(\frac{\sigma\pi N_{it}}{r_t}\Big)^{\frac{\sigma}{1-\sigma}}. \tag{4.38}$$

Therefore, the expected growth rate is:

$$g_{it} = \mu_{it}(\gamma_i - 1) = \lambda_i^{\frac{1}{1-\sigma}}\Big(\frac{\sigma\pi N_{it}}{r_t}\Big)^{\frac{\sigma}{1-\sigma}}(\gamma_i - 1). \tag{4.39}$$

Market Clearing

$$\begin{aligned} Y_{mt} + p_{st}Y_{st} &= C_{mt} + p_{st}C_{st} + p_{xmt}x_{mt} + p_{xst}x_{st} + R_{mt} + R_{st} + CA_t \qquad (4.40) \\ CA_t &\equiv X_t - M_t = KA_t \\ KA_t &\equiv R_{mt} + R_{st} - a_{y,t}L_{y,t-1} - a_{m,t}L_{m,t-1}. \end{aligned}$$

4.5.1 Theoretical Analysis

In a first-pass analysis, we focus on a simple case where we assume free mobility ($\phi_n = 0$), homothetic preferences ($\bar{c_{j,s}} = 0, j \in \{y, m, o\}$), full depreciation for capital invested in R&D ($\delta = 1$), and that the young cannot borrow ($\theta = 0$). Intermediate goods and investment goods are derived from manufactured goods, and only manufactured goods are tradable. From the equilibrium condition, we get:

$$\left(\frac{\omega_s}{\omega_m}\right)^{\frac{1}{\epsilon}}\left(\frac{Y_{st}}{Y_{mt} - p_{imt}x_{mt} - p_{ist}x_{st} - a_{mt+1}L_{mt}}\right)^{-\frac{1}{\epsilon}} = p_{st}. \tag{4.41}$$

Wages and interest rates are equal across sectors:

$$w_{y,t} = e_t\alpha^{\frac{2\alpha}{1-\alpha}}A_{mt} = e_t p_{st}\alpha^{\frac{2\alpha}{1-\alpha}}A_{st}, \tag{4.42}$$

$$w_{m,t} = \alpha^{\frac{2\alpha}{1-\alpha}}A_{mt} = p_{st}\alpha^{\frac{2\alpha}{1-\alpha}}A_{st}, \tag{4.43}$$

$$r_t = \phi'(m_{mt})\pi N_{mt} = \phi'(m_{st})\pi N_{st}. \tag{4.44}$$

By combining the expressions of wages, we have:

$$p_{st} = \frac{A_{mt}}{A_{st}} \tag{4.45}$$

We have the following proposition:

Proposition 3 Labor share in services rises with population growth. With endogenous growth, demand side is more sensitive to demographic shocks than the case of exogenous growth.

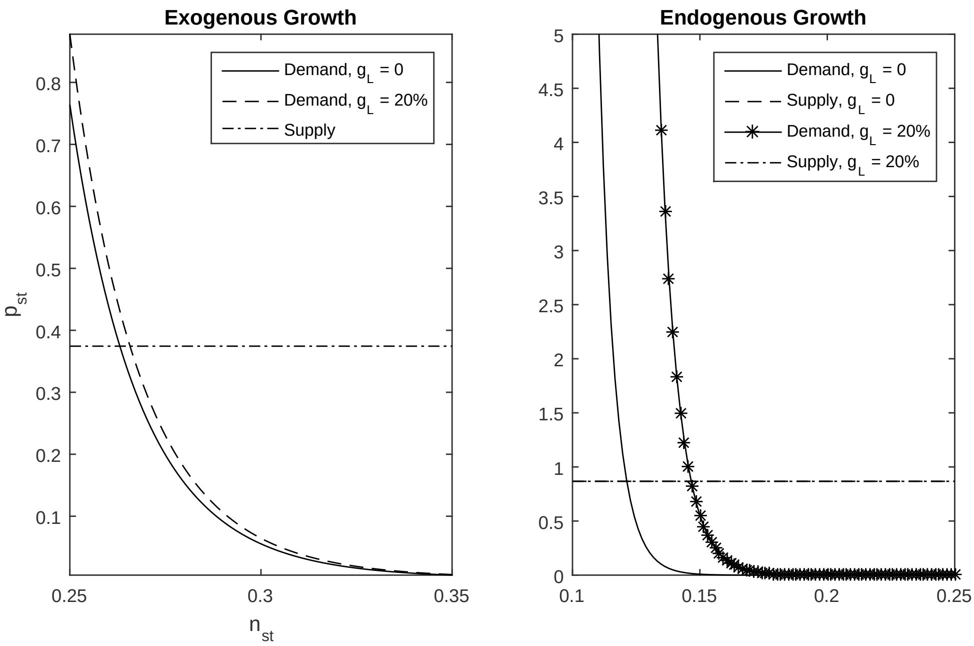
Proof We first rewrite equation (4.41) in the following form:

$$\left(\frac{\omega_s}{\omega_m}\right)^{\frac{1}{\epsilon}}\left[\frac{\alpha^{\frac{2\alpha}{1-\alpha}}A_{st}N_{st}}{\alpha^{\frac{2\alpha}{1-\alpha}}A_{mt}N_{mt} - \alpha^{\frac{1+\alpha}{1-\alpha}}A_{mt}N_{mt} - \alpha^{\frac{1+\alpha}{1-\alpha}}A_{st}N_{st} - \frac{\beta}{1+\beta}\alpha^{\frac{2\alpha}{1-\alpha}}A_{mt}L_{mt}}\right]^{-\frac{1}{\epsilon}} = \frac{A_{mt}}{A_{st}}. \tag{4.46}$$

In our simulation (the right subfigure of Figure (4.8)), the LHS of equation (4.46), which represents the demand side, is convex and decreasing in n_{st}; the RHS, which represents the supply side, remains almost constant. By taking the past values as given, according to our simulation, a positive demographic shock moves LHS to the right and increases the value of n_{st}. With endogenous growth, the demand side/LHS is more sensitive to demographic shocks, because manufactured goods are not only used for investment, but also for producing intermediate goods, which makes the LHS more sensitive to population growth. With endogenous growth, heterogenous TFP growth (RHS, the supply side) plays little role compared to demand of investment (LHS, demand side). It is due to this intermediate good effect, the effect of demographic shock on employment share in services is amplified with endogenous growth.

There are three channels that may affect structural change. First, with higher growth rate for the number of young generation, innovative activities can be boosts in both sectors and finally promote structural change toward services. Second, more young people reduces demand for investment goods, which promote structural change toward services. On the other hand, the fact that more labor working in the service sector encourages innovation in the sector, thus mitigate TFP growth gap between manufacturing and services, therefore slow down the rise of services. These three forces rises simultaneously. In our numerical examples above, we show that the first and second channel dominate and demographic growth promotes

Figure 4.8: Equilibrium value of n_{st}, exogenous vs. endogenous growth



structural change. Especially when σ is very small, *i.e.* growth is insensitive to input, the second channel still works and push labor from manufacturing to the service sector.

A natural question is: will the trend of structural change be reversed when ϵ is large? Numerically, as we can see in figure (4.9), even when the elasticity of substitution is large (for example, $\epsilon = 5.0$), demographic growth can still have positive impact on the growth of services. It is beause that the second channel (that more young reduces the demand for investment goods) is dominant, and makes the service sector grow even when sectoral goods are highly substitutable.

The property shown in Figure (4.9) is interesting, because it tells that demographic shock's impact doesn't depend on sectoral goods' substitutability. Large value of elasticity of substitution (ϵ) may reverse the direction of structural change, but it cannot reverse the effect of demographic shock. With endogenous TFP growth, it seems that the second channel, i.e. investment effect is dominant, thus demographic growth promotes the growth of service sector regardless of the actual trend of structural change.

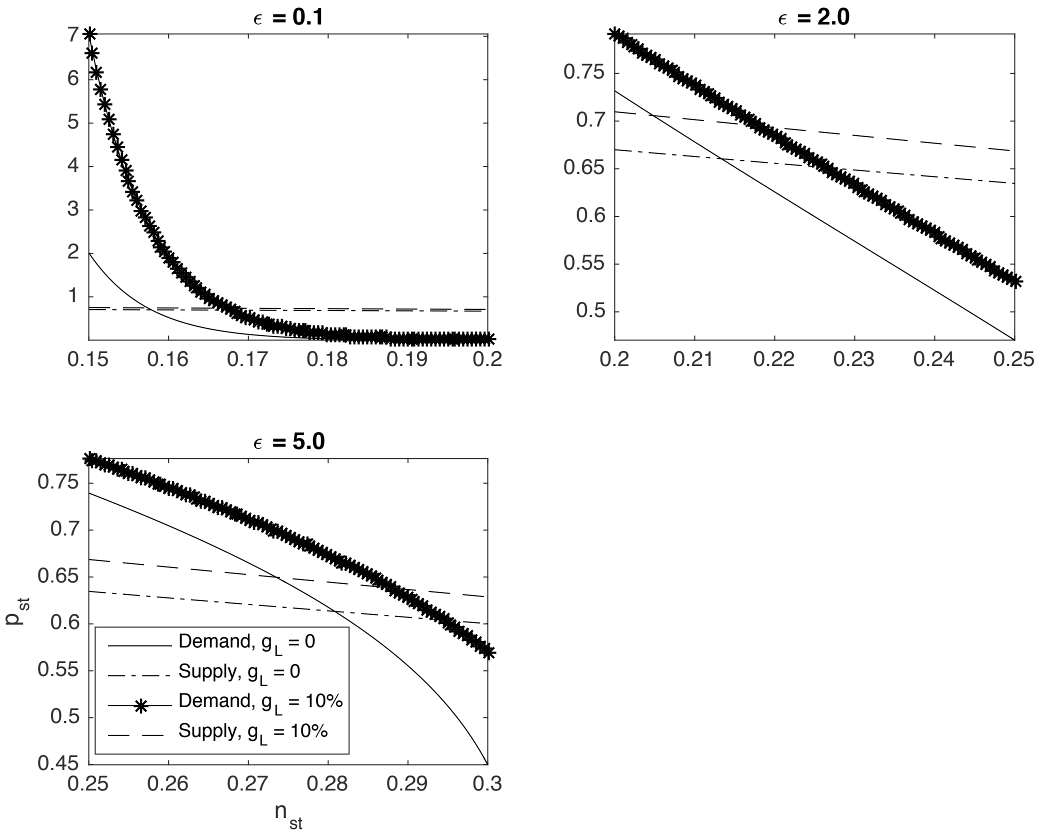
4.5.2 Simulation

In this part, we simulate our model of endogenous growth by simply adding the assumption that middle-aged workers are immobile. We do not consider frictions like non-homothetic preference functions or heteogenous labor-capital subsititutability across sectors, because we have shown that both are secondary factors in Section 4.

Calibration

In calibration, we assume that in long run steady-state, the economy has zero growth in both technology and population. Most of parameters are identical to the part of exogenous growth, except that steady-state TFP growth rates are no longer zero, since labor is always positive. We also assume full capital depreciation and homothetic preferences. In the innovation part,

Figure 4.9: Equilibrium value of n_{st}, with different ϵ



there is also no simple way to identify the parameter σ, the elasticity of new intermediate goods with respect to R&D expenditure. Griliches (1990) presents some estimates using the number of new patents as a proxy for technological change. The estimates are noisy and range from about 0.4 to 1.0, depending on the use of panel versus cross-sectional data. We accordingly set σ equal to 0.6, about the midpoint of these estimates. We choose λ to reproduce reasonable success rate for entrepreneurs (in the range of 10%), γ_s and γ_m to reproduce reasonable growth rates. In Table (4.10), new parameters compared to exogenous growth (Table (4.6) and (4.7)) are in boldface.

Results

In our simulation, one interval represents 20-year period. Demographic shock influences structural change by promoting innovation thus sectoral TFP growth rates, and more importantly, by reducing demand for investment goods. The effect of demographic shock is thus amplified to 8pp more employment share in services from 1950s to today, given 1pp more annual population growth. However, with exogenous TFP growth, the effect of 1pp more annual population growth only promote employment share in services by 2pp within 60 years (cf. Figure (4.10)).

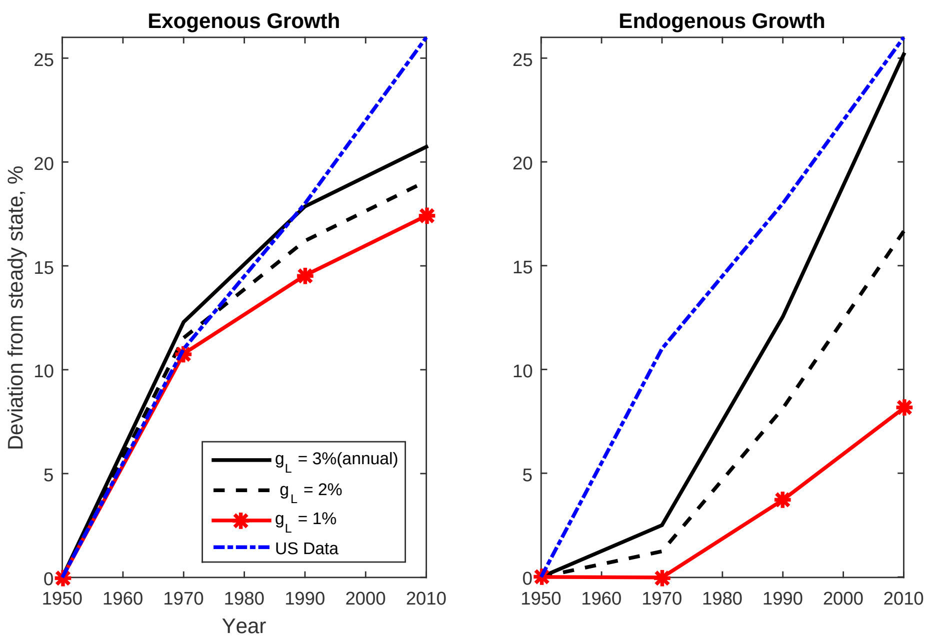
As mentioned before, there are three channels that may affect structural change. First, with higher growth rate for the number of young generation, innovative activities can be boosts in both sectors and finally promote structural change toward services. Second, more young people reduces demand for investment goods, which promote structural change toward

Table 4.10: Parameter and steady-state values

parameter		steady-state	
β	0.10	A_m	1.00
σ_s	**0.60**	r	3.00
σ_m	**0.60**	g_s	0.00
ω_s	0.50	g_m	0.00
ω_m	0.50	g_L	0.00
θ	0.10	n_{ys}	0.58
ϵ	0.10	n_{ms}	0.58
$\bar{c}_{ys}$	0.00	e	0.30
$\bar{c}_{ms}$	0.00	L_y	1.00
$\bar{c}_{os}$	0.00	p_s	**0.40**
λ_s	**5.99**		
λ_m	**7.27**		
γ_s	**3.10**		
γ_m	**9.40**		
δ	1.00		
α	**0.21**		

services. On the other hand, the fact that more labor working in the service sector encourages innovation in the sector, thus mitigate TFP growth gap between manufacturing and services, therefore slow down the rise of services. These three forces rises simultaneously. In our simulation, we not only show that the first and second channel are dominant, but also demonstrate that the impact can be significantly amplified by the immobility of middle-aged workers.

Figure 4.10: RFs (response functions) of employment share in services n_{st} to population growth rates, Exogenous vs. Endogenous sectoral TFP growths



4.6 Conclusion

In this paper, we study the potential impact of demographic shock on industrial structure. We classify three channels which may effect the structural change: labor mobility, demand, and capital stock. We establish a 3-period 2-sector OLG model, and look into the effect of each factor by shutting down the other channels. We find that while the growth of young generation may boost the growth of service sector, the effect is very limited under the assumption of exogenous TFP growth. This positive effect comes from labor supply from young workers.

We then extend our model to endogenous TFP growth. Our simulation show that the effect of demographic shock may be amplified. Effects coming from innovation surprisingly doesn't play a big role for this amplification. The amplification mainly comes from the input of intermediate goods, which makes demand more sensitive to demographic shocks. In our counterfactual experiment, 1pp more annual population growth would have increased employment share in services by 8pp today within the past 60 years in US.

4.7 Appendix

4.7.1 Proofs

Derivation for Equation (4.15)

Reminding that labor and capital are freely mobile across sectors, so we have equal wages and interest rates across sectors:

$$\begin{aligned} w_{y,t} &= e_t(1-\alpha)A_{mt}k_{mt}^{\alpha} = e_t p_{st}(1-\alpha)A_{st}k_{st}^{\alpha}, &(4.47)\\ w_{m,t} &= (1-\alpha)A_{mt}k_{mt}^{\alpha} = p_{st}(1-\alpha)A_{st}k_{st}^{\alpha}, &(4.48)\\ r_t &= \alpha k_{mt}^{\alpha-1} = p_{st}\alpha k_{st}^{\alpha-1}. &(4.49)\end{aligned}$$

where

$$k_{jt} = \frac{K_{jt}}{A_{jt}N_{jt}} \tag{4.50}$$

is the ratio of capital per efficient labor in sector j.

Combining the expressions of wages and interest rates, we set:

$$\begin{aligned} \frac{w_{y,t}}{r_t} &= \frac{1-\alpha}{\alpha}e_t A_{mt}k_{mt} = \frac{1-\alpha}{\alpha}e_t A_{st}k_{st}, &(4.51)\\ \frac{w_{m,t}}{r_t} &= \frac{1-\alpha}{\alpha}A_{mt}k_{mt} = \frac{1-\alpha}{\alpha}A_{st}k_{st}. &(4.52)\end{aligned}$$

The above relations imply that

$$k_{st} = \frac{A_{mt}}{A_{st}}k_{mt}. \tag{4.53}$$

From equation (4.77) and F.O.Cs for middle-aged and retirees, we have

$$a_{m,t+1} = \frac{\beta}{1+\beta}w_{m,t} = \frac{\beta}{1+\beta}(1-\alpha)A_{mt}k_{mt}^{\alpha}. \tag{4.54}$$

From equation (4.13), we have:

$$\left(\frac{\omega_s}{\omega_m}\right)^{\frac{1}{\epsilon}}\left(\frac{A_{st}N_{st}k_{st}^{\alpha}}{A_{mt}N_{mt}k_{mt}^{\alpha} - a_{m,t+1}L_{m,t}}\right)^{-\frac{1}{\epsilon}} = p_{st}. \tag{4.55}$$

Combining Equation (4.55) and (4.14), we get:

$$\left(\frac{\omega_s}{\omega_m}\right)^{\frac{1}{\epsilon}}\left(\frac{A_{st}N_{st}k_{st}^{\alpha}}{A_{mt}N_{mt}k_{mt}^{\alpha} - a_{m,t+1}L_{m,t}}\right)^{-\frac{1}{\epsilon}} = \left(\frac{A_{mt}}{A_{st}}\right)^{1-\alpha}. \tag{4.56}$$

For convenience, let's take

$$\begin{aligned} N_{st} &= (L_{y,t}+L_{m,t})n_{st}, &(4.57)\\ N_{mt} &= (L_{y,t}+L_{m,t})(1-n_{st}), &(4.58)\end{aligned}$$

where n_{st} and $1-n_{st}$ are shares of labor working in service and manufacturing sector, respectively.

Plugging Equations (4.58) and capital condition (4.53) into Equation (4.56), we get Equation (4.15). After a few manipulation, we have Equation (4.16).

Proof for propositon 1

Lemma The capital-effective-labor ratio k_{mt} decreases with population growth rate.

Proof We have

$$K_t = k_{mt} A_{mt} N_{mt} + k_{st} A_{st} N_{st}. \tag{4.59}$$

From equation (4.56), we can obtain the expressions of n_{mt} and n_{st}:

$$\begin{aligned} N_{mt} &= \frac{eL_{y,t} + L_{m,t} - \frac{\beta}{1+\beta}(1-\alpha_m)L_{m,t}}{1 + \frac{\omega_s}{\omega_m}(\frac{A_{mt}}{A_{st}})^{(1-\epsilon)(1-\alpha)}} + \frac{\beta}{1+\beta}(1-\alpha)L_{m,t}, \\ N_{st} &= [eL_{y,t} + L_{m,t} - \frac{\beta}{1+\beta}(1-\alpha)L_{m,t}][1 - \frac{1}{1 + \frac{\omega_s}{\omega_m}(\frac{A_{mt}}{A_{st}})^{(1-\epsilon)(1-\alpha)}}]. \end{aligned} \tag{4.60}$$

By plugging the expressions of $a_{y,t+1}$ and $a_{m,t+1}$ into the market clearing condition of capital, and combining it with equation (4.59), we get

$$\begin{aligned}
&\frac{\beta}{1+\beta}w_{m,t-1}L_{m,t-1} \qquad (4.61)\\
= \;& k_{mt}A_{mt}[\frac{eL_{y,t}+L_{m,t}-\frac{\beta}{1+\beta}(1-\alpha)L_{m,t}}{1+\frac{\omega_s}{\omega_m}(\frac{A_{mt}}{A_{st}})^{(1-\epsilon)(1-\alpha)}}+\frac{\beta}{1+\beta}(1-\alpha)L_{m,t}]\\
+ \;& k_{st}A_{st}[eL_{y,t}+L_{m,t}-\frac{\beta}{1+\beta}(1-\alpha)L_{m,t}][1-\frac{1}{1+\frac{\omega_s}{\omega_m}(\frac{A_{mt}}{A_{st}})^{(1-\epsilon)(1-\alpha)}}]\\
\Leftrightarrow \;& \frac{\beta}{1+\beta}(1-\alpha)A_{mt-1}k_{mt-1}^{\alpha}L_{m,t-1}\\
= \;& k_{mt}A_{mt}[\frac{eL_{y,t}+L_{m,t}-\frac{\beta}{1+\beta}(1-\alpha)L_{m,t}}{1+\frac{\omega_s}{\omega_m}(\frac{A_{mt}}{A_{st}})^{(1-\epsilon)(1-\alpha)}}+\frac{\beta}{1+\beta}(1-\alpha)L_{m,t}]\\
+ \;& k_{mt}A_{mt}[eL_{y,t}+L_{m,t}-\frac{\beta}{1+\beta}(1-\alpha)L_{m,t}][1-\frac{1}{1+\frac{\omega_s}{\omega_m}(\frac{A_{mt}}{A_{st}})^{(1-\epsilon)(1-\alpha)}}]\\
\Leftrightarrow \;& \frac{\beta}{1+\beta}(1-\alpha)k_{mt-1}^{\alpha}\\
= \;& k_{mt}(1+\gamma_{mt})[\frac{e(1+g_{Lt})(1+g_{Lt-1})+(1+g_{Lt-1})-\frac{\beta}{1+\beta}(1-\alpha)(1+g_{Lt-1})}{1+\frac{\omega_s}{\omega_m}(\frac{A_{mt}}{A_{st}})^{(1-\epsilon)(1-\alpha)}}\\
&+\frac{\beta}{1+\beta}(1-\alpha)(1+g_{Lt-1})]\\
+ \;& k_{mt}(1+\gamma_{mt})[e(1+g_{Lt})(1+g_{Lt-1})+(1+g_{Lt-1})\\
&-\frac{\beta}{1+\beta}(1-\alpha)(1+g_{Lt-1})][1-\frac{1}{1+\frac{\omega_s}{\omega_m}(\frac{A_{mt}}{A_{st}})^{(1-\epsilon)(1-\alpha)}}]\\
\Leftrightarrow \;& \frac{\beta}{1+\beta}(1-\alpha)k_{mt-1}^{\alpha}\\
= \;& k_{mt}(1+\gamma_{mt})(1+g_{Lt-1})\{[\frac{e(1+g_{Lt})+1-\frac{\beta}{1+\beta}(1-\alpha)}{1+\frac{\omega_s}{\omega_m}(\frac{A_{mt}}{A_{st}})^{(1-\epsilon)(1-\alpha)}}+\frac{\beta}{1+\beta}(1-\alpha)]\\
+ \;& [e(1+g_{Lt})+1-\frac{\beta}{1+\beta}(1-\alpha)][1-\frac{1}{1+\frac{\omega_s}{\omega_m}(\frac{A_{mt}}{A_{st}})^{(1-\epsilon)(1-\alpha)}}]\}\\
\Leftrightarrow \;& \frac{\beta}{1+\beta}(1-\alpha)k_{mt-1}^{\alpha}=k_{mt}(1+\gamma_{mt})(1+g_{Lt-1})\{\frac{\beta}{1+\beta}(1-\alpha)+e(1+g_{Lt})+1-\frac{\beta}{1+\beta}(1-\alpha)\}\\
\Leftrightarrow \;& \frac{\beta}{1+\beta}(1-\alpha)k_{mt-1}^{\alpha}=k_{mt}(1+\gamma_{mt})(1+g_{Lt-1})[e(1+g_{Lt})+1].
\end{aligned}$$

Therefore, given the past values of variables and other things equal, k_{mt} decreases with population growth rate $g_{L,t}$ and $g_{L,t-1}$. □

From equation (4.62), we obtain the steady-state capital-effective-labor ratio:

$$k_m=\{\frac{\beta(1-\alpha)}{(1+\beta)(1+\gamma_m)(1+g_L)[e(1+g_L)+1]}\}^{\frac{1}{1-\alpha}}. \qquad (4.62)$$

Proposition 1 Kaldor facts hold in steady-state, *i.e.* K_t and Y_t grow at the same constant rate.

Proof We have

$$K_{t+1} = \frac{\beta(1-\alpha)}{1+\beta} A_{mt} k_{mt}^{\alpha} L_{m,t}. \tag{4.63}$$

In steady-state, productivities and population grow at constant rate γ_m, γ_s, and g_L, respectively. Therefore,

$$\frac{K_{t+1}}{K_t} = (1+\gamma_m)(1+g_L). \tag{4.64}$$

On the other hand, production equals to

$$\begin{aligned} Y_t &= A_{mt} N_{mt} k_{mt}^{\alpha} + p_{st} A_{st} N_{st} k_{st}^{\alpha} \\ &= A_{mt} N_{mt} k_{mt}^{\alpha} + A_{mt} N_{st} k_{mt}^{\alpha} \\ &= A_{mt} k_{mt}^{\alpha} (e_t L_{y,t} + L_{m,t}). \end{aligned} \tag{4.65}$$

In steady-state,

$$\frac{Y_{t+1}}{Y_t} = (1+\gamma_m)(1+g_L) = \frac{K_{t+1}}{K_t}. \tag{4.66}$$

Therefore, capital-production ration remains constant overtime, *i.e.* Kaldor facts hold. □

proof for proposition 3

We apply the following relation on equation (4.46)

$$A_{it} = A_{it-1}[1 + \mu_{it}(\gamma_i - 1)], \tag{4.67}$$

and equation (4.46) becomes

$$(\frac{\omega_s}{\omega_m})^{\frac{1}{\epsilon}} [\frac{\alpha^{\frac{2\alpha}{1-\alpha}} A_{st-1}[1+\mu_{st}(\gamma_s - 1)] N_{st}}{XX - YY - ZZ}]^{-\frac{1}{\epsilon}} = \frac{A_{mt-1}[1+\mu_{mt}(\gamma_m - 1)]}{A_{st-1}[1+\mu_{st}(\gamma_s - 1)]}, \tag{4.68}$$

where

$$XX = (\alpha^{\frac{2\alpha}{1-\alpha}} - \alpha^{\frac{1+\alpha}{1-\alpha}}) A_{mt-1}[1+\mu_{mt}(\gamma_m - 1)] N_{mt}$$

$$YY = \alpha^{\frac{1+\alpha}{1-\alpha}} A_{st-1}[1+\mu_{st}(\gamma_s - 1)] N_{st}$$

and

$$ZZ = \frac{\beta}{1+\beta} \alpha^{\frac{2\alpha}{1-\alpha}} L_{mt-1} A_{mt-1}[1+\mu_{mt}(\gamma_m - 1)].$$

This is equivalent to

$$\{\frac{\frac{An_{st}}{L_t^{\frac{\sigma}{1-\sigma}}} + Bn_{st}^{\frac{1}{1-\sigma}}}{\frac{Cn_{mt}}{L_t^{\frac{\sigma}{1-\sigma}}} + \frac{Dn_{st}}{L_t^{\frac{\sigma}{1-\sigma}}} + En_{mt}^{\frac{1}{1-\sigma}} + Fn_{st}^{\frac{1}{1-\sigma}} + \frac{M}{L_t^{\frac{1}{1-\sigma}}} + \frac{Nn_{mt}^{\frac{\sigma}{1-\sigma}}}{L_t^{\frac{1+\sigma}{1-\sigma}}}}\}^{-\frac{1}{\epsilon}} = \frac{\frac{I}{L_t^{\frac{\sigma}{1-\sigma}}} + Jn_{mt}^{\frac{\sigma}{1-\sigma}}}{\frac{G}{L_t^{\frac{\sigma}{1-\sigma}}} + Hn_{st}^{\frac{\sigma}{1-\sigma}}}. \tag{4.69}$$

with $A, B, C, E, G, H, I, J > 0, D, F < 0$, $L_t \equiv L_{y,t} + L_{m,t}$, $n_{st} \equiv \frac{N_{st}}{L_t}$ and $n_{mt} \equiv \frac{N_{mt}}{L_t}$.

Specifically, parameter values are:

$$
\begin{aligned}
A &\equiv \alpha^{\frac{2\alpha}{1-\alpha}} A_{st-1} \\
B &\equiv \alpha^{\frac{2\alpha}{1-\alpha}} A_{st-1}(\gamma_s - 1)\lambda_s^{\frac{1}{1-\sigma}} (\frac{\sigma\pi}{r})^{\frac{\sigma}{1-\sigma}} \\
C &\equiv (\alpha^{\frac{2\alpha}{1-\alpha}} - \alpha^{\frac{1+\alpha}{1-\alpha}}) A_{mt-1} \\
D &\equiv -\alpha^{\frac{1+\alpha}{1-\alpha}} A_{st-1} \\
E &\equiv (\alpha^{\frac{2\alpha}{1-\alpha}} - \alpha^{\frac{1+\alpha}{1-\alpha}}) A_{mt-1}(\gamma_m - 1)\lambda_m^{\frac{1}{1-\sigma}} (\frac{\sigma\pi}{r})^{\frac{\sigma}{1-\sigma}} \\
F &\equiv -\alpha^{\frac{1+\alpha}{1-\alpha}} A_{st-1}(\gamma_s - 1)\lambda_s^{\frac{1}{1-\sigma}} (\frac{\sigma\pi}{r})^{\frac{\sigma}{1-\sigma}} \\
M &\equiv -\frac{\beta}{1+\beta}\alpha^{\frac{2\alpha}{1-\alpha}} A_{mt-1} L_{m-1} \\
N &\equiv -\frac{\beta}{1+\beta}\alpha^{\frac{2\alpha}{1-\alpha}} A_{mt-1} L_{m-1}(\gamma_m - 1)\lambda_m^{\frac{1}{1-\sigma}} (\frac{\sigma\pi}{r})^{\frac{\sigma}{1-\sigma}} \\
G &\equiv A_{st-1} \\
H &\equiv A_{st-1}(\gamma_s - 1)\lambda_s^{\frac{1}{1-\sigma}} (\frac{\sigma\pi}{r})^{\frac{\sigma}{1-\sigma}} \\
I &\equiv A_{mt-1} \\
J &\equiv A_{mt-1}(\gamma_m - 1)\lambda_m^{\frac{1}{1-\sigma}} (\frac{\sigma\pi}{r})^{\frac{\sigma}{1-\sigma}}
\end{aligned}
\tag{4.70}
$$

4.7.2 threshold for ϵ

To determine the threshold of ϵ, first remind us the equilibrium condition (4.69), and let us define:

$$
\begin{aligned}
F(n_{st}, L_t) &= \frac{\frac{An_{st}}{L_t^{\frac{\sigma}{1-\sigma}}} + Bn_{st}^{\frac{1}{1-\sigma}}}{\frac{Cn_{mt}}{L_t^{\frac{\sigma}{1-\sigma}}} + \frac{Dn_{st}}{L_t^{\frac{\sigma}{1-\sigma}}} + En_{mt}^{\frac{1}{1-\sigma}} + Fn_{st}^{\frac{1}{1-\sigma}} + \frac{M}{L_t^{\frac{1}{1-\sigma}}} + \frac{Nn_{mt}^{\frac{\sigma}{1-\sigma}}}{L_t}} - \{\frac{\frac{G}{L_t^{\frac{\sigma}{1-\sigma}}} + Hn_{st}^{\frac{\sigma}{1-\sigma}}}{\frac{I}{L_t^{\frac{\sigma}{1-\sigma}}} + Jn_{mt}^{\frac{\sigma}{1-\sigma}}}\}^{\epsilon} \\
&= P - Q^{\epsilon},
\end{aligned}
\tag{4.71}
$$

with

$$
\begin{aligned}
P &\equiv \frac{\frac{An_{st}}{L_t^{\frac{\sigma}{1-\sigma}}} + Bn_{st}^{\frac{1}{1-\sigma}}}{\frac{Cn_{mt}}{L_t^{\frac{\sigma}{1-\sigma}}} + \frac{Dn_{st}}{L_t^{\frac{\sigma}{1-\sigma}}} + En_{mt}^{\frac{1}{1-\sigma}} + Fn_{st}^{\frac{1}{1-\sigma}} + \frac{M}{L_t^{\frac{1}{1-\sigma}}} + \frac{Nn_{mt}^{\frac{\sigma}{1-\sigma}}}{L_t}} \\
Q &\equiv \frac{\frac{G}{L_t^{\frac{\sigma}{1-\sigma}}} + Hn_{st}^{\frac{\sigma}{1-\sigma}}}{\frac{I}{L_t^{\frac{\sigma}{1-\sigma}}} + Jn_{mt}^{\frac{\sigma}{1-\sigma}}}.
\end{aligned}
\tag{4.72}
$$

Taking the derivative for implicit functions, we get:

$$\frac{\partial n_{st}}{\partial L_t} = -\frac{\partial F/\partial L_t}{\partial F/\partial n_{st}}.$$

In order to calculate the threshold for ϵ, we set:

$$\frac{\partial n_{st}}{\partial L_t} = -\frac{\partial F/\partial L_t}{\partial F/\partial n_{st}} = 0,$$

which is equivalent to

$$\frac{\partial F}{\partial L_t} = 0. \tag{4.73}$$

By plugging the definition of F into equation (4.73), and after some manipulations, we have

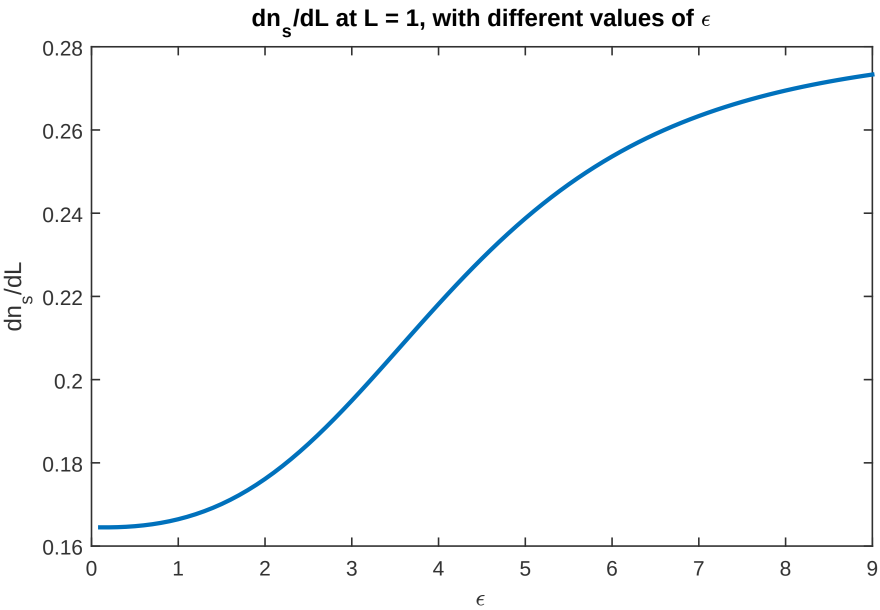
$$\epsilon Q^{\epsilon-1} = S,$$

where

$$S \equiv \frac{\partial P/\partial L_t}{\partial Q/\partial L_t}. \tag{4.74}$$

So here we see that the expression of ϵ is fairly complicated and depends on many factors. Analytically, it is difficult to solve. However, basing on this expression (equation (4.74)), we can give some numerical experiments given the values of other parameters and variables. A simple illustration is shown in figure (4.11).

Figure 4.11: $\frac{dn_s}{dL}(\epsilon)|_{L=1}$, with different values of ϵ



4.7.3 F.O.Cs

Exogenous Growth: homothetic preferences

F.O.C for young:

$$\begin{aligned} \omega_s^{\frac{1}{\epsilon}} c_{y,st}^{-\frac{1}{\epsilon}} C_{y,t}^{\frac{1}{\epsilon}-1} &= \lambda_{y,t} p_{st}, \\ \omega_m^{\frac{1}{\epsilon}} c_{y,mt}^{-\frac{1}{\epsilon}} C_{y,t}^{\frac{1}{\epsilon}-1} &= \lambda_{y,t}. \end{aligned} \tag{4.75}$$

F.O.C for middle-aged:

$$\begin{aligned} \omega_s^{\frac{1}{\epsilon}} c_{m,st+1}^{-\frac{1}{\epsilon}} C_{m,t+1}^{\frac{1}{\epsilon}-1} &= \lambda_{m,t+1} p_{st+1}, \\ \omega_m^{\frac{1}{\epsilon}} c_{m,mt+1}^{-\frac{1}{\epsilon}} C_{m,t+1}^{\frac{1}{\epsilon}-1} &= \lambda_{m,t+1}, \\ r &= \frac{\lambda_{m,t+1}}{\beta \lambda_{o,t+2}}. \end{aligned} \tag{4.76}$$

F.O.C for retired:

$$\begin{aligned} \omega_s^{\frac{1}{\epsilon}} c_{o,st+2}^{-\frac{1}{\epsilon}} C_{o,t+2}^{\frac{1}{\epsilon}-1} &= \lambda_{o,t+2} p_{st+2}, \\ \omega_m^{\frac{1}{\epsilon}} c_{o,mt+2}^{-\frac{1}{\epsilon}} C_{o,t+2}^{\frac{1}{\epsilon}-1} &= \lambda_{o,t+2}. \end{aligned} \tag{4.77}$$

Exogenous Growth: non-homothetic preferences

F.O.C for young:

$$\begin{aligned} \omega_s^{\frac{1}{\epsilon}} (c_{y,st} + \bar{c_{y,s}})^{-\frac{1}{\epsilon}} C_{y,t}^{\frac{1}{\epsilon}-1} &= \lambda_{y,t} p_{st}, \\ \omega_m^{\frac{1}{\epsilon}} c_{y,mt}^{-\frac{1}{\epsilon}} C_{y,t}^{\frac{1}{\epsilon}-1} &= \lambda_{y,t} \\ \lambda_{y,t}(w_{y,st} - w_{y,mt}) + \lambda_{m,t+1} \beta \phi_n (n_{m,st+1} - n_{y,st}) &= 0. \end{aligned} \tag{4.78}$$

Middle-age:

$$\begin{aligned} \omega_s^{\frac{1}{\epsilon}} (c_{m,st+1} + \bar{c_{m,s}})^{-\frac{1}{\epsilon}} C_{m,t+1}^{\frac{1}{\epsilon}-1} &= \lambda_{m,t+1} p_{st+1}, \\ \omega_m^{\frac{1}{\epsilon}} c_{m,mt+1}^{-\frac{1}{\epsilon}} C_{m,t+1}^{\frac{1}{\epsilon}-1} &= \lambda_{m,t+1} \\ (w_{m,st+1} - w_{m,mt+1}) - \phi_n (n_{m,st+1} - n_{y,st}) &= 0 \\ r &= \frac{\lambda_{m,t+1}}{\beta \lambda_{o,t+2}}. \end{aligned} \tag{4.79}$$

Retired:

$$\begin{aligned} \omega_s^{\frac{1}{\epsilon}} (c_{o,st+2} + \bar{c_{o,s}})^{-\frac{1}{\epsilon}} C_{o,t+2}^{\frac{1}{\epsilon}-1} &= \lambda_{o,t+2} p_{st+2}, \\ \omega_m^{\frac{1}{\epsilon}} c_{o,mt+2}^{-\frac{1}{\epsilon}} C_{o,t+2}^{\frac{1}{\epsilon}-1} &= \lambda_{o,t+2}. \end{aligned} \tag{4.80}$$

Chapitre 5

Financial Integration and Labor Mobility in The Monetary Union

5.1 Introduction

In the aftermath of 2008 financial crisis, the divergent performances across EMU member countries become the focus of policy debate (Figure (5.1)). The discuss on Optimum Currency Area comes back to people's sight. Among the various remedies, factor mobility is considered to be a potential cure. What is the effect of factor mobility facing asymmetric shocks? Regarding to the recent experience of European Monetary Union, factor mobility, especially the labor mobility is on the agenda of policy makers. Despite the apparent importance of labor and capital mobility for the stability of a currency union, there is few widely accepted studies on the interactions between labor and capital mobilities. By establishing a two-country model, we study the potential interactions between financial integration and labor mobility facing asymmetric shocks in the currency union. Our results show that while labor mobility reduces unemployment rates, financial mobility in contrast increases unemployment rates in both economies. Interestingly, factor mobility might not stimulate production due to the fall in employment. We find that shocks on financial mobility cost have secondary effects compared to shocks on labor mobility cost. We also calibrate our model to the EMU and simulate scenario to mimic the recent experiences across EMU member countries. Our results suggests that the divergence of member countries might not be due to asymmetric TFP shocks, but rather its association with the rise/increase of labor mobility costs.

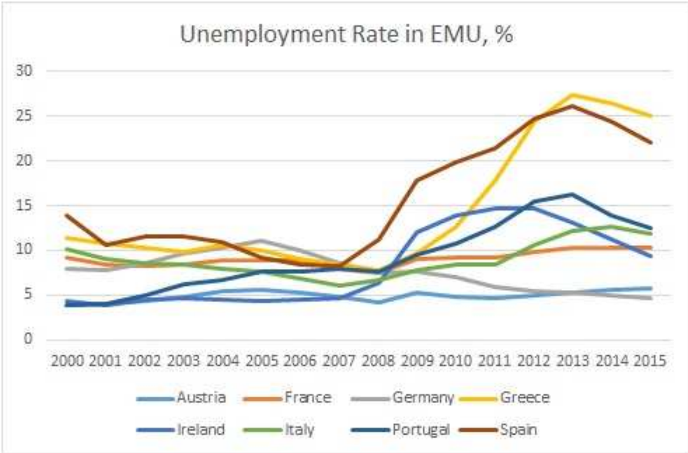
In the influential paper of Mundell (1961), Mundell proposed two important channels for an optimum currency area: 1. internal labor mobility; and 2. price and wage flexibility. For the first, asymmetric shocks lead to labor market imbalances across member countries. Labor mobility helps alleviate unemployment pressure in countries hit by negative shocks, since unemployed workers can choose to move to another member countries in which it is easier to find a new job. For the second, with flexible prices and wages, the region hit by negative shocks may automatically adjust/lower its price and wage level, which restores its competitivity and stimulate demand from the goods and labor markets. In EMU, although the financial market seems to be well integrated, labor mobility is still low relative to the United States. In EMU, workers from other member countries represent only 3% of total labor force compare to 30% across the US states[1].

On the capital side, many research papers show that financial integration or a high capital mobility helps diversify portfolio investment and thus reduce risk from asymmetric shocks. Nevertheless, Krugman (1993) argues that capital mobility tends to amplify regional asymmetric shocks. Krugman (1993)'s arguments are consistent with literatures concerning the financial accelerator. In our experiment, we find that a higher degree of banker's mobility may reduce local credit supply and reduce local job creation. Therefore, there will be more stay unemployed workers and naturally more stay unemployed workers will decide to move.

[1]See, for example, Arpaia, Kiss, Palvolgyi and Turrini (2015) and Curdia and Nechio (2017).

Therefore, similar to Krugman (1993), capital mobility does not necessarily have positive impact in our model.

Figure 5.1: Unemployment rates across EMU member countries



We establish a theoretical model to study the interaction between factor mobilities. Similar to Pilossoph (2014), our theory is based on three literatures: the country-specific labor market dynamics from the island model in Lucas and Prescott (1974), search and matching in local labor market from Mortensen and Pissarides (1994), and worker's mobility choice from Discret Choice Theory. The worker's mobility choice is similar to the self-selection model in Roy (1951). Besides the pecuniary moving cost including transport, rent, etc., we also assume that when a worker moves to another country, he/she takes one more period to learn and adapt to the new environment, which we also consider as a form of mobility cost. The financial friction part is also search and matching which is similar to Wasmer and Weil (2004). Bankers have the same mobility choice as workers. We assume that entrepreneurs are local and do not move across countries. We first simulate the model with symmetric calibration, and we find that reducing labor mobility cost helps releasing labor market tightness, thanks to less staying unemployed workers. The effect of financial mobility cost is very small compared to the effects on labor mobility cost. We then calibrate the model with asymmetric choices according to core and periphery EMU member countries. Our results show that asymmetric TFP shocks alone have very limited impact on the labor market, but the association with reductions in labor mobility costs does have significant impact to reduce unemployment rates and improve employment rates.

Related literatures include Mundell (1961) who emphasized the role of factor mobility and price flexibility in the Optimum Currency Union. Recently, Farhi and Werning (2014) study the role of labor mobility within a currency union suffering from nominal rigidities. By combining trade openness and labor mobility, Farhi and Werning (2014) study the impact of labor mobility in the scenarios with external and internal shocks, respectively. Please refer to Dellas and Tavlas (2009) for more detailed literature reviews on the OCA theory.

Our paper is organised as following: in Section 2, we represent the theoretical model; in Section 3, we calibrate the two-countrt model under the symmetric case and simulate the scenario with deterministic and stochastic shocks on productivity and factor mobility costs; in Section 4, we do the same experiment in the asymmetric case by calibrating the model to the European Monetary Union, and mimic the scenario after 2008 financial crisis; Section 5 concludes our results.

5.2 Model

The model consists of two countries, and in each country there are three types of agents: entrepreneurs, workers and bankers. We assume that entrepreneurs' activities are local. Workers work for entrepreneurs and can choose which country to stay (labor mobility). Bankers have capital and can choose which country to invest in (financial integration).

5.2.1 Consumption

Consumers optimize their utility basing on their consumption C_t, which is the composite (CES) of consumption in goods produced in the two countries:

$$C_t = [\omega_s^{\frac{1}{\epsilon}} c_{i,t}^{\frac{\epsilon-1}{\epsilon}} + \omega_m^{\frac{1}{\epsilon}} c_{j,t}^{\frac{\epsilon-1}{\epsilon}}]^{\frac{\epsilon}{\epsilon-1}}, \tag{5.1}$$

with $c_{i,t}$ and $c_{j,t}$ the consumption of goods produced in country i and country j, and ω_i, ω_j the relative weights of goods produced in the two countries.

By minimizing the cost, we have:

$$\left(\frac{\omega_i}{\omega_j}\right)^{\frac{1}{\epsilon}} \left(\frac{c_{i,t}}{c_{j,t}}\right)^{-\frac{1}{\epsilon}} = p_{i,t}, \tag{5.2}$$

where $p_{i,t}$ is the relative price of goods produced in country i.

5.2.2 Workers

As in Pilossoph (2014), there are three distinct states of the workers: employment, stay unemployment, and move unemployment. Let W_i, S_i, and $S_j - \eta$ represent their respective values, where S_j is the value of stay unemployment in country j and η is the moving cost. If δ_i represents the exogenous separation probability in country i and w_i represents the worker's wage, the value of a job to an employed worker l in country i (net of idiosyncratic taste shocks) is given by:

$$\begin{aligned} W_{i,t} &= w_{i,t} + (1-\delta_i)\beta E_t(W_{i,t+1} + \epsilon_{i,l,t+1}) \\ &+ \delta_i \beta E_t[\max(S_{i,t+1} + \epsilon_{i,l,t+1}, S_{j,t+1} - \eta + \epsilon_{j,l,t+1})], \end{aligned} \tag{5.3}$$

where $\epsilon_{i,l,t+1}$ represents the worker's taste draw for next period in country i. The value of being a stay unemployed worker in country i for worker l (net of idiosyncratic taste shocks) is given by:

$$\begin{aligned} S_{i,t} &= b_i + f_i(\theta_{i,t})\beta E_t(W_{i,t+1} + \epsilon_{i,l,t+1}) \\ &+ (1 - f_i(\theta_{i,t}))\beta E_t[\max(S_{i,t+1} + \epsilon_{i,l,t+1}, S_{j,t+1} - \eta + \epsilon_{j,l,t+1})], \end{aligned} \tag{5.4}$$

where b_i is the value of leisure for the unemployed (or unemployment benefit).

5.2.3 Labor Market

Each country has their own labor market, therefore country-specific unemployment rates. For country i, the labor force consists of three groups: the employed ($e_{i,t}$), unemployed who stay in the same country ($s_{i,t}$), and unemployed who decide to leave to the other country ($m_{ij,t}$).

$$l_{i,t} = e_{i,t} + s_{i,t} + m_{ij,t}. \tag{5.5}$$

We define the matching function in country i's labor market as:

$$\Gamma_i(v_{i,t}, s_{i,t}) = \sigma_i v_{i,t}^g s_{i,t}^{1-g}, \tag{5.6}$$

where $v_{i,t}$ is the number of job vacancies, and $s_{i,t}$ is the number of stay unemployed people looking for jobs. We define the country's labor market tightness as $\theta_{i,t} = \frac{v_{i,t}}{s_{i,t}}$. We define $q_i(\theta_{i,t}) = \frac{\Gamma_i(v_{i,t}, s_{i,t})}{v_{i,t}}$ the probability for a job vacancy to be filled by the proper employee, and $f_i(\theta_{i,t}) = \frac{\Gamma_i(v_{i,t}, s_{i,t})}{s_{i,t}}$ the probability for a job seeker to find a job.

The stock of employed workers in country i in period $t+1$ is given by:

$$e_{i,t+1} = e_{i,t}(1-\delta_i) + s_{i,t} f_i(\theta_{i,t}). \tag{5.7}$$

5.2.4 Bankers

There are three distinct states of the bankers: maintaining contract with an entrepreneur, contract finished and keep investing in the same country, and contract finished and looking for investment in the other country. Let W_i^b, S_i^b, and $S_j^b - \eta^b$ represent their respective values. If δ_i^b represents the exogenous separation probability in country i, for banker l, the value of maintaining contract with an entrepreneur in country i (net of idiosyncratic taste shocks) is given by:

$$\begin{aligned} W_{i,t}^b &= (1-\delta_i)\rho_{i,t} - \delta_i c_{1i}^e + (1-\delta_i^b)\beta E_t(W_{i,t+1}^b + \epsilon_{i,l,t+1}) \\ &\quad + \delta_i^b \beta E_t[\max(S_{i,t+1}^b + \epsilon_{i,l,t+1}, S_{j,t+1}^b - \eta^b + \epsilon_{j,l,t+1})], \end{aligned} \tag{5.8}$$

where $\epsilon_{i,l,t+1}$ represents the banker's taste draw for next period in country i. With probability $1-\delta_i^b$, the banker enjoys repayment from the entrepreneur; with probability δ_i, the banker finances the entrepreneur to recruit workers with recruitment cost c_{1i}^e. The value of looking for investment in the same country i for banker l (net of idiosyncratic taste shocks) is given by:

$$\begin{aligned} S_{i,t}^b &= -c_i^b + q_i(\phi_{i,t})\beta E_t(W_{i,t+1}^b + \epsilon_{i,l,t+1}) \\ &\quad + (1-q_i(\phi_{i,t}))\beta E_t[\max(S_{i,t+1}^b + \epsilon_{i,l,t+1}, S_{j,t+1}^b - \eta^b + \epsilon_{j,l,t+1})], \end{aligned} \tag{5.9}$$

where c_i^b is the value of search effort for the banker.

5.2.5 Credit Market

The credit markets within each country are subject to standard search frictions. For each country i, let $b_{i,t}$ denote the total size of bankers. The investment will consist of current contracted bankers $w_{i,t}^b$ and stayers/movers. Stayers $s_{i,t}^b$ will be bankers searching for investment in country i. Movers $m_{ij,t}^b$ will be bankers searching for investment in country j. Thus, the total bankers' size in country i will be given by:

$$b_{i,t} = w_{i,t}^b + s_{i,t}^b + m_{ij,t}^b. \tag{5.10}$$

The probability that stayers in country i meet jobs in country i is determined by the country-specific matching function $\Gamma_i^b(v_{i,t}^b, s_{i,t}^b)$, where $v_{i,t}^b$ represents the total number of investment vacancies in country i. $\Gamma_i^b(v_{i,t}^b, s_{i,t}^b)$ is constant returns to scale and has the particular form:

$$\Gamma_i^b(v_{i,t}^b, s_{i,t}^b) = \sigma_i^b (v_{i,t}^b)^g (s_{i,t}^b)^{1-g}. \tag{5.11}$$

where σ_i^b is the country-specific match efficiency and g is the vacancy share of the matching function. Letting $\phi_{i,t} = \frac{v_{i,t}^b}{s_{i,t}^b}$ denote the country's credit market tightness, the probability that vacancies in country i turn into investment is given by $q_i(\phi_{i,t}) = \frac{\Gamma_i^b(v_{i,t}^b, s_{i,t}^b)}{v_{i,t}^b}$. The probability that job seekers find jobs in country i is given by $f_i(\phi_{i,t}) = \frac{\Gamma_i^b(v_{i,t}^b, s_{i,t}^b)}{s_{i,t}^b}$. Therefore, the transition probabilities satisfy the standard relationship $f_i(\phi_{i,t}) = q_i(\phi_{i,t})\phi_{i,t}$.

The stock of contracted bankers in country i in period $t+1$ is given by:

$$e_{i,t+1}^b = e_{i,t}^b(1-\delta_i) + s_{i,t}^b f_i(\phi_{i,t}). \tag{5.12}$$

5.2.6 Entrepreneurs

Turning to the entrepreneurs, each entrepreneur has three states: maintaining contract with the banker and the worker, maintaining contract with the banker but breaking up contract with the worker, and terminating the banking contract. Let W_{1i}^e, W_{2i}^e, S_i^e represent their respective values. The value of maintaining contract with a banker and a worker in country i (net of idiosyncratic taste shocks) is given by:

$$W_{1i,t}^e = p_i y_{i,t} - w_{i,t} - \rho_{i,t} + (1-\delta_i^b)\beta E_t[(1-\delta_i)W_{1i,t+1}^e + \delta_i W_{2i,t+1}^e] + \delta_i^b \beta E_t(S_{i,t+1}^e), \tag{5.13}$$

The value of maintaining contract with a banker and breaking up with the worker in country i (net of idiosyncratic taste shocks) is given by:

$$W_{2i,t}^e = (1-\delta_i^b)\beta E_t[q_i(\theta_{i,t+1})W_{1i,t+1}^e + (1-q_i(\theta_{i,t+1}))W_{2i,t+1}^e] + \delta_i^b \beta E_t(S_{i,t+1}^e), \tag{5.14}$$

The value of looking for investment in the same country i for entrepreneur l (net of idiosyncratic taste shocks) is given by:

$$S_{i,t}^e = -c_{2i}^e + f_i(\phi_{i,t})\beta E_t(W_{2i,t+1}^e) + (1-f_i(\phi_{i,t}))\beta E_t(S_{i,t+1}^e), \tag{5.15}$$

where c_{2i}^e represent the searching cost for the entrepreneurs.

Production follows the form:

$$y_{i,t} = a_{i,t}. \tag{5.16}$$

The wage $w_{i,t}$ is determined by the bargaining between the entrepreneur and the worker:

$$(1-bargain)(W_{i,t} - S_{i,t}) = bargain(W_{1i,t}^e - W_{2i,t}^e). \tag{5.17}$$

The financing cost $\rho_{i,t}$ is similarly determined by the bargaining between the banker and the entrepreneur:

$$(1-bargain)(W_{2i,t}^e - S_{i,t}^e) = bargain(W_{i,t}^b - S_{i,t}^b). \tag{5.18}$$

5.3 Symmetric Case

5.3.1 Calibration

In the calibration part, we first consider a symmetric case, in which two countries have identical characters. We set quarterly discount rate β to 0.99, corresponding to an annual interest rate around 4%. The breaking up rate δ is set to 0.03, consistent to Abowd and Zellner (1985)'s finding and a broad literature[2]. The unemployment benefit b is about 40%

[2]See, for example, Auray, Fuller, Lkhagvasuren and Terracol (2017) and Shimer (2005).

of income as in Shimer (2005). We assume the vacancy filling rate $q(\theta) = 1.2$ corresponding to a monthly vacancy rate at 40%. The credit matching efficiency $f(\phi) = 0.5$, equivalent to a monthly matching efficiency at 1/6. Seperation rates $\delta = \delta_b = 0.03$. Unemployment benefit is set to 40% of wage. Consistent to literature Morten and Oliveira (2016), migration cost is about 0.8 to 1.2 times of annual wage, we set $\eta = \eta_b = 4 * w$ in benchmark setting. For the matching function, we choose the value of $g = 0.5$, and $\sigma = 0.5$ for the labor market and $\sigma_b = 0.525$ for the credit market, comparable to Shimer (2005) and Petrosky-Nadeau and Wasmer (2013). For the Discret Choice function, we set the value of $\rho = 0.3$ as in Pilossoph (2014). The elasticity of substitution ϵ is set to 1.20, implying that goods produced in the two countries are subsitutable rather than complementary. The recruitment cost c^e_{1i} is set to 3.6% of annual wage. We assume symmeric searching cost in the credit market, i.e. $c^b_i = c^e_{2i}$.

Table 5.1: Parameterization

Parameter	
β	0.99
δ	0.03
σ	0.5
σ_b	0.525
g	0.5
ρ	0.3
ϵ	1.20
η	0.26
η_b	0.26
b	0.026
c^b_i	1.56
c^e_{1i}	0.009
c^e_{2i}	1.56

5.3.2 Simulation

Shocks on Productivity and Mobility Costs

In this part, we simulate the scenario in which country j experience a negative TFP shock, and we compare the scenario with different labor or banker mobility costs.

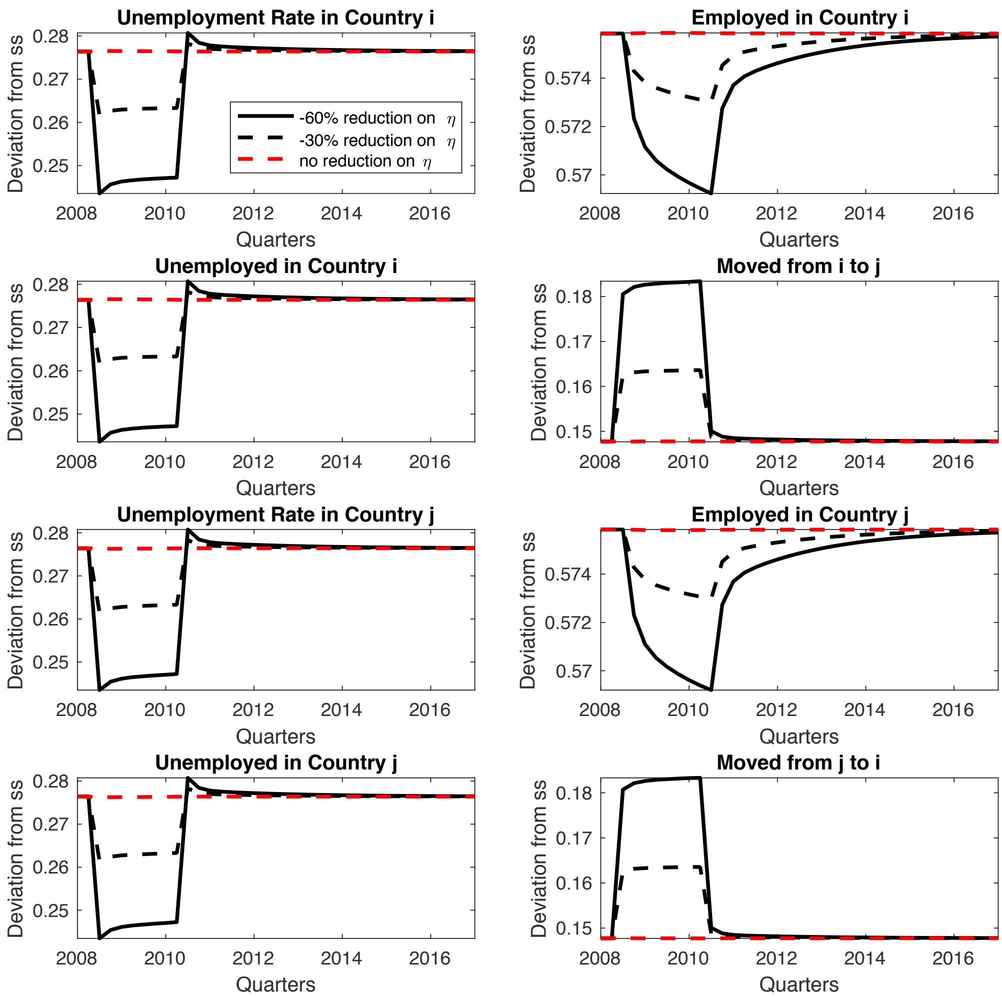
When labor mobility cost η decreases, the probability for unemployed to stay π_{ii} declines, which reduces the flow of unemployed people in domestic country. For this reason, unemployment rate falls (Figure 5.2).

When financial mobility cost η_b decreases, the probability for bankers to stay π^b_{ii} decreases, which reduces potential funding in the domestic country. For this reason, it is more difficult for entrepreneurs to find financial support, thus create less jobs. As a result, unemployment rate rises (Figure 5.3).

Robustness Test - Wage & Price Rigidities

In this section, we test the robustness of the model with wage and price rigidities. Within a currency union, the adjustment channels facing asymmetric shocks include : 1. wage adjustment 2. price adjustment and 3. labor and capital mobility. By assuming always a -1% TFP shock in country j, and a corresponding -30% reduction on labor mobility cost, we compare between scenarios with different wage rigidities. Our simulation shows that wage

Figure 5.2: simulation of -1% TFP shock in country j, η represents labor mobility cost

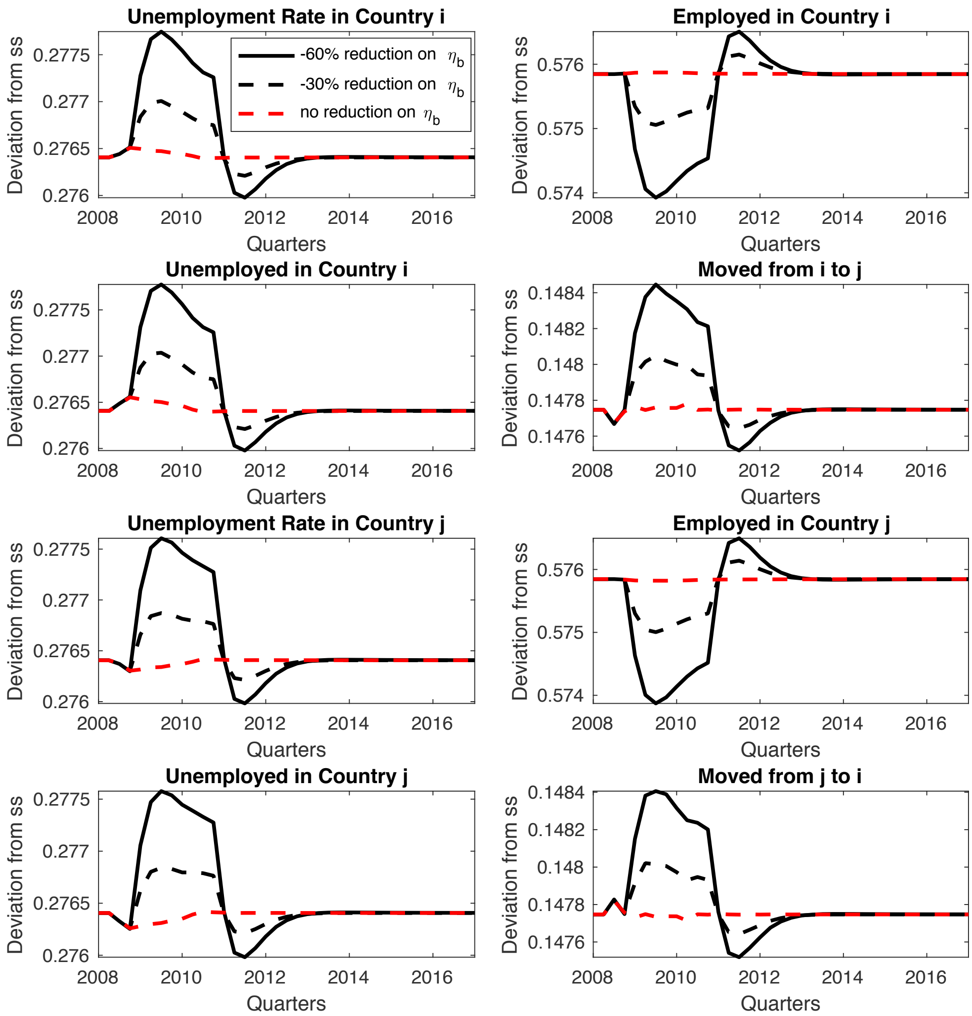


rigidity doesn't have much influence on employment in the economy, except for expected wages in the two countries (Figure (5.4)). It shows that the reduction of labor mobility cost reduces stay unemployment, releases labor market pressure/tightness, thus increases wages in both economies. Impact on wages increases with wage rigidity: when wage is flexible ($\lambda = 0.0001$), reduction of labor mobility cost η by 30% increase expected wage by 10%; when $\lambda = 0.5$, meaning that firms have a half probability to retain the steady state wage level, wage expectation can increase by 50%; when wage is rigid ($\lambda = 0.9$), reduction of labor mobility cost η by 30% increase expected wage by 200%, meaning that every 1pp of cost reduction increases expected wage by 6.67pp. We also compare the scenarios in which price is flexible/rigid. Our simulation shows that the difference between flexible and rigid relative price p_i is almost negligeable (Figure (5.5)).

Stochastic Simulation on Mobility Costs

We start by the stochastic simulation, with a -30% negative shock on labor mobility cost η. Figure (5.8) - (5.13) in appendix show us the IRFs of key variables to the mobility cost shock. In this scenario, as it is less costly to move, more workers move from one country to the other. Stay unemployment falls in both economies. As there are less staying workers

Figure 5.3: simulation of -1% TFP shock in country j, η_b represents banker's mobility cost

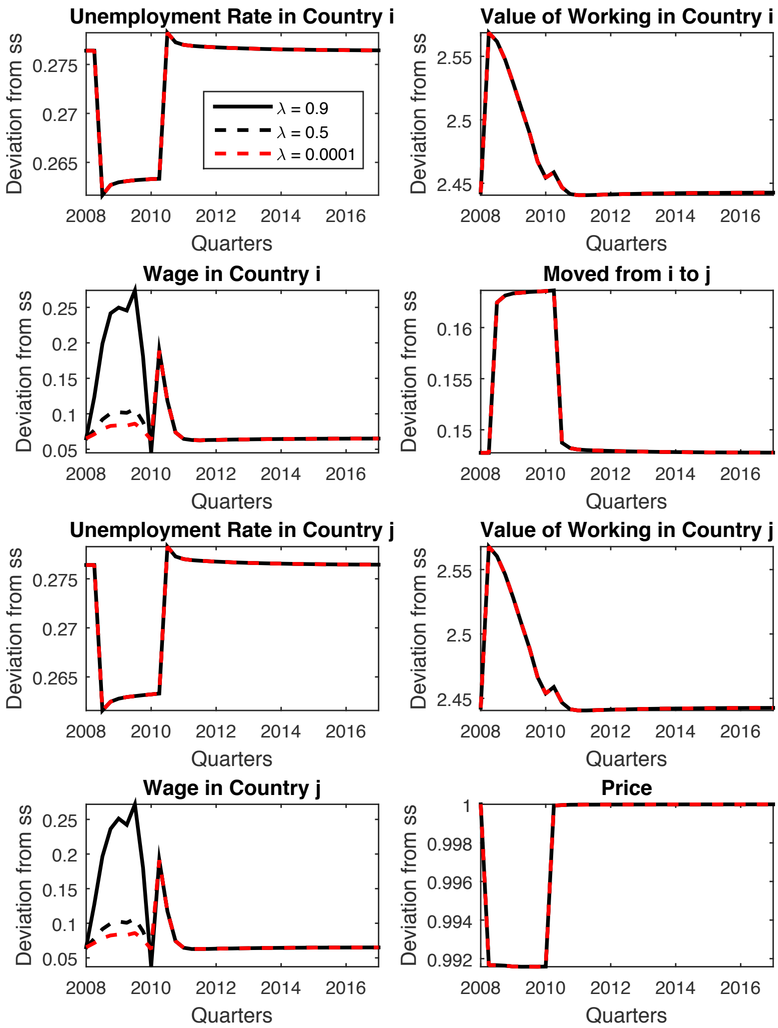


looking for jobs, employment in both countries fall. In general, the unemployment rates fall, implying that the effect on stay unemployment becomes dominant. Wages in both economies increase, thanks to released labor market tightness.

Next, we simulate the scenario in which we give a negative shock on banker's mobility cost. Figure (5.14) - (5.19) show us the IRFs of key variables to -30% negative shock on banker's mobility cost. In this scenario, as it is less costly to move, more bankers move from one country to the other. Number of bankers who stay in a country falls in both economies. As there are less staying bankers looking for investment opportunities, less entrepreneurs find financial support to start the project. As a result, employment in both countries fall, and there are more stay unemployed people (s_i/s_j) in each economy. In general, the unemployment rates rise, implying that the effect on stay unemployment becomes dominant. Wages in both economies fall, due to labor market tightening.

To sum up, reducing labor mobility cost may alleviate unemployment rate, but not necessarily stimulate production due to the decrease in employed workers. Reducing banker's

Figure 5.4: simulation of 30% reduction on labor mobility cost η, wage rigidity $\lambda = 0.9$, 0.5 and 0.0001, respectively



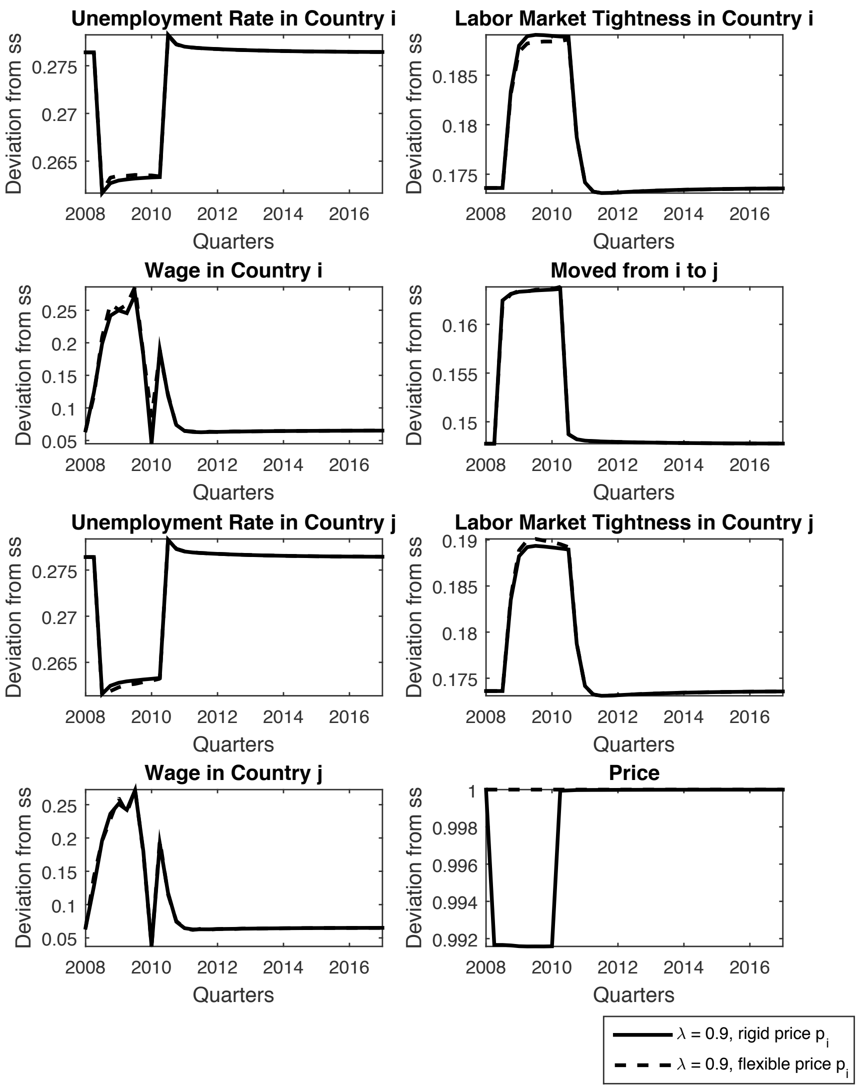
mobility cost motivate bankers to move between countries, implying less staying bankers looking for investment, thus reducing funding opportunities for entrepreneurs. This may reduce job opportunities and increase unemployment rate. Labor mobility reduces unemployment rates, and financial mobility in contrast increases unemployment rates in both economies. Interestingly, factor mobility might not stimulate production due to the fall in employment.

5.4 Asymmetric Case

5.4.1 Calibration

We then consider the asymmetric case, and calibrate according to the European Monetary Union (EMU). We set the two countries as core and periphery. The core represents the countries of Germany, France, Austria, Belgium, Finland, Luxembourg, Netherlands and Finland. The periphery country represents countries of Spain, Portugal, Ireland, Greece and Italy. The unemployment benefit b is about 40% of income as in Shimer (2005). For the core

Figure 5.5: simulation of 30% reduction on labor mobility cost η, wage rigidity $\lambda = 0.9$, flexible vs. rigid prices



country, we set the vacancy filling rate $q(\theta) = 1.2$ corresponding to a monthly vacancy rate at 40%, and a monthly job finding rate around 20%[3]. The credit matching efficiency $f(\phi) = 0.5$, equivalent to a monthly matching efficiency at 1/6 as in Brzustowski, Petrosky-Nadeau and Wasmer (2016). From data of IMF (1990-2007), we set the relative labor force as 1: 1.44 for the periphery and the core; and the relative productivity is set at 1:1.08. Relative price in the two countries is 1:1.14. Unemployment benefit is set to 40% of wage. The steady state employment rate is around 60% as in the data. The definition of unemployment in our model is defined as the proportion of stay-unemployed workers, which is about 30%. This number is larger than the data (5-10%), because in the real world, we neglect the deactive population. We compute the vacancy filling rate and credit matching efficiency in periphery country so that the inflow and outflow in the labor and credit markets are fulfilled.

[3] Murtin and Robin (2016)

Table 5.2: Parameterization

	Core	Periphery
β	0.99	0.99
δ	0.03	0.03
b	0.026	0.019
c_b	1.705	1.379
c_{e1}	0.010	0.007
c_{e2}	1.705	1.379
η	0.264	0.194
η_b	0.264	0.194
σ	0.5	0.5
g	0.5	0.5
ρ	0.3	0.3
ϵ	1.20	1.20

5.4.2 Simulation - Scenario after 2008 financial crisis

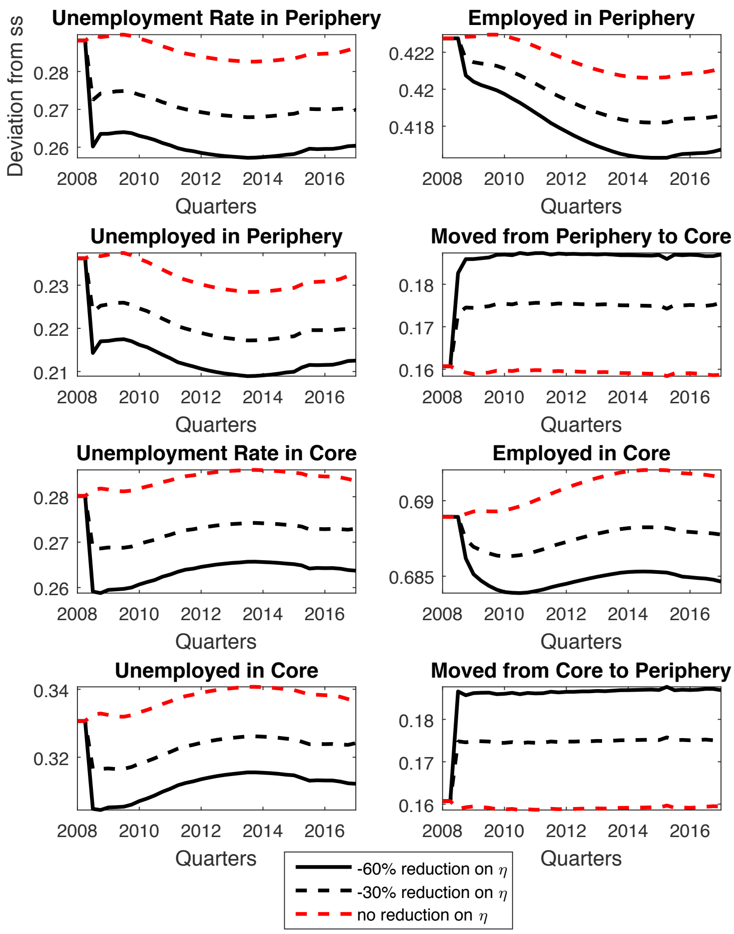
In this section, we simulate the scenario of EMU in the aftermath of 2008 financial crisis. We first give a series of quarterly TFP shocks from 2008Q1 to 2017Q1. We set the shock sizes from the OECD dataset. We compare this baseline scenario with scenarios in which we impose reductions on labor mobility cost by 30% and 60%, respectively. Figure (5.6) shows us the simulation results. We have a few remarks: first, without shocks on labor mobility cost, the TFP shocks along have very limited impact on employment (less than $\pm 0.5\%$); second, when associating with policies that reduce labor mobility cost, the impact of crisis on labor market is significantly mitigated. In our simulation, with 60% reduction on labor mobility cost, the unemployment rate falls by 3pp in the periphery, and 2pp in the core. From another point of view, the divergence across member countries which we see in data (Figure (5.1)) might not be simply due to asymmetric TFP shocks, but suspiciously attributed to the association with rises/increases in labor mobility costs, such as unfavorable migration policies, etc.

We then simulate the case with different financial mobility costs: the banker's mobility cost is reduced by 30% and 60%, respectively. Figure (5.7) shows us the results. We remark that employment indicators in our model is much less sensitive to financial mobility cost compared to labor mobility cost. Unemployment fluctuations in the two countries co-move with the number of employed people, meaning that the rise/fall of employed workers affect the number of stay-unemployed people and thus influence the overall unemployment rate. In general, this effect is very small as stated in the previous paragraph.

5.5 Conclusion

Factor mobility is expected to stabilize impact of asymmetric shocks within a monetary union. By establishing a two-country model, we study the potential interactions between financial integration and labor mobility in front of asymmetric shocks. Our results show that while labor mobility reduces unemployment rates, financial mobility in contrast increases unemployment rates in both economies. Compared to labor mobility cost, the effect of financial mobility cost on labor market is secondary. Interestingly, factor mobility might not stimulate production due to the fall in employment. We also calibrate the model to the European Monetary Union and simulate the scenario in the aftermath of 2008 financial crisis. Our counterfactual experiments show that the divergence across member countries might not

Figure 5.6: Simulation of the crisis after 2008, with shocks on labor mobility cost



simply due to asymmetric TFP shocks, but rather their association with the increase of labor mobility costs. This finding also provides potential complements to answer Shimer's puzzle which states that the unemployment fluctuation generated by search and matching model is much smaller than what we observe in data.

5.6 Appendix

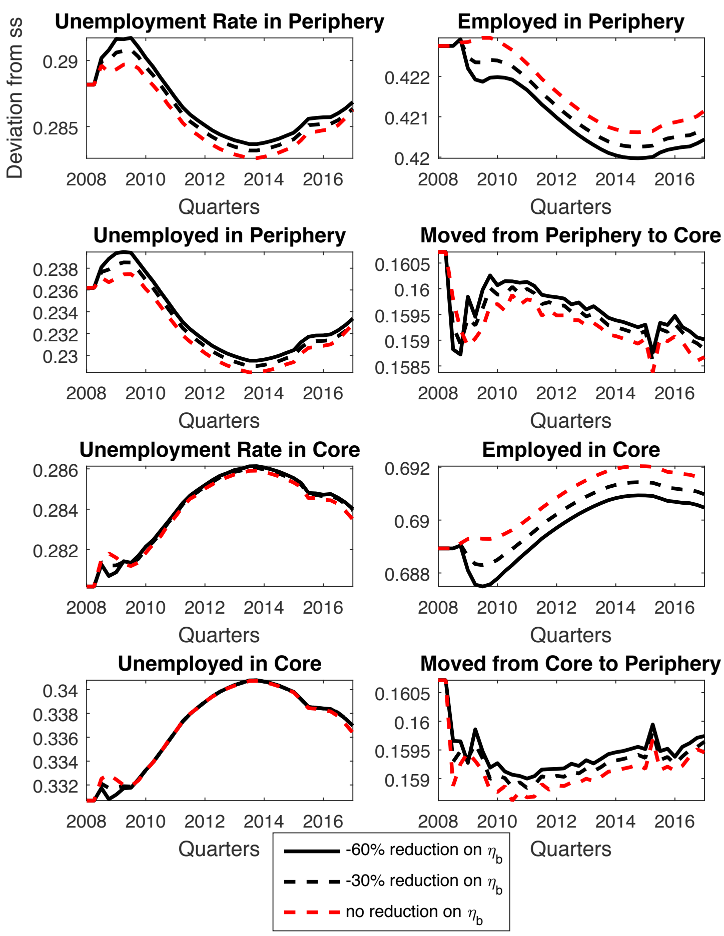
5.6.1 Discret Choice Theory

Workers & Bankers

The worker's problem in unemployment is to choose whether to remain stay unemployed or to become move unemployed and transition to the other country. The probability that a worker facing the reallocation choice to become move unemployed is given by:

$$\begin{aligned} \pi_{ij,t+1} &= Pr(S_{i,t+1} + \epsilon_{i,l,t+1} < S_{j,t+1} - \eta + \epsilon_{j,l,t+1}) \\ &= \frac{1}{1 + exp(\frac{S_{i,t+1} - S_{j,t+1} + \eta}{\rho})} \end{aligned} \tag{5.19}$$

Figure 5.7: Simulation of the crisis after 2008, with shocks on banker's mobility cost



Furthermore, we can write the value functions in country i as a function of these move probabilities:

$$\begin{aligned} W_{i,t} &= w_{i,t} + (1-\delta_i)\beta E_t(W_{i,t+1}) + \delta_i \beta \pi_{ii,t+1} E_t(S_{i,t+1}) + \delta_i \beta \pi_{ij,t+1} E_t(S_{j,t+1} - \eta), \\ S_{i,t} &= b_i + f_i(\theta_{i,t})\beta E_t(W_{i,t+1}) + (1 - f_i(\theta_{i,t}))\beta \pi_{ii,t+1} E_t(S_{i,t+1}) \\ &\quad + (1 - f_i(\theta_{i,t}))\beta \pi_{ij,t+1} E_t(S_{j,t+1} - \eta), \end{aligned} \tag{5.20}$$

Similarly, for bankers, we can rewrite the banker's value functions in country i as:

$$\begin{aligned} W^b_{i,t} &= \rho_{i,t} - \gamma_{i,t} + (1-\delta^b_i)\beta E_t(W^b_{i,t+1}) + \delta^b_i \beta \pi^b_{ii,t+1} E_t(S^b_{i,t+1}) + \delta^b_i \beta \pi^b_{ij,t+1} E_t(S^b_{j,t+1} - \eta^b), \\ S^b_{i,t} &= -c^b_i + q_i(\phi_{i,t})\beta E_t(W^b_{i,t+1} + \epsilon_{i,l,t+1}) + (1 - q_i(\phi_{i,t}))\beta \pi^b_{ii,t+1} E_t(S^b_{i,t+1}) \\ &\quad + (1 - f_i(\phi_{i,t}))\beta \pi^b_{ij,t+1} E_t(S^b_{j,t+1} - \eta^b). \end{aligned} \tag{5.21}$$

Inflow & Outflow

For workers, their inflow & outflow dynamics are:

$$e_{i,t+1} = (1-\delta_i)e_{i,t} + f_i(\theta_{i,t})s_{i,t}, \tag{5.22}$$

$$s_{i,t+1} = \pi_{ii,t}[\delta_i e_{i,t} + (1 - f_i(\theta_{i,t}))s_{i,t} + m_{ji,t}], \tag{5.23}$$

$$m_{ji,t+1} = \pi_{ji,t}[\delta_j e_{j,t} + (1 - f_j(\theta_{j,t}))s_{j,t} + m_{ij,t}]. \tag{5.24}$$

For bankers, their inflow & outflow dynamics are:

$$
\begin{aligned}
e^b_{i,t+1} &= (1-\delta^b_i)e^b_{i,t} + q_i(\phi_{i,t})s^b_{i,t}, && (5.25)\\
s^b_{i,t+1} &= \pi^b_{ii,t}[\delta^b_i e^b_{i,t} + (1-q_i(\phi_{i,t}))s^b_{i,t} + m^b_{ji,t}], && (5.26)\\
m^b_{ji,t+1} &= \pi^b_{ji,t}[\delta^b_j e^b_{j,t} + (1-q_j(\phi_{j,t}))s^b_{j,t} + m^b_{ij,t}] && (5.27)
\end{aligned}
$$

For entrepreneurs, their dynamics are:

$$
\begin{aligned}
w^e_{1i,t+1} &= (1-\delta^b_i)[q_i(\theta_{i,t})w^e_{2i,t} + (1-\delta_i)w^e_{1i,t}], && (5.28)\\
w^e_{2i,t+1} &= (1-\delta^b_i)[(1-q_i(\theta_{i,t}))w^e_{2i,t} + \delta^b_i w^e_{1i,t}] + f_i(\phi_{i,t})s^e_{i,t}, && (5.29)\\
s^e_{i,t+1} &= (1-f_i(\phi_{i,t}))s^e_{i,t} + \delta^b_i(w^e_{1i,t} + w^e_{2i,t}). && (5.30)
\end{aligned}
$$

5.6.2 IRFs

Symmetric Case

Stochastic shock on labor mobility cost η

Figure 5.8: IRFs of -30% shock on η, the labor mobility cost

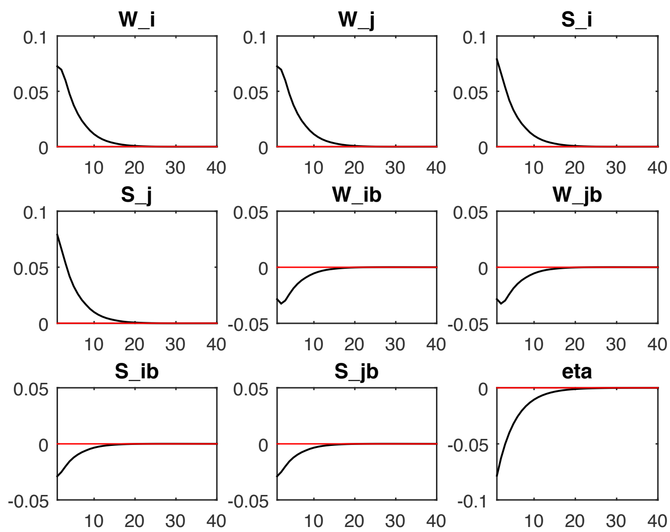


Figure 5.9: IRFs of -30% shock on η, the labor mobility cost

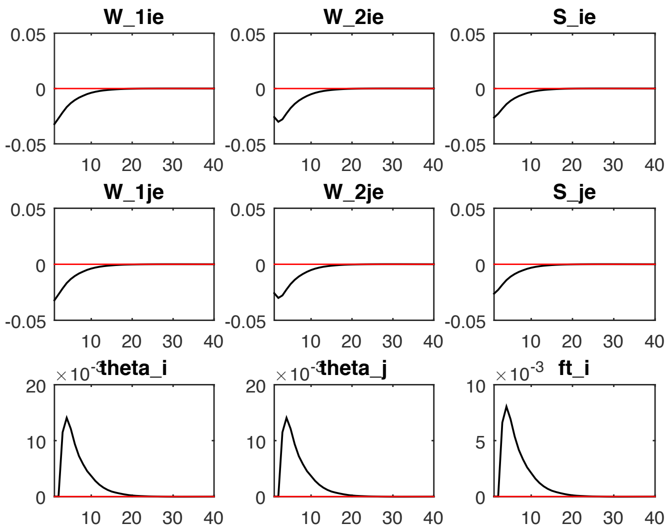


Figure 5.10: IRFs of -30% shock on η, the labor mobility cost

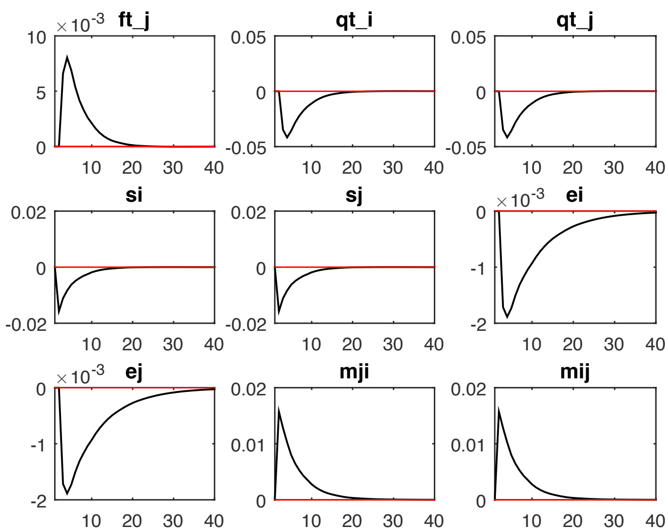


Figure 5.11: IRFs of -30% shock on η, the labor mobility cost

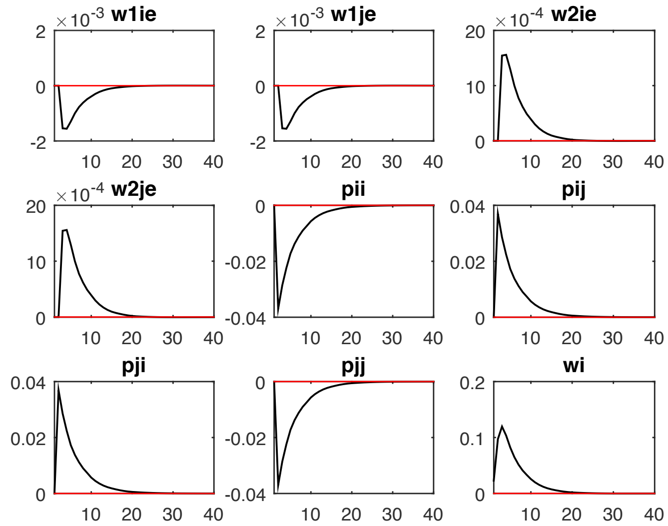


Figure 5.12: IRFs of -30% shock on η, the labor mobility cost

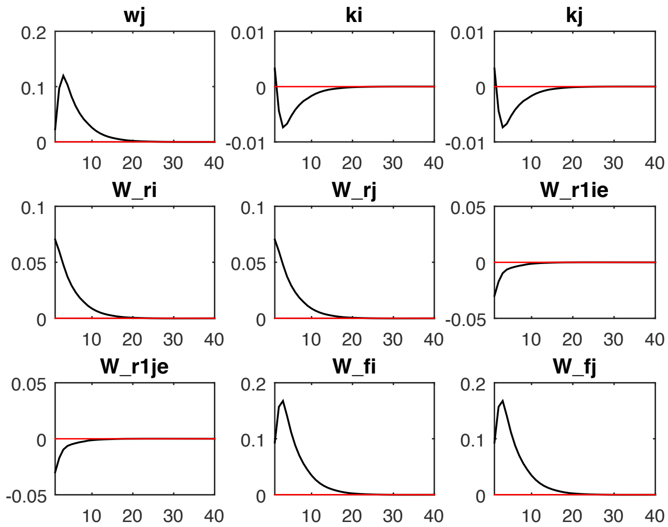
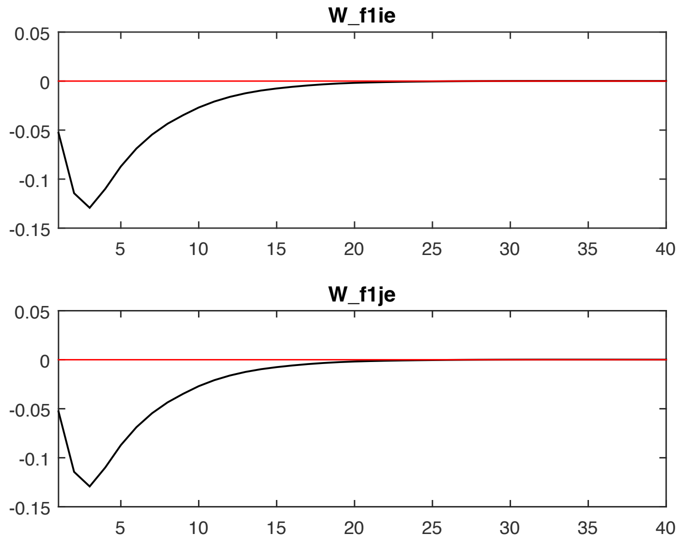


Figure 5.13: IRFs of -30% shock on η, the labor mobility cost



Stochastic shock on banker's mobility cost η_b

Figure 5.14: IRFs of -30% shock on η_b, the mobility cost for bankers

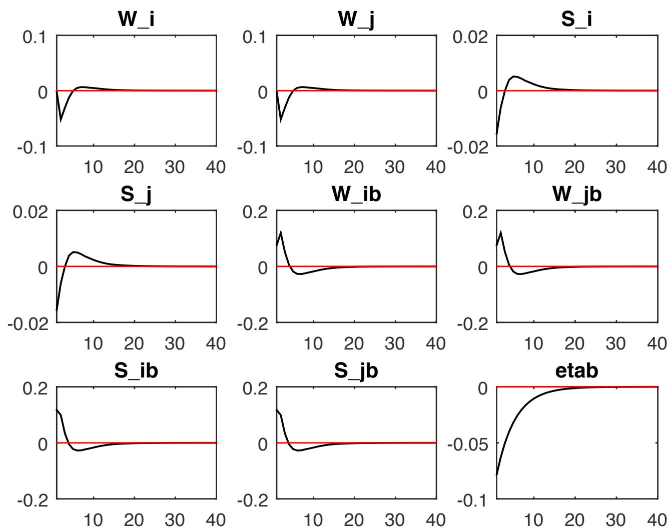


Figure 5.15: IRFs of -30% shock on η_b, the mobility cost for bankers

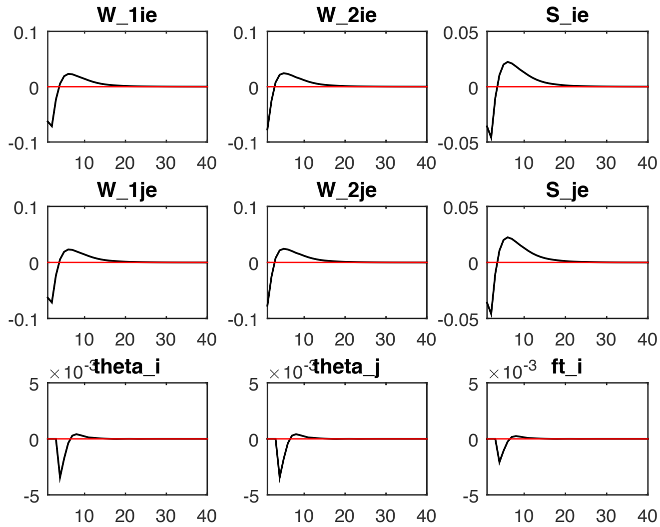


Figure 5.16: IRFs of -30% shock on η_b, the mobility cost for bankers

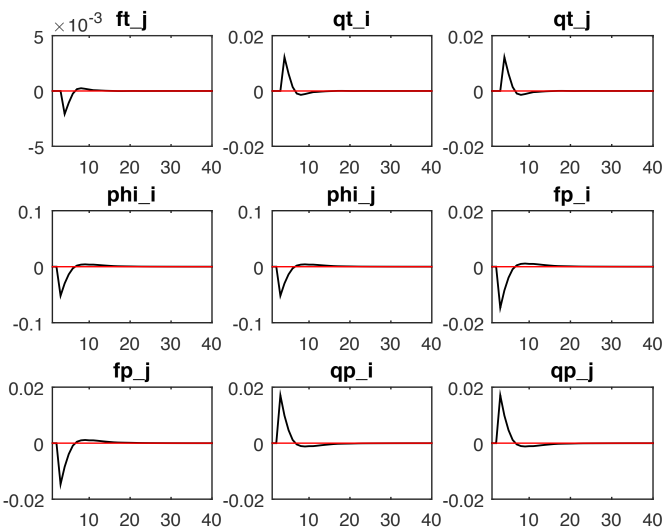


Figure 5.17: IRFs of -30% shock on η_b, the mobility cost for bankers

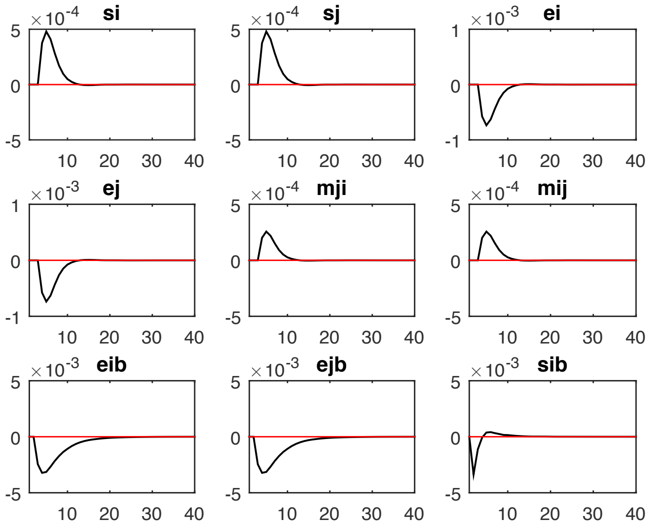


Figure 5.18: IRFs of -30% shock on η_b, the mobility cost for bankers

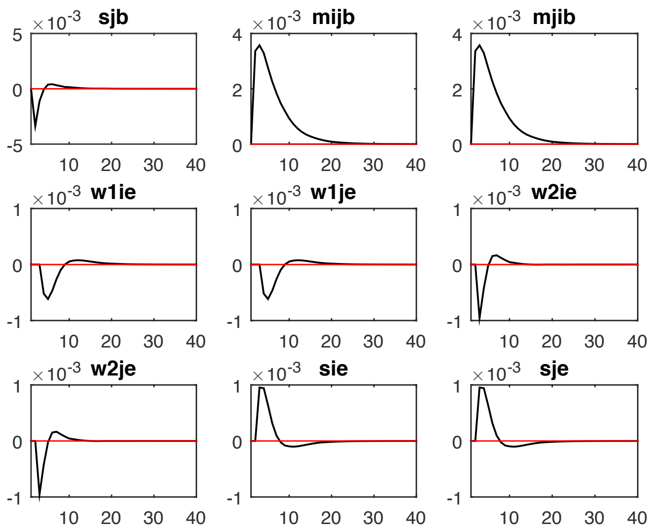


Figure 5.19: IRFs of -30% shock on η_b, the mobility cost for bankers

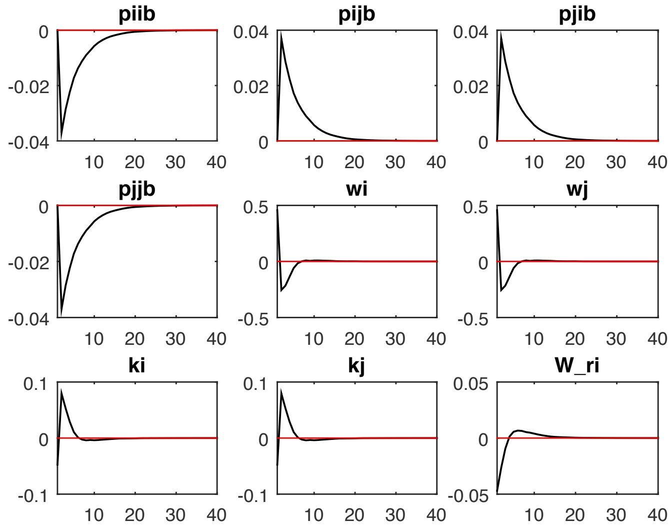
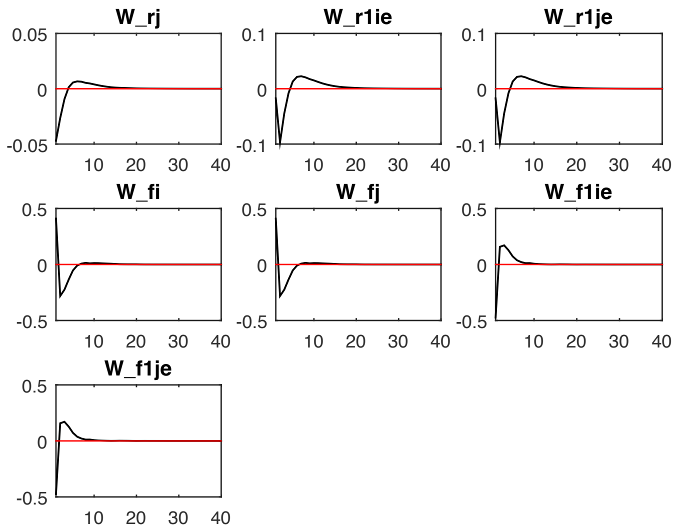


Figure 5.20: IRFs of -30% shock on η_b, the mobility cost for bankers



Asymmetric Case

Stochastic shock on worker's mobility cost η

Figure 5.21: IRFs of -30% shock on η, the mobility cost for workers

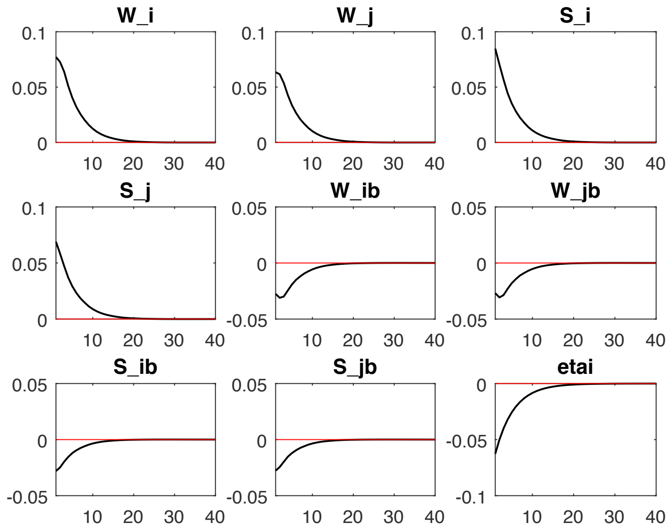


Figure 5.22: IRFs of -30% shock on η, the mobility cost for workers

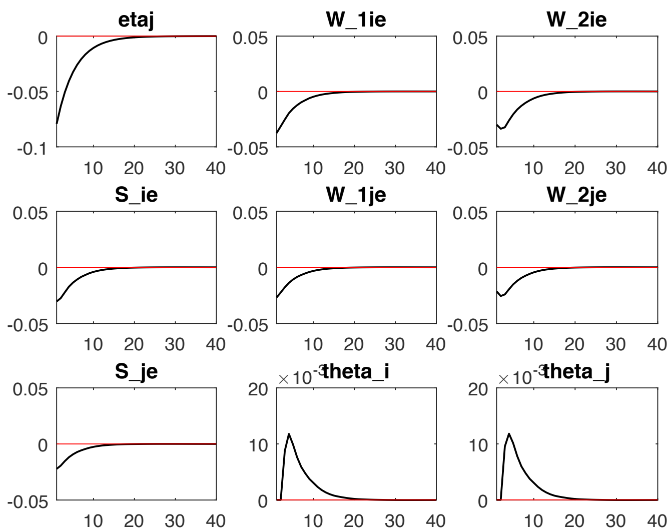


Figure 5.23: IRFs of -30% shock on η, the mobility cost for workers

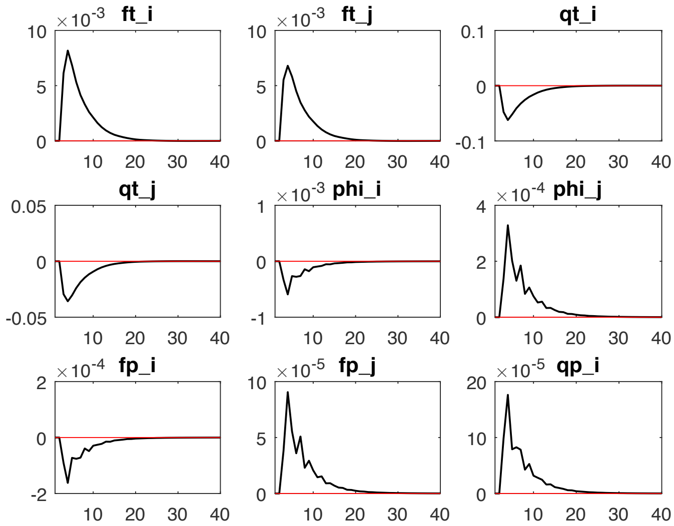


Figure 5.24: IRFs of -30% shock on η, the mobility cost for workers

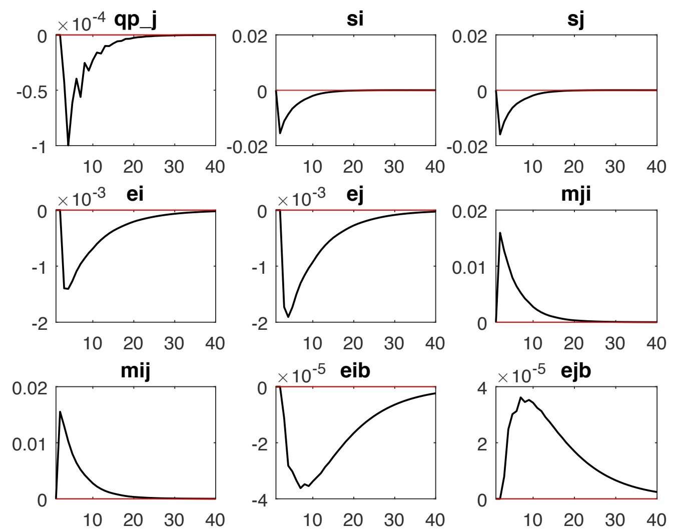


Figure 5.25: IRFs of -30% shock on η, the mobility cost for workers

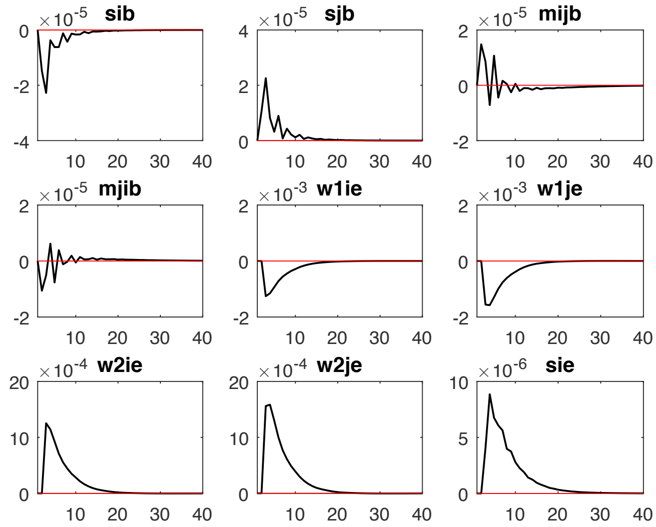


Figure 5.26: IRFs of -30% shock on η, the mobility cost for workers

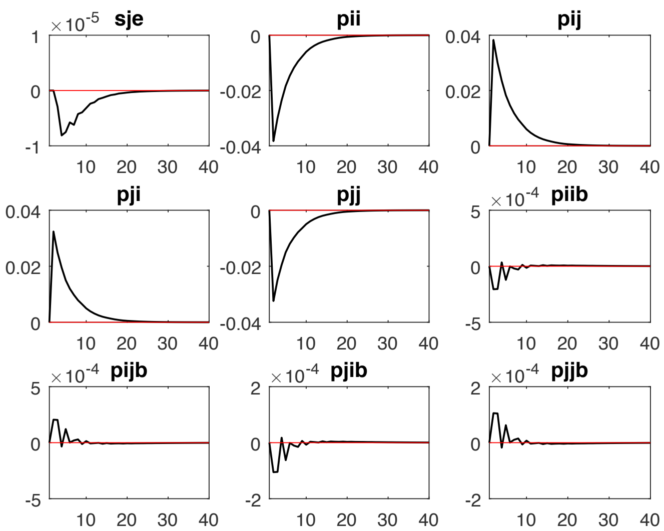


Figure 5.27: IRFs of -30% shock on η, the mobility cost for workers

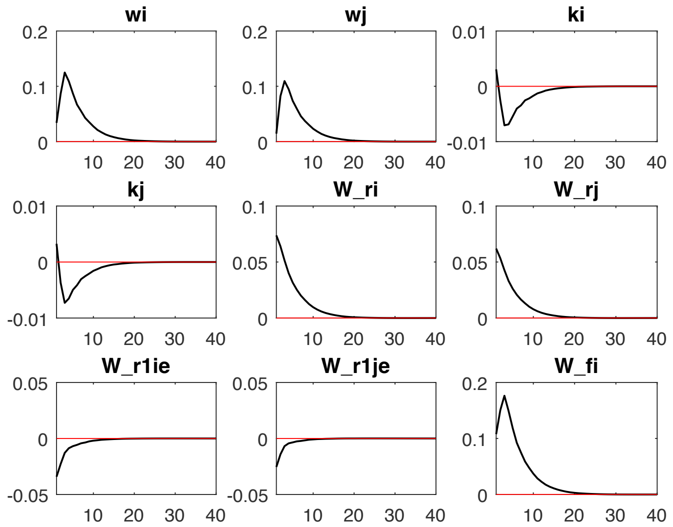
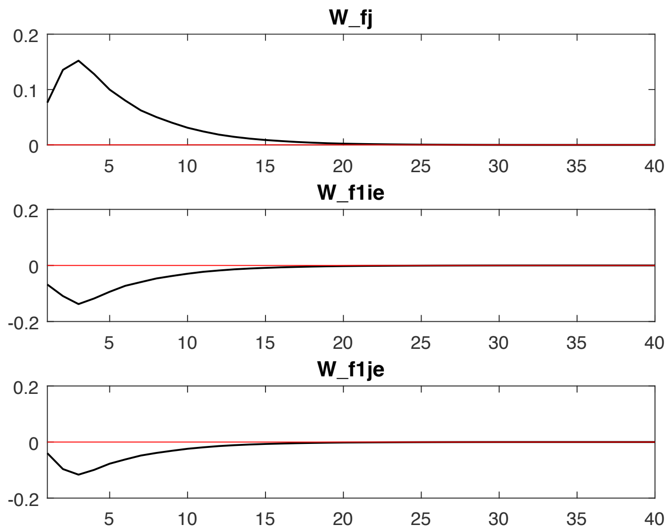


Figure 5.28: IRFs of -30% shock on η, the mobility cost for workers



Stochastic shock on banker's mobility cost η_b

Figure 5.29: IRFs of -1% shock on η_b, the mobility cost for bankers

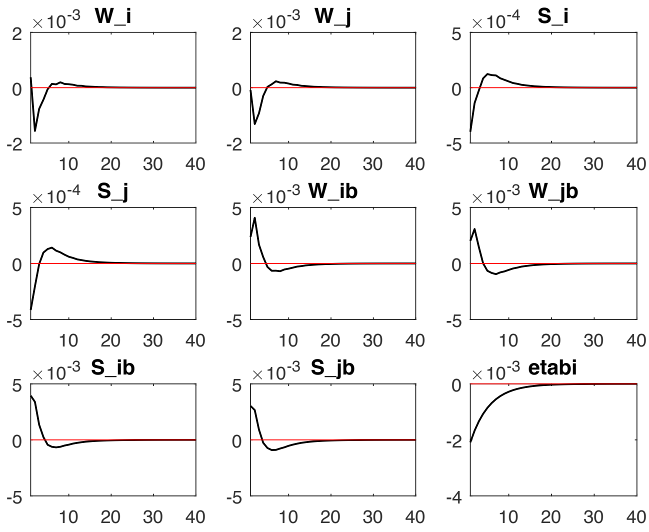


Figure 5.30: IRFs of -1% shock on η_b, the mobility cost for bankers

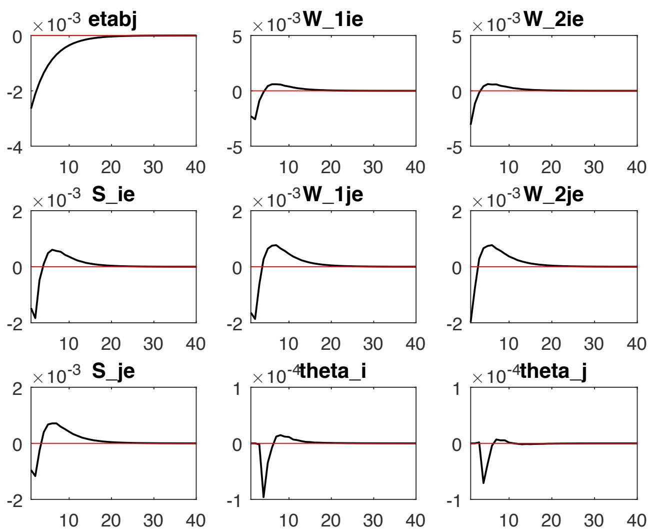


Figure 5.31: IRFs of -1% shock on η_b, the mobility cost for bankers

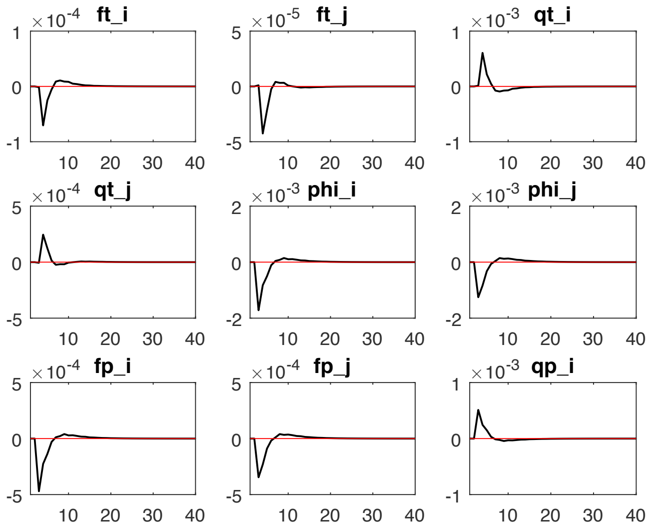


Figure 5.32: IRFs of -1% shock on η_b, the mobility cost for bankers

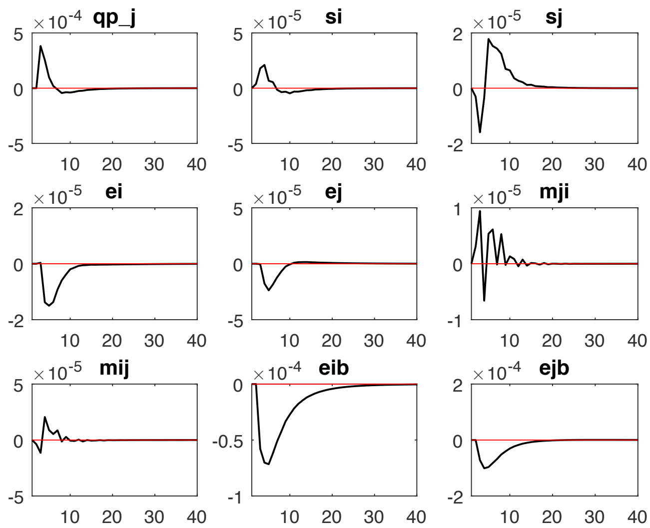


Figure 5.33: IRFs of -1% shock on η_b, the mobility cost for bankers

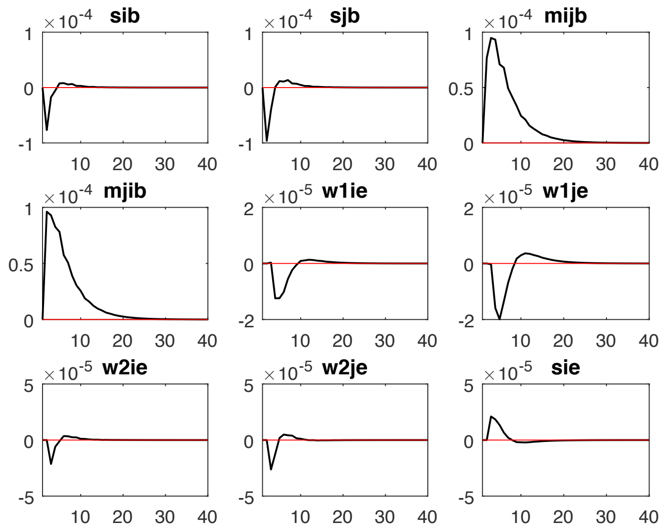


Figure 5.34: IRFs of -1% shock on η_b, the mobility cost for bankers

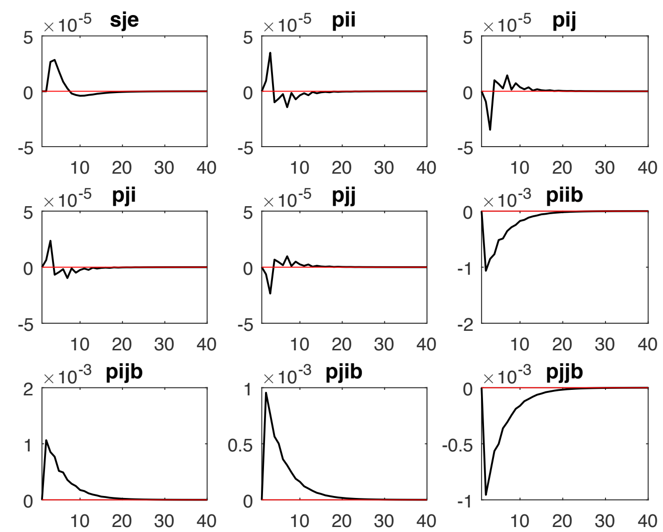


Figure 5.35: IRFs of -1% shock on η_b, the mobility cost for bankers

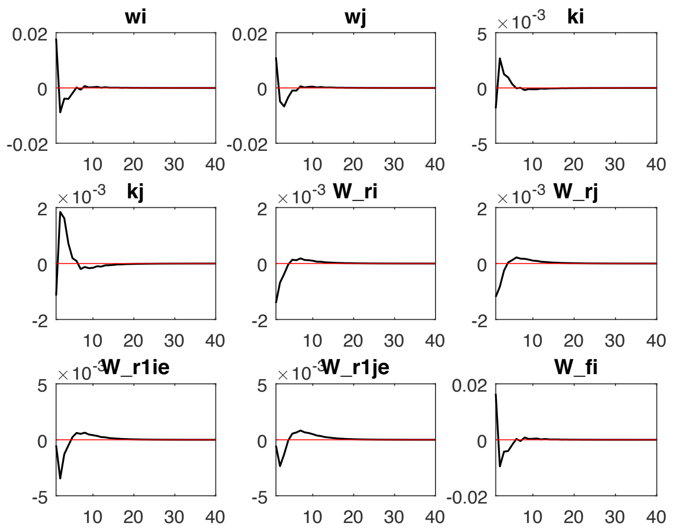
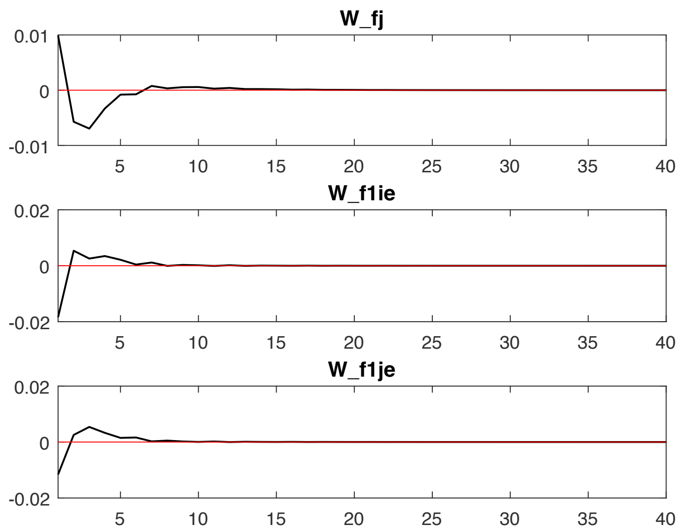


Figure 5.36: IRFs of -1% shock on η_b, the mobility cost for bankers



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Résumé

Il y a quatre chapitres dans cette thèse.

Dans le premier chapitre, nous analysons les intéractions entre le marché interbancaire et le risque de défaut souverain dans un modèle d'équilibre général à deux pays, en focalisant sur la transmission de la crise financière récente et la politique monétaire non conventionnelle.

Dans le deuxième chapitre, les effets de la dévaluation fiscale sur les indicateurs macroéconomiques et le bien être sont analysés en utilisant un modèle à deux pays en union monétaire où les variétés de biens et le commerce sont endogènes.

Dans le troisième chapitre, l'impact du facteur démographique sur la croissance du secteur des services à long terme est mis en exergue.

Dans le quatrième chapitre, on étudie les effets de la mobilité des travailleurs et de la mobilité du capital dans une union monétaire.

Mots Clés: Récession, Marché Interbancaire, Risque de Défaut Souverain, Politique Monétaire, Dévaluations Fiscales, Commerciabilité Endogène, Variétés Endogènes, Union Monétaire, Taux d'Impôt, Changement Structurel, Vieillissement de la Population, Croissance Endogène, Mobilité des Facteurs, Chocs Asymétriques.

Abstract

This thesis studies challenges for modern developped economies, including the structural change toward services, population ageing, weak labor mobility in the EMU and unconventional monetary policies after the 2008 financial crisis. The manuscript is divided into four chapters.

In the first chapter, we analyze the interaction between interbank markets and default risk using a two-country dynamic general equilibrium model, with a focus on the transmission of the recent financial crisis and unconventional monetary policies.

In the second chapter, we investigate the effects of fiscal devaluations on key macroeconomic aggregates and welfare using a two-country monetary-union model with endogenous varieties and endogenous tradability.

In the third chapter, we study the impact of demographic factor and the growth of service sector by using a multi-sectoral OLG model, and effectuate counterfactual experiments in which the annual growth rate of young generation is $\pm$1pp than the actual growth rate.

In the fourth chapter, we study the potential interactions between financial integration and labor mobility in a currency union facing asymmetric shocks, and simulate the impacts of 2008 financial crisis under different mobility costs.

Keywords: Recession, Interbank Market, Sovereign Default Risk, Monetary Policy, Fiscal Devaluations, Endogenous Tradability, Endogenous Varieties, Monetary Union, Taxes, Structural Change, Population Ageing, Endogenous Growth, Factor Mobility, Asymmetric Shocks.