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PHD THESIS

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Three empiral essays in French household taxation

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THÈSE

Pour l'obtention du grade de docteur en Sciences Économiques
de l'École des Hautes Études en Sciences Sociales

Présentée et soutenue publiquement le 27 juin 2019 par

Adrien Pacifico

Trois essais empiriques sur la taxation des ménages Français

Sous la direction de :
Olivier Bargain   Alain Trannoy

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Résumé en français

Cette thèse est composée de trois chapitres traitant de la fiscalité des ménages Français. Le premier traite de la fréquence de l'impôt, et plus précisément compare un système de taxe annuel avec un système de taxe mensuel. En prenant pour hypothèse que la fonction d'utilité des ménages est concave en fonction du revenu disponible, inter-temporellement additive, et que les ménages n'épargnent pas, nous évaluons les gains à augmenter la fréquence de l'impôt. Ces gains évalués en *money metric* sont potentiellement très importants, de l'ordre de plusieurs milliards d'euros.
Le deuxième chapitre traite de la coopération au sein des couples de cohabitant en regardant l'allocation des enfants entre leurs deux foyers fiscaux. Il y est montré qu'un quart des couples ne respectent pas l'efficience Paretienne en ne choisissant pas la meilleure allocation. En expliquant l'allocation, nous voyons qu'elle est due en grande partie à de l'inertie dans les choix qui sont faits, mais également à de la coopération. En effet les couples qui n'optimisent pas ont tendance à plus se séparer l'année d'après, tandis que les couples qui optimisent ont plus tendance à se marier ou à se pacser.
Le troisième chapitre tente d'évaluer l'abaissement du plafond du quotient familial de 2012/2013 en adoptant une méthodologie en triple différence qui permet de distinguer les effets de revenus des effets de substitutions.
Discipline : Sciences économiques
Mots clefs : Impôt sur le revenu, Ménages, France, Microsimulation

Summary in English

This thesis contains three chapters that concern the taxation of French households. The first one is about the frequency of the tax, and compare an annual tax system to a monthly one. With households utility functions that are concave in disposable income, inter-temporally additive and where households do not save, we evaluate the gains either in utility or in money metric to increase the frequency of the tax for France. The simulation shows that the gains are positive and can be potentially large.
The second chapter is about coopération within cohabiting couples by looking at how children are allocated between the two fiscal units. We show that a quarter of the households do not respect the Pareto efficiency by not choosing the optimal allocation. We show that inertia has a role, but also cooperation between cohabitants. Indeed we show that couples that do not optimize are more likely to separate, while those who do optimize are more likely to engage in a civil union.
The third chapter tries to evaluate the lowering of the maximum child tax break by relying on a triple difference methodology that allows disentangling substitution effects and income effects.
Field: Economics
Key words: Income Tax, Household, France, Microsimulation

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Introduction

Cette thèse que je considère appartenir au champ de l'économie publique, avec un fort intérêt sur les questions de taxation contient trois chapitres.

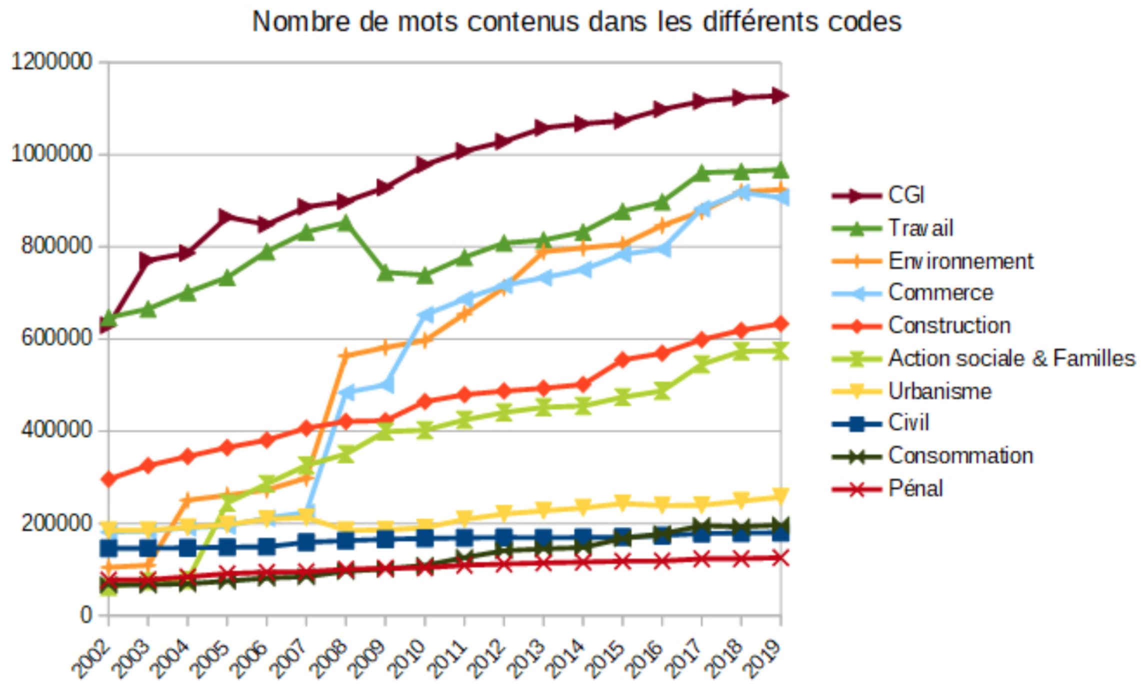
- Le premier traite de la temporalité de l'impôt en général et pose la question de l'impact de sa fréquence en particulier.
- Le second concerne l'allocation optimale des enfants sur les feuilles fiscales entre concubins qui ont la particularité de constituer deux entités fiscales en France.
- Le troisième chapitre tente d'évaluer les réactions comportementales sur la base taxable des ménages aisés touchés par la réforme de l'abaissement du plafond du quotient familial qui a eu lieu sous le quinquénat Hollande entre 2012 et 2013.

Avant de revenir plus en profondeur sur ces chapitres et d'en aborder l'intérêt pour le débat public et scientifique de chacun, je souhaiterai prendre une vue plus générale sur divers aspects consubtantiels (mais trop souvent omis) à la recherche en économie de la taxation en France : sa nécessité, ses outils dans le cadre institutionnel, et leurs évolutions récentes.

Transparence de la vie publique L'article 14 de la déclaration des droits de l'homme et du citoyen (DDHC), texte fondateur et ayant valeur constitutionelle en France, statue que *"Tous les Citoyens ont le droit de constater, par eux-mêmes ou par leurs représentants, la nécessité de la contribution publique, de la consentir librement, d'en suivre l'emploi, et d'en déterminer la quotité, l'assiette, le recouvrement et la durée"*.

L'impôt ne pouvant être levé de manière arbitraire, le parlement détermine un ensemble de règles fiscales généralement votées en fin d'année civile suite aux propositions du gouvernement (qui propose un projet de loi de finance (PLF) au parlement).

Le système fiscal a connu une inflation législative, qui pour l'immense majorité des citoyens empêche d'atteindre l'idéal démocratique de transparence. En effet le Code Général des Impots (CGI) constué de 2 livres et 4 annexes dépasse allègrement les 1 million de mots. À titre de comparaison, "À la recherche du temps perdu" l'œuvre littéraire la plus longue de la littérature Française contient 1,5 million de mots.



(Source: Dalloz actualité du 29/04/2019 "Pas de pause pour les nouvelles normes")

Ainsi, il faudra à un lecteur, lisant à une vitesse de 200 mots par minutes, plus de 85 heures de lecture continue pour connaitre l'ensemble des règles fiscales.

"À la recherche du temps perdu" appartient à la catégorie des lectures exigeantes, mais en comparaison au CGI, sa lecture semblera à la plupart des lecteurs comme une lecture assez facile.

En effet on peut reprocher également aux textes qui composent le CGI une certaine complexité, qui rend, même pour le lecteur le plus érudit, la lecture de ce code ardue. Prenons par exemple l'article 197 du CGI qui représente le cœur de la fonction de l'impôt sur le revenu.

```
I. - En ce qui concerne les contribuables visés à l'article 4 B, il est
↪  fait application des règles suivantes pour le calcul de l'impôt sur
↪  le revenu :

1. L'impôt est calculé en appliquant à la fraction de chaque part de
↪  revenu qui excède 9 964 € le taux de :

- 14 % pour la fraction supérieure à 9 964 € et inférieure ou égale à 27
↪  519 € ;
```

```
- 30 % pour la fraction supérieure à 27 519 € et inférieure ou égale à
 ↪  73 779 € ;

- 41 % pour la fraction supérieure à 73 779 € et inférieure ou égale à
 ↪  156 244 € ;

- 45 % pour la fraction supérieure à 156 244 €
```

Cette partie plutôt simple décrit le barème linéaire en tranche.

```
2. La réduction d'impôt résultant de l'application du quotient familial
 ↪  ne peut excéder 1 551 € par demi-part ou la moitié de cette somme
 ↪  par quart de part s'ajoutant à une part pour les contribuables
 ↪  célibataires, divorcés, veufs ou soumis à l'imposition distincte
 ↪  prévue au 4 de l'article 6 et à deux parts pour les contribuables
 ↪  mariés soumis à une imposition commune.

Toutefois, pour les contribuables célibataires, divorcés, ou soumis à
 ↪  l'imposition distincte prévue au 4 de l'article 6 qui répondent aux
 ↪  conditions fixées au II de l'article 194, la réduction d'impôt
 ↪  correspondant à la part accordée au titre du premier enfant à charge
 ↪  est limitée à 3 660 € Lorsque les contribuables entretiennent
 ↪  uniquement des enfants dont la charge est réputée également partagée
 ↪  entre l'un et l'autre des parents, la réduction d'impôt
 ↪  correspondant à la demi-part accordée au titre de chacun des deux
 ↪  premiers enfants est limitée à la moitié de cette somme.

Par dérogation aux dispositions du premier alinéa, la réduction d'impôt
 ↪  résultant de l'application du quotient familial, accordée aux
 ↪  contribuables qui bénéficient des dispositions des a, b et e du 1 de
 ↪  l'article 195, ne peut excéder 927 € ;
```

```
Les contribuables qui bénéficient d'une demi-part au titre des a, b, c,
 ↪  d, d bis, e et f du 1 ainsi que des 2 à 6 de l'article 195 ont droit
 ↪  à une réduction d'impôt égale à 1 547 € pour chacune de ces
 ↪  demi-parts lorsque la réduction de leur cotisation d'impôt est
 ↪  plafonnée en application du premier alinéa. La réduction d'impôt est
 ↪  égale à la moitié de cette somme lorsque la majoration visée au 2 de
 ↪  l'article 195 est de un quart de part. Cette réduction d'impôt ne
 ↪  peut toutefois excéder l'augmentation de la cotisation d'impôt
 ↪  résultant du plafonnement.

Les contribuables veufs ayant des enfants à charge qui bénéficient d'une
 ↪  part supplémentaire de quotient familial en application du I de
 ↪  l'article 194 ont droit à une réduction d'impôt égale à 1 728 € pour
 ↪  cette part supplémentaire lorsque la réduction de leur cotisation
 ↪  d'impôt est plafonnée en application du premier alinéa du présent 2.
 ↪  Cette réduction d'impôt ne peut toutefois excéder l'augmentation de
 ↪  la cotisation d'impôt résultant du plafonnement.
```

La partie concernant le quotient familal qui est l'objet d'étude du dernier chapitre de cette thèse. On voit que de nombreuses situations existent.

```
3. Le montant de l'impôt résultant de l'application des dispositions
 ↪  précédentes est réduit de 30 %, dans la limite de 2 450 €, pour les
 ↪  contribuables domiciliés dans les départements de la Guadeloupe, de
 ↪  la Martinique et de la Réunion ; cette réduction est égale à 40 %,
 ↪  dans la limite de 4 050 €, pour les contribuables domiciliés dans
 ↪  les départements de la Guyane et de Mayotte ;
```

Celle-ci concerne les exceptions pour les DOM-TOM.

```
4. a. Le montant de l'impôt résultant de l'application des dispositions
 ↪  précédentes est diminué, dans la limite de son montant, de la
 ↪  différence entre 1 196 € et les trois quarts de son montant pour les
 ↪  contribuables célibataires, divorcés ou veufs et de la différence
 ↪  entre 1 970 € et les trois quarts de son montant pour les
 ↪  contribuables soumis à imposition commune.
```

Ici est décrite la décote de l'impôt sur le revenu.

La longueur et la complexité des règles fiscales fait qu'aucun citoyen ne se retrouve dans ce que Maurice Allais (et d'autres) qualifiait de *maquis fiscal.* L'administration fiscale elle même ne se refère plus à la loi directement mais une interprétation de celle-ci via le BOFIP. (Ce qui permet ensuite à des avocats fiscalistes de contester les interprétation de l'administration fiscale de la loi, afin que de riches clients paient moins d'impôts.)

Au delà de simplement désigner quels citoyens va assumer la charge publique, les règles fiscales définissent un système d'incitation.

Cette complexité fiscale devient tellement grande que le législateur se retrouve lui même engoncé dans le maquis fiscal, ignorant des impacts des nouvelles lois qu'il mettrait en place, et perdrait ses nuits dans des commissions parlementaires à être à la recherche de incitations perdues. En témoigne par exemple la tribune "Pour un débat budgétaire responsable et libéré de l'arbitraire" (Le Monde du 19 avril 2018) signé par des députés de l'ensemble du spectre politique (de *Les Républicains* à *La France Insoumise*) qui fait état du fait que les lois sont votées dans un *brouillard* concernant les répartitions des revenus, de l'impact de notre fiscalité, la vie des citoyens, et des prévisions de recettes et de dépenses du gouvernement.

Solutions à la complexité

La solution première à la complexité, est la transformation des règles législatives en règles formelles.

Par exemple le barème de l'impôt sur le revenu cité plus haut est de fait une fonction linéraire par morceaux, qui détermine le montant de l'impôt selon la fonction suivante :

$$s(y) = \sum_{j \leq k-1} mj(\beta j + 1 - \beta j) + m_k(y - \beta_j)$$

où $s()$ est la fonction d'impôt, y la base taxable et où

$$0 < m_0 < m_1 < ... < m_p$$

est une séquence de taux marginaux (habituellement croissante), et

$$0 = \beta_0 < \beta_1 < ... < \beta_n$$

sont les seuils qui définissent sur quelle partie du revenu imposable un taux spécifique

s'applique pour un revenu $y \in [\beta_k, \beta_{k+1}]$.
Ce travail de transformation des règles législatives en règles mathématiques est accompli depuis toujours par l'adminsitration fiscale afin de prélever l'impôt, mais également par les économistes, notamment dans leurs travaux de modélisation (par définition simplificateurs de la réalité).
La transcription de l'ensemble des règles législatives en règles formelles est un travail fastidieux. Même une fois l'ensemble de ces règles formalisées, elles peuvent intéragir entre elles, rendant très complexe l'analyse du système sociofiscal. La solution trouvée est de transcrire ces règles formelles en langage informatique, qui peuvent ensuite pour une situation fiscale donnée nous fournir l'ensemble des métriques désirés pour faciliter l'analyse du législateur, de l'administration fiscale, de l'économiste et du citoyen.
L'outil résultant de ce processus est appelé un simulateur car il simule les impôts et taxes dont sont redevable les citoyens, et puisqu'il s'applique à des entités microéconomiques (les individus, les ménages, les foyers, les entreprises), il est appelé microsimulation fiscale.

Ouverture des simulateurs Lors du commencement de cette thèse, les microsimulateurs interne aux administrations n'étaient pas accessible au public, et le plus souvent inaccessible aux chercheurs.
Depuis, le code source du modèle INES utilisé par l'INSEE et la DRESS a été ouvert (malgré un coût d'accés dommageable – inscription, utilisation de logiciel propriétaires). Suite à un procés administratif initié par un étudiant de la Paris School of Economics, le code source de la DGFiP a été ouvert dans le cadre d'un hackathon auquel j'ai participé. Ce code source est celui utilisé par l'administration fiscale pour le calcul de l'impôt, il peut donc être qualifié de microsimulateur parfait.
Cette thèse s'est fortement appuyée sur un microsimulateur libre et ouvert **OpenFisca** né au Commissariat général à la stratégie et à la prospective (CGSP). Alors qu'en 2014 son avenir était incertain, il bénéficie aujourd'hui de plus de 70 contributeurs, sert à des simulateurs destinés aux citoyens (dont www.mesdroitssociaux.gouv.fr et `https : / / mes-aides . gouv . fr` dont le gouvernement fait de la publicité sur facebook. Il est également proposé aux citoyens de consulter MesDroitsSociaux.gouv.fr à la fin de la déclaration de l'impôt sur le revenu 2019.

D'autres pays que la France tel que la Nouvelle-Zélande, la Tunisie, le Sénégal, le Mali, la Cote d'Ivoire et l'Italie ont aussi leurs système fiscal codé dans OpenFisca.
Cette tendance à l'ouverture totale ou partielle du code est bénéfique dans deux dimensions. 1. Cela permet aux articles scientifiques d'être reproductible (si les données sont accessibles), ou à minima de savoir exactement le travail fait par les auteurs. Malheureusement, cette pratique est rare, et je n'ai trouvé aucun article relevant du champ de l'Elasticity of Taxable Income où le code source était disponible. Cela est dommageable car d'expérience, de toutes petites modifications dans le code peuvent mener à de très grandes variations dans les estimations. 2. Cela permet aux citoyens de pouvoir se faire une idée de comment fonctionne l'impôt.
Il est possible de lancer très simplement des simulations pour montrer comment fonctionnent divers mécanismes de l'impôt. J'ai par exemple créé avec openfisca un Jupyter Notebook qui essaye d'expliquer les mécanismes simples de l'impôt sur le revenu [1].

1. https://mybinder.org/v2/gh/adrienpacifico/openfisca-france-notebook-story/master?filepath=notebooks%2Fcomment_fonctionne_l_Impot_sur_le_revenu_francais.ipynb

L'impôt au sens large L'impôt au sens large n'incompore pas uniquement l'impôt sur le revenu, mais peut inclure l'ensemble des prélèvements et versements impliquant des transferts entre citoyens. Il peut donc également inclure les aides sociales (vues par les économistes comme des impôts négatifs) telles que le RSA ou la prime d'activité. Cela inclus également les cotisations sociales, les taxes et droits d'accises, l'impôt qui repose sur les entreprises, l'ensemble de la taxation locale.

Cela inclut aussi l'ensemble des transferts en nature tel que l'aide juridictionnelle, la protection universelle maladie (PUMA anciennement CMU). La politique du logement social (1% du pib, et où les logements parisiens du parc social coutent le quart du prix de marché et dont les plus pauvres ne sont pas forcément les premiers bénéficiaires).

Sont aussi inclus l'assurance chomage, maladie, viellesse, l'ensemble des biens publics fournit aux citoyens, mais également l'ensemble des aides locales (transports gratuits, tarifs de cantine).

Tout ceci crée un empilement d'instruments redistributifs rendant très difficile d'évaluer l'impact redistributif du système socio-fiscal au sens large, et cela même en supposant l'absence de réactions comportementales et problèmes d'incidence fiscale.

En effet ne pas inclure les aides locales, tel qu'une gratuité d'accés aux transports en commun, peut mener à un calcul très biaisé du revenu disponible d'un ménage (Anne et L'Horty 2011). Les dépenses d'investissement public vont bénéficier de manière différenciée aux citoyens, et pas uniquement du haut vers le bas de la distribution des revenus (e.g. les 100 millions d'euros de subvention versés annuellement à l'Opéra de Paris).

Le montant des dépenses publiques représente 56% du PIB Français en 2017 ce qui laisse supposer des niveaux de redistributions très élevés entre les citoyens bien au délà de ce qui est considéré par les études les plus complètes utilisant les microsimulateurs les plus complets.

C'est pour cela qu'il me semble essentiel de construire un outil d'analyse du système socio-fiscal Français (En accord avec la tribune du Monde du 20 Janvier 2017 (Bozio & Coatanlem)).

En effet chaque administration ne peut, à elle seule développer, réécrire l'ensemble du système socio-fiscal au sens large. Un système commun et globalisé est nécessaire pour que puisse être inclu des aides allant des bourses étudiantes sur critères sociaux (Bourses CNOUS) juqu'aux réductions d'impôt liés aux habitations classées monuments historiques (Article 41 F du CGI), en passant par la bibliothèque gratuite pour les chomeurs à Marseille, les transports à moitié prix pour les étudiants à Paris, le barème et la fiche de valeur cadastrale permettant de calculer la taxe foncière des logements du Havre, ou de la possibilité pour un ménage de bénéficier de chèques vacances.

La solution possible est un logiciel libre, ou chaque administration pourrait contribuer à incorporer les divers détails des prestations et prélèvements qui relèvent de leurs compétance. Openfisca propose ce modèle et il me semblerait adapté que les différentes administrations cessent d'éparpiller leurs efforts pour répliquer de multiples fois le même travail, ce qui permettrait entre autre d'avancer dans les mesures d'impact sur les politiques publiques.

Une fois ce travail important de transformer tous les textes législatifs et réglementaires impliquant des transferts réalisés, il est nécessaire de connaitre la composition de la population. En effet, l'impact redistributif d'une règle fiscale ainsi que son coût pour les finances publiques dépendra du nombre de personnes concernées par ces règles fiscales. Comment peut-on évaluer l'impact d'une augmentation du RSA si l'on en connait pas le nombre d'allocataire ? Qu'en est-il de l'impact d'un changement du barème de l'impôt sur le revenu si l'on ne connaît pas la population située dans chaque tranche de revenus ?

Les données

Les sources des données permettant de faire de l'évaluation sont multiples. Nous ignorerons ici le cas de la fiscalité liée aux entreprises. Concernant la taxation indirecte, la seule source permettant de faire de l'évaluation est à ma connaissance l'enquête budget de familles (BdF) (voir Ruiz & Trannoy (2008)). L'enquête peut d'ailleurs être utilisée avec OpenFisca indirect taxation (telle qu'utilisée par Douenne (2018) ou Ben Jello et al (2019)).

En se concentrant uniquement sur la taxation directe au sens large, c'est à dire en incluant les aides sociales), les sources sont beaucoup plus nombreuses. Fideli permet de s'intéresser à la taxation locale et permet de bénéficier d'information sur le logement. Felin contient l'exhaustif des feuilles fiscales des ménages aisés et un échantillon du reste des ménages et permet de manipuler les données plus facilement qu'avec le fichier POTE.

POTE est le fichier exhaustif des déclarations fiscales soit 36 millions d'observations ; auparavant non panélisable, il est depuis mai 2019 panélisable pour les revenus de 2006 à 2018 et fait nouveau cela inclut également un panel ISF/IFI et répertorie les sorties de territoire. Hormis les problématiques techniques impliquées par la taille de cette nouvelle base de plus de 6 To de données, il est probable qu'elle donne naissance à d'excellents

articles d'économie.
L'ERFS, utilisé dans le premier chapitre de cette thèse, est un apparillage entre POTE et l'enquête emploi et contient des informations personnelles sur les individus tel que le niveau d'étude, la nature de l'emploi, etc. L'ERFS est panélisable jusqu'à 18 mois pour 1/6 des 50 000 ménages qui la compose. L'Échantillon Démographique Permanent (EDP), utilisé dans le deuxième et troisisème chapitre de cette thèse, est un appariement entre plusieurs données d'enquête telles que le recensement, et de données administratives incluant les information des déclarations sociales nominatives (DADS), la base FIDELI, et la base POTE. Elle est la seule permettant de suivre en panel des individus sur plusieurs années tout en bénéficiant d'informations transverses sur le logement (FIDELI), le niveau d'étude (Recencement), le nombre d'heures travaillées et la structure de l'entreprise (DADS), les choix de nuptialité ou de natalité (bases états civil) , ou les revenus et l'impôt sur le revenu (POTE), tout en étant sur une large population (plus de 2 millions de foyers fiscaux et plus de 6 millions d'individus). Elle était également la seule base permettant de suivre des foyers fiscaux en panel avant que ceci soit fait avec POTE.
Un enjeu de données est lié aux DSN (ex DADS) qui permettrait d'avoir des données mensuelles de revenus sur de longue période. Les données produites par la caisse des allocations famililales (CAF) que ce soit l' Échantillon National des Allocataires ou FILEAS permettrait de faire de la microsimulation exhaustive sur les aides sociales. Les FH-DADS qui sont un appariement fichier historique des demandeurs d'emploi et des déclarations annuelles de données sociales, permettrait de faire le lien entre les incitations jointes de l'assurance chomage et du RSA dans une logique de temporalité de l'impôt comme traité dans le premier chapitre de cette thèse.

Accès aux données via le CASD Ces données fiscales dont l'accès à l'ensemble des chercheurs est récente ne se fait pas sans un ensemble de coûts. En effet à l'exception des membres de l'INSEE, l'accès se fait par le CASD via un boitier d'accès à distance.
Afin d'obtenir cet accès à distance, il faut d'abord faire valider son projet auprès du CNIS afin d'évaluer si le projet répond aux enjeux d'intérêt généraux visant à accorder l'accès à des données confidentielles (pouvant porter une atteinte à la vie privée, ou au secret des affaires). Cette procédure prend environ six mois.
Ensuite, si le projet est validé auprès du CNIS et que toutes les autorisations légales sont accordées, une prise d'empreinte se fait dans les locaux du CASD avec une séance d'enrôlement informant sur les règles de confidentialitées associées à l'accès et la publica-

tion de résultats issus des données. Ces règles devront être respectées durant l'export des résultats via le serveur distant.
La durée de préparation des données a été assez importante pour ma part. Une partie due très probablement à un manque d'organisation, mais également de la difficulté de gérer des bases assez larges qui prennent plus que la taille de la mémoire vive de la machine fournie par le casd qui dispose d'une configuration peu puissante par défaut. Traiter des millions d'observations (par exemple pour l'EDP possède plus de 6 millions d'individus dans les bases fiscales) peut prendre un temps considérable qui ralentit le travail s'il n'est pas planifié avec soin. Chaque erreur de code fait perdre un temps significatif, et l'attente de souvent plusieurs dizaines de secondes à l'exécution de chaque commande rend difficile de garder le fil de sa pensée.

Vérification des scénarios (et impacts comportementaux. . .) Une fois les données permettant de générer des simulations socio-fiscales dans un logiciel de microsimulation, il faut ensuite s'assurer de la validité des simulations. En effet au moins 3 sources sources d'erreurs peuvent conduire à une mauvaise évaluation du système socio-fiscal.

- Erreur dans le codage du système socio-fiscal

  Les règles socio-fiscales sont complexes et contiennent de nombreuses exceptions. Il est très facile de se tromper dans le codage de la formule d'une prestation ou se tromper dans la valeur d'un paramètre. Une technique est de fournir un ensemble de tests (appelé tests unitaires en informatique) que l'on sait vrai et qui viennent tester que pour une situation donnée le logiciel de microsimulation renvoie les bons calculs de prestations et prélèvements. Cet ensemble de tests, en plus de s'assurer de l'exactitude des calculs des prestations, permet également de s'assurer lors de modifications du code (par exemple en actualisant la législation) que cela ne vient pas "casser" les anciens calculs. Ceci est connu sous le nom d'intégration continue, et permet de s'assurer pour toute nouvelle version du code que les tests précédents passent toujours. OpenFisca est à ma connaissance le seul microsimulateur en France à suivre cette logique.
- Erreur dans la préparation des données ou dans les données : Une autre source d'erreur peut être dans la préparation des données. Les données sur la microsimulation des ménages peuvent faire l'objet de manipulations plus ou moins complexes, notamment à cause de la gestion des différentes entités considérées par le système socio-fiscal (la famille, le foyer fiscal, le ménage, les individus) qui amènent à des

opérations nombreuses d'agrégations et de désagrégations de ces entités. Ensuite un travail important d'identification et de renommage des variables doit être effectué pour coller au microsimulateur.

Par exemple la préparation des données de l'ERFS avec Openfisca représente aujourd'hui aux alentours des 2500 lignes de code. Il est plus que probable que des erreurs aux impacts plus ou moins importants existent au sein d'un code aussi long.

— Erreurs dans les données (ou limitations) :

  Ensuite les données peuvent faire l'objet de limitations, que ce soit dans la véracité de l'information,la granularité et la complétude de l'information disponible, ou le nombre d'observations. **La véracité** peut être remise en cause quand les données sont issues d'enquêtes déclaratives de la part des ménages comme avec l'enquête emploi ou un biais important de déclaration peut avoir un impact important sur les résultats. **La granularité** de l'information peut être limitante, dans l'EDP par exemple nous ne disposons pour certaines variables que de l'agrégation de plusieurs cases fiscales qui rendent impossible par exemple une prise en compte fine des crédits d'impôts, ou même des calculs de la base taxable. Il en est de même de la **complétude** de l'information disponible, au sein de l'EDP l'information sur la déduction pour frais professionnel (Case AK) n'est pas présente, et entraine l'obligation de faire des hypothèses simplificatrices pour calculer la base taxable (dans les chapitre II et III de cette thèse, d'appliquer un abatement forfaitaire de 10% pour tous les revenus salariaux).

  Ensuite le **nombre d'observations** disponibles et la représentativité des données (une fois les poids appliqués) est déterminante. Il est dificile avec l'ERFS qui contient environ 50 000 ménages, d'imaginer calculer de manière précise l'impact d'une réforme fiscale qui concernerait les 1000 foyers fiscaux les plus riches de France. Par exemple la contribution exceptionnelle sur les hauts revenus qui rajoute des tranches implicites de 48 et 49% à l'impot sur le revenu pour les foyers gagnant plus de respectivement 250 000 et 500 000 euros sera à mon avis assez dure à évaluer avec l'ERFS dans l'impact sur le montant agrégé de l'impôt sur le revenu étant donné que cette prestation impacte les foyers aux alentours du dernier millile de l'impôt sur le revenu.

Il faudra donc arbitrer en fonction de l'objectif recherché entre les bases de données. Des bases exhaustives comme le fichier POTE ou exaustive sur le haut de la distribution (FELIN) permettront une estimation très précise de l'impôt sur le revenu. Cependant, elles ne permettront pas d'accéder à certaines variables telles que le niveau de diplome, le type de contrat de travail, et d'autres variables utiles pour l'analyse économique. Une base comme l'ERFS permettra d'accéder à ces variables, mais souffrira d'une trop petite taille d'échantillonage. S'il faut utiliser de l'information fiscale en panel sur plus de 18 mois, seule l'EDP le permet (pour l'instant sur 6 ans), elle a une taille qui permettrait surement une évaluation assez précise de l'impôt sur le revenu (plus de 2 millions de foyers fiscaux). Seule la précision de l'information fiscale est à remettre en cause car de près de 600 cases qui composent la déclaration d'impôt sur le revenu, seule une partie de l'information est résumée en une vingtaine de variables, et l'absence de documentation fait qu'il est difficile de savoir comment elles ont été constuites.

Validation des données Une étape importante est la validation du modèle de simulation. Cette étape est malheureusement trop souvent mise de côté, elle est cependant essentielle et centrale pour le débat public.

Quelle est la précision et la capacité d'un modèle de microsimulation à prévoir l'impact d'une réforme fiscale ? J'ignore à quel point les évaluations de réformes faites par la DGFiP, la CAF, L'INSEE-DRESS sont précises, et s'il existe un biais systématique. Mon expérience est que les chiffrages fournis aux parlementaires sont rarement facilement accéssible et peu précis sur les moyens mis en œuvre pour assurer la qualité des chiffrages. Fait notable cependant, une note de validation du modèle figé INES sort annuellement pour comparer les calages du modèle fait avec les poids de l'ERFS et les agrégats de la comptabilité nationale. Cette note permet de comparer le système sociofiscal d'une année N en utilisant l'ERFS N-2 et à cause de délai lié à la production données, il y a deux ans de décalage sur le système sociofiscal analysé. En février 2019 est donc sorti le document "VALIDATION DU MODE'LE FIGE' INES 2017" qui évalue le calage du système socio-fiscal en 2017 en utilisant les données 2015. Les calages utilisant l'ERFS en utilisant uniquement les poids de l'enquête emploi sont très bons sur de nombreuses prestations.

Bien qu'il soit dommage que ce document ne soit pas facilement accessible puisqu'il faut pour y accéder aller sur la forge Adullact,[2] s'inscrire, puis s'identifier, cet exemple devrait être suvit par l'ensemble des autres microsimulateurs dans une démarche saine et transparente sur les limites et capacités réelles des simulateurs à appréhender la réalité du système socio-fiscal.

2. https://adullact.net/projects/ines-libre/

À terme il serait très intéressant que plusieurs institutions mettent en concurence différents microsimulateurs utilisant potentiellement différentes bases de données pour faire des analyses ex-anté de réformes du système socio-fiscal, et ensuite ex-post analyser et expliquer les écarts entre la prévision et la réalisation des différents modèles.
Mieux, étant donné l'importance des résultats donnés par ces simulateurs dans le débat public, et afin d'assurer la reproductibilité et la transparence des résultats, il serait intéressant que le code et les résultats ayant été générés par ce code, soit publié, et certifié par une entité indépendante telle que CASCAD dont je parlerai plus loin dans cette introduction.

De l'importance de microsimulateurs libres avec des outils libres menant à un possible outil unifié Au delà de la possibilité pour différentes administrations et organismes de coder les prestations dont ils ont la charge, un modèle libre de microsimulation tel qu'OpenFisca dont le cœur (openfisca-core) est étudié pour s'adapter à tout type de système socio-fiscal, ouvre la porte à des études inter-pays. Le fait de n'utiliser aucun logiciel propriétaire rend l'accès beaucoup plus facile pour des pays en développement, permettrait d'être totalement transparent sur les simulations réalisées.
Pour prendre un exemple inverse, EUROMOD nécessite d'avoir accès au système d'exploitation Windows. L'accès est conditionnel à une demande motivée de chercheurs. Le code n'est pas libre. Il n'est pas possible pour un citoyen de contrôler les hypothèses de simulations, ou de corriger les erreurs présentes au sein du code. Un pays n'appartenant pas au projet ne peut pas être ajouté. Cela peut amener également à poser des questions sur les comparaisons inter-pays réalisées avec ce logiciel, qui à mon sens ne répond pas au critères essentiels de réfutabilité nécessaire à la démarche scientifique.

Au sujet de la reproductibilité en économie, et en économie de la taxation. La science économique, et les sciences sociales en général souffrent d'une crise de reproductibilité. Andrew C. Chang and Phillip Li (2016) ont montré que moins de 50% des résultats des 13 meilleures revues d'économie sont reproductibles, même après contact avec les auteurs et corrections des erreurs de code. Les économistes ne sont pas des codeurs, et n'appliquent pas les méthodologies standard pour éviter les erreurs de code. La probabilité d'avoir des résultats faux est donc très élevée, et est d'autant plus élevée que le code pour préparer les données est complexe, et les bases de données larges.
Hors, les articles d'économies utilisent de plus en plus de très larges bases de données

administratives, complexes, et confidentielles. Le travail devient de plus en plus long, les erreurs de plus en plus nombreuses. La non disponibilité du code, et la difficulté d'accès aux données rend peu probable que les résultats d'un article soient vérifiés.

Certains articles d'économies ont pourtant une grande influence sur les débats publics. Growth in a Time of Debt de Reinhard et Rogoff, publié dans l'AER en 2010 a été utilisé pour justifier les politiques d'austérité. Ce papier n'utilisait cependant ni de données complexes ou difficilement accessibles, ni de traitement sophistiqués, il a été publié dans une des meilleures revues d'économie, a bénéficié d'une grande publicité de par ses résultats originaux. Il y a eu cependant un délai considérable avant que les résultats faux de ce papier soient dénoncés, cela qu'une fois que les auteurs aient partagé leurs fichiers, et que plusieurs erreurs aient été repérées. Que penser de la probabilité qu'un papier contenant des erreurs soit remis en cause s'il est publié dans une revue moins prestigieuse, dont le code est plus long et plus complexe, et dont l'accès aux données se fait pas un long processus administratif garant de la confidentialité des données ?

La recherche empirique en économie de la taxation a des conséquences importantes sur le débat public. Par exemple les estimations entre études sur l'élasticité des ménages à hauts revenus varient beaucoup en fonction des choix de modélisation allant de -1 à +1... De plus le choix du sample à des effets importants sur les résultats, Kopczuk (2005) montre que la sélection du sample a un impact généralement plus important que le choix de modélisation. Face à une telle incertitude sur les résultats, il serait attendu que les résultats soient parfaitement transparents, le code immédiatement accéssible, et les instructions pour reproduire les résultats d'un papier minutieusement documentés. Ce n'est malheureusement pas les cas, l'accès aux code ayant servi à produire les résultats de la quasi-totalité des articles que j'ai pu lire ne sont pas disponible. Une partie utilise le modèle TAXSIM du NBER dont seule une version partielle est disponible aux chercheurs n'appartenant pas au NBER. Les donnnées administratives ne sont accéssible qu'en se déplaçant dans les locaux de l'Internal Revenue Service (IRS).

Une question qui peut se poser est comment rendre reproductible la recherche en économie, montrer comment les résultats on été produit malgré la présence l'utilisation de données confidentielles ? Une solution mise en avant entre autre par le dernier prix nobel en date Paul Romer [https://paulromer.net/jupyter-mathematica-and-the-future-of-the-research-paper/] est l'utilisation de Jupyter Notebook. Un Jupyter Notebook permet d'avoir à la fois le code exécuté, mais également la sortie correspondante au code exécuté sur un seul document. Sauf fraude savamment orchestrée, un Jupyter Notebook permet de s'assurer

qu'un résultat est bien issu de l'exécution d'une (ou d'un petit ensemble) de ligne de code particulier.
Une des rares fierté que j'ai au sujet de cette thèse est d'avoir rendu complètement reproductible le deuxième chapitre de cette thèse en créant un script qui permet d'exécuter le code de A à Z et d'observer un grand ensemble de résultats (bien plus nombreux que ceux figurant dans le chapitre).

Et sont consultable en suivant le lien suivant : https://nbviewer.jupyter.org/github/adrienpacifico/A-Direct-Measure-of-Inefficiency-within-Couples/blob/master/1-Start.ipynb .

Afin de s'assurer que le travail est effectivement reproductible, celui-ci a également fait l'objet d'une certification par l'agence de certification CASCAD. CASCAD est une agence internationale de certification basé en France, lancée par Christophe Hurlin et Christophe Pérignon, qui s'assure qu'un code a bien produit les résultats d'un papier, et leur donne une note de reproductibilité. Ils disposent d'un accès à l'ensemble des bases disponible au CASD via un accord exceptionnel du CNIS. Le deuxième chapitre de cette thèse à été "A Direct Measure of Inefficiency within Couples: Tax Optimization in French cohabiting couples" a été le premier à être certifié dans l'histoire de cette agence, et probablement le permier papier tournant sur des données confidentielles dont le résultat a été certifié.

Bien que cette certification ne donne pas un gage sur l'absence d'erreurs dans le code amenant à des résultats potentiellement faux, elle permet de s'assurer que les sorties disponible sont effectivement issues de l'exécution du code et de la base de donnée citée. Un chercheur pourra essayer de comprendre le code aiyant amené au résultat, et relancer le code à l'intérieur d'un projet auprés du CASD s'il souhaite reproduire les résultats et aller plus loin s'il souhaite creuser cette thématique.

Les trois chapitres de la thèse

Cette thèse a fait l'objet de trois chapitres. Je vais brièvement les décrire, énoncer l'intérêt pour le débat public qu'ils comportent et donner mon point de vue sur leurs apports et faiblesses.

0.1 La temporalité du système socio-fiscal

Le premier chapitre de cette thèse intitulé *Monthly Income Tax Frequency: Theoretical and Empirical Investigations* co-écrit avec mes directeurs de thèse Olivier Bargain & Alain Trannoy a été travaillé d'Avril 2014 à Juin 2017. Il contient une partie théorique analysant différentes temporalités ou fréquences possibles de l'impôt. Il montre sous différentes hypothèses (incluant l'absence d'épargne) que de grands gains de bien-être peuvent être faits en augmentant la fréquence de l'impôt. Ces gains sont d'autant plus grands que les individus sont pauvres, car les effets d'assurance sont plus forts pour les ménages les moins aisés aux vues de l'utilité marginale décroissante du revenu disponible. De plus les ménages modestes font face à de fortes variations de revenus. Les ménages aisés eux sont faiblement impacté par une telle réforme car, leurs revenus varient peu, et que leurs hauts niveau de revenu fait que les variations de revenu disponible entre un système mensuel et annuel ont un impact faible sur leur bien être.

L'effet antagoniste à l'effet d'assurance lié à une augmentation de la fréquence de l'impôt est celui lié à l'inégalité de Jensen. Si une fonction d'impôt est convexe, une augmentation de la fréquence de cet impôt entrainera une augmentation de l'impôt à payer pour les ménages qui ont un revenu qui varie. Cet effet est relativement faible pour les ménages aisés, car les tranches très larges de l'impôt sur le revenu font que la plupart des ménages font face à une imposition linéaire (tant qu'ils n'ont pas de très large variation de revenu), qui a un impact nul sur le montant d'impôt à payer. À l'inverse les ménages pauvres faut face de part le recouvrement d'une multitudes d'aides sociales et d'abattements d'impôt d'un barème généralisé très accidenté, et où souvent l'impôt au sens large n'est pas convexe (voire même non monotone dans certains cas).

0.2 Coopération au sein des couples de cohabitant

Deuxième chapitre de la thèse, celui-ci a été co-écrit avec Olivier Bargain, Damien Echevin, et Nicolas Moreau. Ce chapitre vise à explorer le comportement de coopération des couples au sein des ménages en observant si les enfants sont alloués de manière optimale entre les deux feuilles fiscales d'un couple de cohabitant. Il montre qu'un quart des ménages ne respectent pas le critère d'efficacité paretienne en ne choisissant pas l'allocation optimale. Les choix d'allocation des ménages font l'objet d'une forte inertie, et qu'en cas de changement d'allocation optimale d'une année sur l'autres les ménages gardent l'allocation précédente. Il montre également que les ménages qui optimisent fiscalement ont plus tendance à se marier et à se pacser l'année d'après, et qu'a l'inverse les ménages qui n'optimisent pas fiscalement ont plus tendance à se séparer, et suggère donc un lien entre optimisation fiscale et coopération au sein du couple. Ce chapitre a été pour moi un défi technique vis à vis des données car il a fait appel à de nombreuses bases et sources de données et de nombreuses transformations ont été nécessaire pour arriver au résultat. J'utilise les données fiscales en panel (sur deux ans) sur les couples de cohabitant. Je dois recalculer l'impôt sur le revenu de chaque cohabitant à partir de données partielles de l'impôt sur le revenu, en vérifiant que l'impôt (seulement visible en agrégé au niveau du ménage) corresponde bien à la somme de l'impôt des deux foyers fiscaux calculé pour deux années. Il faut ensuite recalculer l'impôt pour chaque allocation alternative possible. Il est également nécessaire d'utiliser les bases de naissances de l'état civil pour s'assurer que les enfants d'un ménage sont bien les enfants "naturels" de chacun de cohabitant en vérifiant que la date de naissance des parents pour chaque enfant est bien celle figurant dans l'état civil. Il a fallu ensuite pour avoir plus de variable de contrôle, faire matcher les ménages de l'enquête de recensement (sur plusieurs années pour avoir le plus) avec les ménages des enquêtes fiscales alors qu'il n'existe pas de clef d'appariement toute faite. L'ensemble de ce travail est proche de celui réalisé par Costemalle qui n'a été publié qu'après que j'ai réalisé le travail. C'est à ma connaissance le premier article à utiliser les bases fiscales de l'EDP en panel pour recalculer l'impôt sur le revenu.

0.3 L'abaissement du quotient familial

Le troisième chapitre de cette thèse à commencé suite à l'écriture d'une note de politique publique (Note IDEP n°6) sur la diminution du gain fiscal à l'enfant pour les familles aisées. Ayant accès à une base assez large, qui était la seule à l'époque permettant de faire une analyse en panel. La possibilité d'utiliser une méthodologie en triple-différence me semblait intéressante et n'avait pas été utilisée (à l'exception de Piketty (1999), mais je ne l'ai appris que plus tard), et me semblait à même d'identifier correctement les réactions comportementales aux réformes de l'abaissement du quotient familial. Malheureusement, les résultats sont peu satisfaisants. Je ne suis pas capable de voir pourquoi l'hypothèse de tendance commune n'est pas respectée malgré de nombreuses vérifications pour d'autres causes (réforme des retraites, problèmes de mesure de la base taxable). L'analyse a été menée avec l'EDP 2015 puis avec l'EDP 2016 pour avoir plus de variables (telles que celles issues des DADS pour avoir les heures de travail). J'ai également essayé de prendre les ménages qui changent de structure familiale via une naissance pour avoir un nouveau contrefactuel. Je n'ai pas eu la capacité d'explorer pleinement ces pistes sur la durée de cette thèse, et l'analyse fournie est celle fait avec l'EDP 2015.

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Chapter 1

Monthly Income Tax Frequency: Theoretical and Empirical Investigations [1]

1. This chapter is a collaboration with Olivier Bargain & Alain Trannoy

The pioneering work of Vickrey (1939, 1947) on the income-tax frequency has not inspired a lot of further studies. We propose an investigation of this issue both from a theoretical and empirical viewpoint within the year. We first show that increasing the income-tax frequency (from an annual tax basis to a monthly tax basis) and refunding the extra-revenue for the taxpayer is Pareto-improving for any convex tax scheme (increasing marginal tax) and any risk-adverter. Welfare gains are all the larger as the infra-annual volatility of income is large and the possibility to borrow is low, implying that the benefits should be larger for the bottom part of the income distribution. We submit an empirical illustration using French administrative tax data and simulations of the current tax-benefit system. Despite that this system is not convex over the whole income domain, we show that increasing the tax frequency can lead to substantial social welfare gains. However the average welfare gain is lower with the proposed system than with the Vickrey's one even though there are less losers.

1 Introduction

Time and risk are difficult matters and the design of tax system does not make an exception when it deals with incomes which are not steady. Usually, the practionners are applying some methods which are both understandable by the layman and easy to implement. For instance, in withholding income tax systems, tax collection is based on monthly income while tax schedules are designed over yearly income, and filing at the end of the year allows using tax allowances to obtain rebates. Benefits also have specific timing of income assessment (for instance in France, earnings of the three past months form the basis of means-tests for social assistance and in-work benefits). Effective taxation then possibly treats various time periods and, hence, different streams of income differently. In this paper, we question the welfare implications of varying the period of observation of the tax base within a year.

Arguably, our question would be irrelevant if people had constant income flows over time. Yet it is clear that many households do face important income variation during the year, either expected (pay rise, seasonal work) or unexpected (income shocks due to business failure or unemployment), voluntary (chosen retirement) or involuntary (low-skill workers forced into temporary work). This is a major motivation for studying the question of within-year tax frequency and its impact on tax-payer utility. Note also that our question would be meaningless if effective taxation was flat. However, this never happens. Effective taxation, i.e. the impact of taxes and benefits, is usually nonlinear. Even in flat-tax countries, the presence of many other instruments, e.g. means-tested benefits, impose some regressivity or progressivity upon the effective tax schedule.

Interestingly, and potentially important for our welfare analysis, the question of tax frequency may be more relevant at the bottom of the distribution. Indeed, for high income households, large income variations are usually required to change tax brackets (especially given the global trend that has consisted in reducing the number of brackets, Peter et al. (2010, Fig. 3, p.468)). For them, this is as if they faced a marginal flat tax around the pre-shock income level. In the lower part of the distribution, however, effective brackets are narrower because of the numerous (and often overlapping) redistributive schemes at low and middle income levels (e.g. social assistance, tax credits, means-tested family benefits, etc.). Thus, even small variations of income may lead to change in effective marginal tax rates (MTR). There is also empirical evidence that this population experience more income fluctuations, and that income variation is more often involuntary, e.g. income shocks due to unemployment (Hills et al., 2006). These aspects are likely to contribute much to the welfare implications of tax frequency that we shall study. [2]

Strangely enough, the question of tax temporality has received little attention in the economic literature. Very few studies make the link between tax-payer utility and tax temporality. The seminal work of Vickrey (1939) focuses on yearly versus lifetime taxation. Vickrey develops the horizontal equity argument that over the lifecycle, people earning the same income should pay the same tax. This leads William Vickrey to propose the celebrated "Cumulative Averaging" tax principle. Initially, the idea was formulated for taxing capital gains and then extended to other types of income. The idea was that an investor should have no incentive to realize her capital gain at one time rather than another on account of the tax. The upshot is that the tax should be completly neutral with respect to the time at which the gain is realized [3].

The present research is devoted to the temporality of the tax within a year. Most developed countries operate a wage withholding tax system [4] which represents the benchmark system in our reasoning. As already mentioned, the amount withheld and paid by the employer to the government each month is applied as a prepayment of income taxes and is refundable if it exceeds the income tax liability. The tax liability is determined by filing the tax return at the end of the year and applying the tax schedule including tax deductions. The current system is far remote from applying a cumulative averaging system à la Vickrey. The first idea which comes out is then to apply the cumulative average proposition.

Three ingredients are needed to compute the tax liabilities according to the cumulative averaging formula: a starting date, a termination date and a tax schedule appropriate to the period covered. The idea of a termination date raises some difficulty for applying the principle over the life cycle because the time of death is uncertain. This difficulty vanishes when applying the mechanism within a year. Each month the taxpayer is paying a withhold tax. This tax is computed as the difference between the theoretical tax liability

2. Note also that poorer people are less able to smooth income because lower resources limit their saving possibilities (Dynan et al. (2004) finds a median saving rate of 1 percent for households in the bottom quintile for US households aged 30-59). In addition, they are often more credit constrained and possibly more myopic (cf. Hastings and Washington, 2010).

3. Vickrey's contribution has triggered important advances in capital taxation (Auerbach, CITE) and dynamic optimal taxation (CITE). An interesting extension of Vickrey's setting is Liebman (2002). He studies a distributionally-neutral Vickrey tax system that would equalize MTRs both over-time for the same individual and across individuals with the same lifetime earnings level, incorporating various motives for efficiency and equity gains (income shocks, myopic agents). Finally, note that the temporality of taxation has also received some attention in law studies following Vickrey, for instance Batchelder (2003) and Fennell and Stark (2005).

4. For capital incomes and earnings of self-employed, the tax payment usually remains on a yearly basis.

of the subperiod running until that month minus the cumulated withheld taxes of all previous months. Two mathematical operations are performed to compute the former. First, the taxbase is computed on a annual basis by assuming that the monthly average income since the beginning of the year will prevail until the end of year. Second, the tax liability is computed on a pro rata temporis basis. That is, the theoretical tax liability for the five first months in May is only the 5/12 of the annual tax liability.

The extension of Vickrey's idea on earnings is not without dispute. Two arguments can be stressed. From a more philosophical view point, we can remind Derek Parfit's provocative stance: *The difference between different persons at the same time is more like the difference between the same person at different times.* That difference in income over time should be taken as a difference in ability to contribute over each period of time. A sport superstar who is able to earn a lot of money over a period of 10 years is a different man from what he will become years after. It is very in line with the static Mirrlees optimal tax model with the efficiency equity tradeoff. Vickrey's tax scheme looks at equity over the life cycle, but if Derek Parfit view is embodied, equity is sacrified for efficiency.

Second it can be emphasized that in many ways human capital is different from financial capital. If the capital market is liquid, you can sell your asset when you want. The labor market is less liquid at least in a given year than the capital market. In many places and many times, for different reasons that we do not develop, the wage does not clear. It means that from the view point of an individual the variability of earnings within a year reflect not only preferences but also features on the local labor market demand as aforementioned. We name the latter the unvoluntary variability. In that case, neutrality with respect to time is not the only property we may want to see respected by the income tax payment. Because of risk aversion, tax smoothing is arguably a property that will come high on the list. The cumulative averaging tax schedule is smoothing the payment of the tax within a year. However it is not the only one and we are here investigating other mechanisms.

In particular, there is a main difference between the framework that we deal with and Vickrey's one. The big strength of the cumulative average formula is each month payment to only depend on the available information. Each month, there is a kind of bayesian revision of what the taxpayer owes, by incorporating the earning information that is disclosed that month. We here adopt a perfect information framework for tax authorities. Namely, the tax authority knows the within-year income stream of the taxpayer from the beginning of the year. This is of course unrealistic, even if there are (econometric) means for the tax authority to forecast the variability of income that prevails for different types of taxpayer. We will comment on that in the conclusion. However we claim that at least from a theoretical perspective and maybe more than that, it is always interesting to compare what we could do in a context of perfect information and what we can do in a context of available information. The difference represents the cost of uncertainty.

In contrast, instead of averaging the income basis of each month, we consider the opposite direction which is to increase the frequency of the tax within the year,empirically illustrated with a move from annual to monthly taxation. The tax liability will be monthly based. If the tax scheme is convex (marginally progressive), the taxpayer will pay more with a monthly tax liability than with an annual tax liability. We show that it is possible to refund each taxpayer the extra amount of taxes and any risk-adverter tax payer will be happier with this system termed the *Monthly tax frequency with compensation,* in short, *Monthly compensated*. We should immediatly stress that our proposal remains neutral with respect to the timing of income within the year. Besides neutrality, there is the issue of welfare gains which depend on the convexity of the tax schedule and the concavity of the utility function, two features that are absent from Vickrey's paradigm. We are more specific but we do not deviate from usual assumptions considered in economic theory.

To the best of our knowledge, we are the first to study the welfare impact of tax frequency within the year, in particular the implications of a shift from annual to monthly taxation. We first suggest a simple theoretical framework in which Jensen's inequality implies that a taxpayer with irregular income streams will pay more with a monthly tax scheme. We derive compensation schemes for the increase in tax liability due to income variation, i.e. compensations equating the amount of tax paid in both annual and monthly systems. We show that the reform with compensation is Pareto improving if utility is increasing, concave and intertemporally additive.[5] We characterize those most concerned by welfare gains, namely those whose incomes vary much over time and who face borrowing constraints.

We then submit an empirical illustration using French administrative data (tax filing data combined with work sequences from the French Labor Force surveys (*Enquête Revenus Fiscaux et sociaux ERFS*). Using simulations of the current income tax, we implement the higher-frequency tax reform and characterize winners and losers. We extend this empirical exercise to effective taxation, i.e. we additionally account for the main redistributive

5. At the center of our theoretical results, Varian (1980) emphasizes the insurance property of an income tax and shows in a two-period model that this insurance component leads to a convex optimal tax scheme.

scheme in France. While our Pareto improving results require the income tax to be convex, real-world effective taxation is rarely so. Moreover, non-convex parts of the effective schedule are typically located in the first half of the income distribution, with the cumulative effect of different instruments (tax credit and benefit withdrawals, social contributions and income tax, etc). Despite this feature, which is particularly present in the case of French taxation, we show that increased tax frequency with compensation leads to substantial welfare gains.

The article is organized as follows. Section 2 presents our theoretical framework and results. Section 3 shows descriptive statistics on France taxpayers earnings. Section 4 submits simulation of a tax frequency reform on French data while section 5 concludes.

2 Theory

The assessment of the tax determines the amount an individual is entitled to pay based on its situation (income streams, family situation, etc). The determined amount known as tax liability leads to a payment of the tax either directly by the taxpayer, or by a third party institution (employer, banks, etc). Appart from the frequency of the assessment of the tax, it can leads to different schedule of payments. In practice in countries with Pay-as-you-earn (PAYE) systems, an amount is withholded at each payroll period which can be viewed as sub-periods of taxation, even though in most countries final tax liability is computed over whole year incomes. Meaning that tax liability is based on yearly income, but tax payments are made before the full realisation of incomes that constitutes the tax base.

Hence, there exists a *reference period* for the tax base in order to determine th teax liability. In cases the government wish to recover taxes before full realisation of income, it may want to apply some rules on sub-periods to compute *sub-period tax liability* based on income, concomitant with the curent sub-period, or based on past income streams.

Those cumulative payments may lead to some differences with respect to tax liability and may imply some implicit lending or borrowing between the taxpayer and the state: in the US, fiscal household has to fill a tax return in April for last year income to pay (or get refunded) the difference between the withholded amount and the tax liability. France is moving slowly to a withholding system which is due to be implemented in 2019.

We first define the framework, then expose five tax frequency regimes before presenting some theoretical results about the comparison of the well-beings they generate. We end the section by discussing the external validity of the results when we embody behavioral reactions.

2.1 Framework

Let us consider a reference period T and sub-periods t from 1 to T. If we take the year length as the reference period and months as the single periods, then T=12, and each month is labeled from 1 to 12. There are twelve sub-periods corresponding to the first month, the two first months, the first quarter and so on. We denote y_t the gross income the taxpayer at period $t = 1, ..., T$ with $y_t \geq 0$. We call $G(.)$ the reference tax schedule, that is the tax schedule for the reference period which is supposed to be increasing and convex. G can be positive (taxes) or negative (benefits). We first study the case of positive taxes and then indicates how the analysis can be extended to the case of a negative income tax. z_t is the disposable income or the net-of-tax income.

We define G_t the *pro rata temporis* single period tax schedule, or in short, the sub-period equivalent tax schedule where $G_t = \frac{1}{T}G(Ty_t)$. The tax liability of period t is denoted g_t. In our proposal, sub-period equivalent tax function only depends of the sub-period income. We should note that for equal income at each sub-periods the reference income tax is just equal to the sum of the sub-period income tax, formally :

$$\sum_{1}^{T} \frac{1}{T} G(Ty) = G(\sum_{1}^{T} y), \forall y \in \mathbb{R}^{+} \tag{1.1}$$

We consider that tax-payers have additive/separable utility functions defined on disposable income:

$$U = \sum_{t=1}^{T} u(z_t)\,, \tag{1.2}$$

where U is the reference period global utility function and u_t is the increasing and concave sub-period utility function of disposable income. $u(.)$ can be viewed as the indirect utility function at constant wage and price.

At this stage, we do not include time discounting or interest rate in this framework. These extensions are discussed in the discussion subsection as well as behavioral responses to the change in taxation frequency.

We recall the well-known mathematical result about partial sums and dominance for a convex or concave function which will be useful in deriving results.

Theorem 1. *Let x and y two income streams $x = (x_1, ..., x_n)$ and $y = (y_1, ..., y_n)$, ranked in decreasing order, i.e., $x_1 \geq x_2 \geq \cdots \geq x_n$ and $y_1 \geq y_2 \geq \cdots \geq y_n$ such that $\sum_{i=1}^n x_i = \sum_{i=1}^n y_i$ and $\sum_{i=1}^k x_i \geq \sum_{i=1}^k y_i$ for $k = 1, ...n-1$. Then $\sum_{i=1}^n f(x_t) \geq \sum_{i=1}^n f(y_t)$ for any f convex function.*

The version of the theorem for a concave function holds for x and y two income streams ranked in increasing orders. The obtained ranking of income distributions corresponds then to the Lorenz ranking of income distributions.

2.2 Five within-year tax payments

Current payment In the US [6] and in many countries, income tax is withholded by the employer based solely on monthly income and monthly situation (family structure). At the end of the year a tax adjustment is proceeded to make the total annual tax liability exactly given by the reference period tax schedule.

$$g_t^C = \begin{cases} \frac{G(Ty_t)}{T}, & \text{if } t \in [1, 11] \\ G(\sum_1^{12} y_t) - \sum_1^{11} \frac{G(Ty_t)}{T}, & \text{if } x = 12. \end{cases}$$

Cumulated Averaging Tax Vickrey's proposal was that each sub-period payment should be equal to the amount one would have paid under the sub-period tax schedule if the total income had been earned in equal amounts in each single period composing the sub-period. Without interest rate it leads to:

$$g_t^V = \frac{t}{T} G\left(T \frac{\sum_{p=0}^t y_p}{t}\right) - \sum_{p=0}^{t-1} g_p^V \tag{1.3}$$

Where g_t^V is the tax paid for a given single period t with Vickrey's tax scheme. On a year span, the taxpayer will have paid exactly the same amount as in the current system $G(\sum_1^{12} y_t)$. We can thus implement a Vickrey's tax scheme on a yearly span – instead of a lifetime span. This is indeed the solutions that seems to be chosen by the Irish PAYE system. [7]

6. https://www.irs.gov/publications/p505/index.html
https://www.irs.gov/pub/irs-pdf/p505.pdf
In fact, the adjustement is made in April after the taxpayer has filled his tax return.
7. http://www.revenue.ie/en/business/paye/guide/employers-guide-paye-calculation.html

Equal Payment Regime In this system, the amount of the tax is based over income of the reference period, $G(\sum_1^T y_t)$. The tax is split equally between all the single periods. If we denote g_t^E the equal monthly payment made at period t, then :

$$g_t^E = \frac{G(\sum_1^T y_t)}{T}$$

As a matter of fact, the Equal Payment Tax is not implementable since the government has to know future income before their realisation. It can still be used as a benchmark. Another limitation is that the monthly income should be higher than the average tax liability, a constraint that can be viewed as severe.

Monthly Tax The monthly tax is the current tax without adjustment at the end of the year

$$g_t^M = \frac{G(Ty_t)}{T}.$$

With a strictly convex tax function those with varying income will pay more tax over the reference period with the montly tax than with the tax on the reference period.

$$\sum_1^T \frac{G(Ty_t)}{T} \geq G(\sum_1^T y_t))$$

Concerning the utility of the tax-payer, its single period utility might be lower or higher with the monthly tax than with the equal payment tax. Two opposite effects are in play: the first one is that more tax is paid with the sub-period tax, which reduces overall income, and thus overall utility. But on the other hand, the fact that the tax is directly linked to the single period income is smoothing the disposable income with a convex tax scheme. The taxpayer pays a smaller tax when earning little and a bigger tax when earning a lot. A risk adverter will like the reduced risk. On the whole, the effect is ambiguous with a mean loss and a reduced variance. The effect depends thus on the shapes of the tax and of the utility function, but also on the different income streams and their dispersion around the annual mean.

Monthly Compensated Tax It is easy to equalize total tax assessement between the equal payment tax and the sub-period tax. We just need to define the parameter λ which will decrease the single period tax schedule and wipe out the extra-tax collected with a monthly taxation scheme.

$$\sum_{1}^{T} \frac{1}{T+\lambda} G(Ty_t) = G\left(\sum_{1}^{T} y_t\right). \tag{1.4}$$

λ is a function of both the convexity of the tax function and the variability of income over the year. It is positive or null.

$$\lambda(y, G) = \frac{\sum_{1}^{T} G(Ty_t)}{G\left(\sum_{1}^{T} y_t\right)} - T.$$

The uncertainty about the income stream should be resolved to compute the parameter λ. Observe also that the value of λ is specific to the income realization of a given taxpayer. We will come back to that point on the discussion sub-section. The tax paid for the monthly compensated tax (MC) is then:

$$g_t^{MC} = \frac{1}{T+\lambda} G(Ty_t)$$

Figure 1 illustates that the compensated income tax represented by (yellow) stars leads to small absolute reduction for the low income sub-period, and a big absolute reduction for the high income sub-period.

We must observe that except the monthly equal tax, the total amount paid at the end of the year to the treasury is the same for the other four tax payments. The neutrality property essential to Vickrey is then satisfied by the four taxation schemes. We must find other criteria to decide between them. The well-being associated to them seems at least an important criterion.

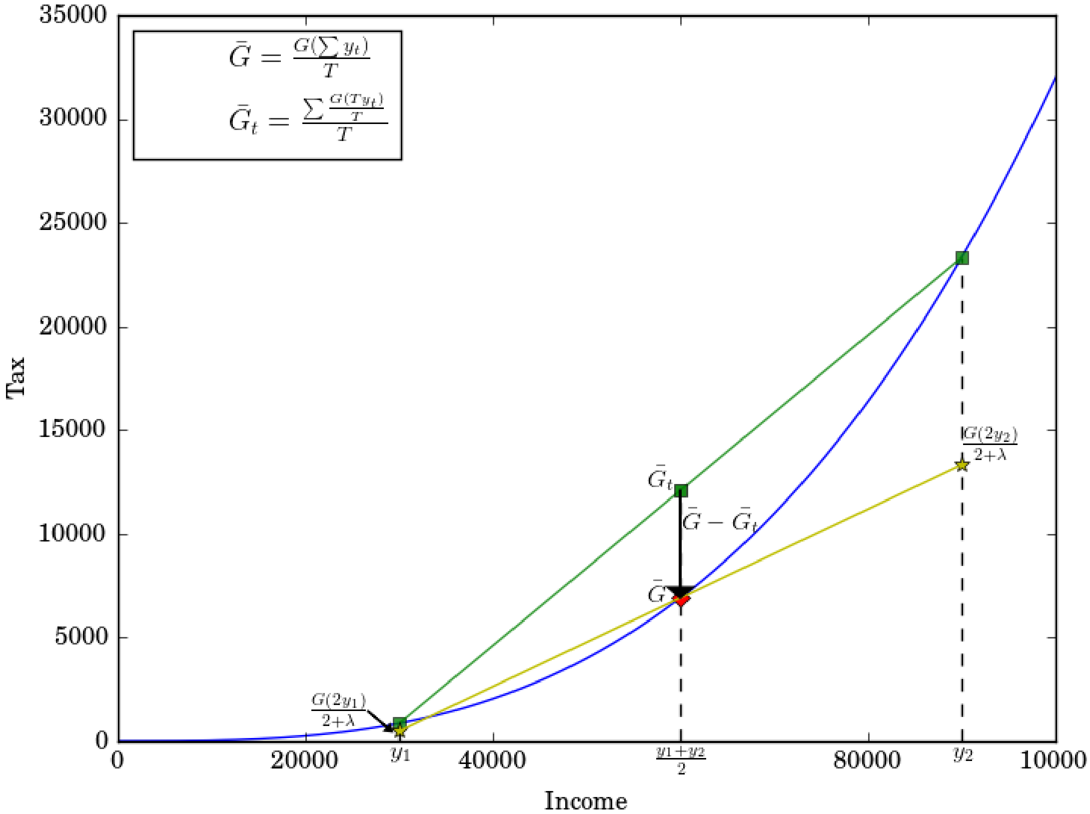
2.3 Comparison of well-being for the tax regimes

We first show that the annual well-being is higher with the monthly compensated scheme than with the equal monthly scheme. The current system is also dominated by the monthly compensated scheme. We end up with a comparison with the Vickrey's proposal by means of simple examples.

Monthly compensated versus equal payment

Theorem 1. *If the subutility is concave and the underlying annual tax schedule is convex, the intertemporal utility of the taxpayer over the yearly span is higher with a monthly*

Figure 1.1 – Monthly Compensated tax versus Monthly tax



compensated scheme than with an equal split scheme.

$$\sum_1^T u_t\left(y_t - \frac{G\left(\sum y_t\right)}{T}\right) \leq \sum_1^T u_t\left(y_t - \frac{G(Ty_t)}{T+\lambda}\right) \tag{1.5}$$

Proof. We check that the conditions of the dominance theorem are satisfied. Clearly because both systems are neutral to the earning timing within the year, the sum of the monthly disposal incomes is the same with the two systems. Now we have to check that the partial sums of monthly tax amounts are lower with the monthly compensated scheme than with the equal payment regime, implying that we have the reverse relation for disposable incomes. It amounts to compare for the first k months which are reranked according to increasing gross income order that:

$$\sum_{t=1}^{k} \frac{1}{T+\lambda} G(Ty_t) \leq \frac{kG(T\bar{y})}{T}$$

with $\bar{y}$ the monthly mean. By definition

$$T+\lambda = \frac{\sum_1^T G(Ty_t)}{G(T\bar{y})}$$

Substituting the value of $T+\lambda$ into the above expression we obtain

$$\frac{\sum_{t=1}^{k} G(Ty_t)}{\sum_1^T G(Ty_t)} G(T\bar{y}) \leq \frac{kG(T\bar{y})}{T}$$

which simplifies in

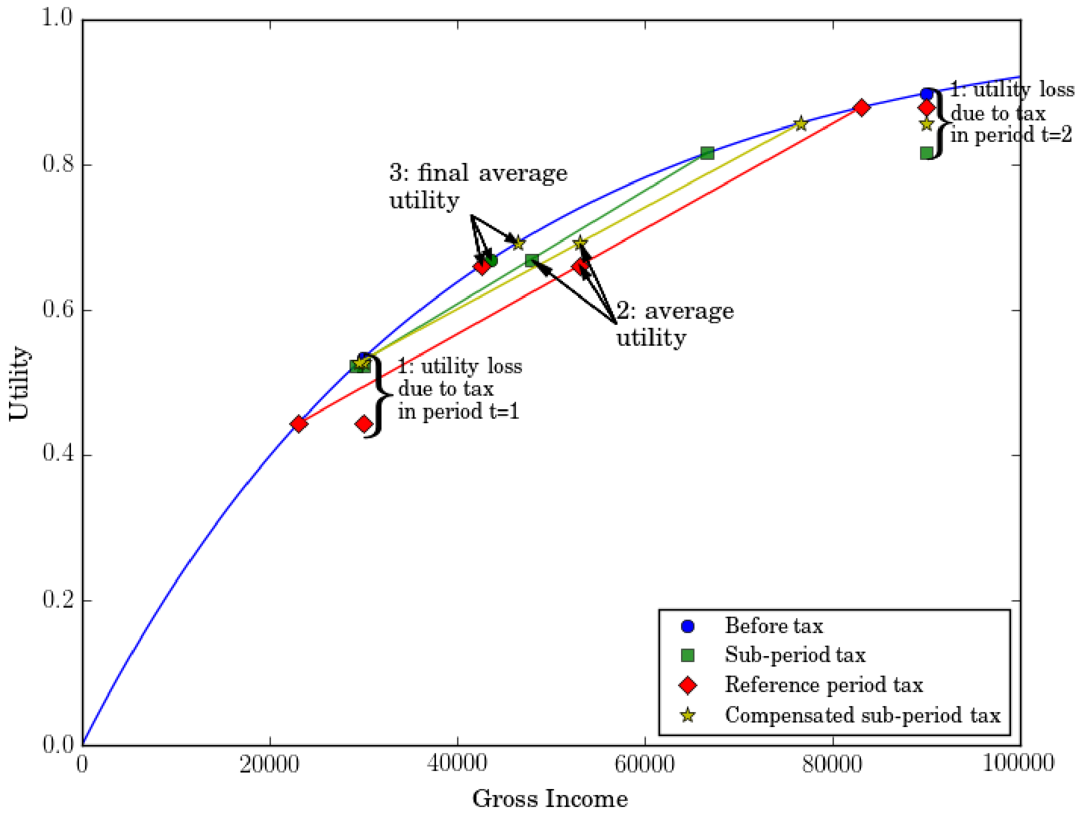
$$\frac{1}{k}\sum_{t=1}^{k} G(Ty_t) \leq \frac{1}{T}\sum_1^T G(Ty_t)$$

which must be true because the partial average of k increasing numbers is always lower than the total average of the same T numbers with $T > k$. $\square$

The proof shows that the result is indeed stronger than the statement of the theorem suggests. It indicates for instance that if the sequence of income is increasing over the year, then all partial intertemporal utility streams covering any sub-period starting from January are higher for the monthly compensated tax scheme than for the equal payment regime. The taxpayer is happier for any subperiod considered, the first k months from $k = 1, .., 12$.

The general idea illustrated by Figure 1.2 is that the compensation takes out the potential negative effect of paying more taxes with a monthly tax base and the only remaining effect

Figure 1.2 – Utility changes with the Monthly compensating scheme



is the income smoothing.

Monthly compensated versus current system For reasons that will appear in a transparent way in the next subsection, we will compare both tax payments when the sequence of gross incomes is increasing within the year. It should be the case for many full-time employees with year-end bonuses.

So let us consider the case where $y_1 \leq y_2 \leq, ..., \leq y_{12}$.

Claim 2. *The monthly compensated system brings out higher welfare than the current system for every subperiod starting from the first month, including the full year. It brings also higher welfare for every month except may be December.*

The statement follows from the fact that $\lambda > 0$ and the mathematical theorem.

Vickrey versus Monthly compensated The Vickrey mechanism is backward looking. The monthly compensated is taking advantage of knowing the full income stream. It is a bit unfair in some sense to compare them since we compare a perfect information mechanism with a mechanism which relies upon the updated information at each month. Nevertheless, it is still interesting to understand in which situations the Vickrey mechanism performs badly. We are considering simple cases which allow us to develop the intuition for more complex situations. Comparing the two mechanisms for more general income streams is not that simple since Vickrey involves substractions and the monthly compensated scheme divisions. This makes the comparision less trackable. There are cases where we cannot conclude from a theoretical view point.

Two sub-periods We suppose that there exists two subperiods, 1 and $T = 2$. Either (first case) $y_1 > y_2$ or (second case) $y_1 < y_2$. In both cases, $g_1^{MC} < g_1^V$ implying that $g_2^{MC} > g_2^V$ because the cumulated taxes are the same. It suffices then to build on the mathematical result to state that:

Claim 3. *In case of an increasing income stream within the year, there will be a welfare gain at each subperiod starting from the first month including the full year to switch from the Vickrey mechanism to the monthly compensated one. In case of a decreasing income stream, the opposite statement holds.*

Three sub-periods Involving a third period in the framework introduces some intricacies. We are able to compare both mechanisms by building upon the two-period case and considering a variable income in the third and last period $T = 3$. We begin with generalizing the previous claim about monotone income streams.

Monotone income streams

Case 1 Increasing income streams $y_1 = y_2 < y_3$

We can think this situation as featuring a year-end bonus following a steady income over the previous months.

The idea is always the same: to check that the conditions of the mathematical theorem holds.

It is still obvious that $g_1^{MC} < g_1^V$.

We now have to look at the second partial sum and we prove that $g_1^{MC} + g_2^{MC} < g_1^V + g_2^V$

By definition $g_1^{MC} + g_2^{MC} = \frac{1}{3+\lambda}[G(3y_1) + G(3y_2)] = \frac{[G(3y_1)+G(3y_2)]}{[G(3y_1)+G(3y_2)+G(3y_3)]} G(y_1 + y_2 + y_3)$

Using now the fact that $y_1 = y_2 = y$ we obtain

$g_1^{MC} + g_2^{MC} = \frac{2G(3y)}{[2G(3y)+G(3y_3)]} G(2y + y_3) = \frac{\frac{2}{3}G(3y)}{[\frac{2}{3}G(3y)+\frac{1}{3}G(3y_3)]} G(2y + y_3)$

On the other hand, $g_1^V + g_2^V = \frac{2}{3} G(\frac{3}{2}(y_1 + y_2)) = \frac{2}{3} G(3y)$

Therefore $g_1^{MC} + g_2^{MC} = \frac{g_1^V + g_2^V}{[g_1^V + g_2^V + \frac{1}{3}G(3y_3)]} G(2y + y_3)$

Then the issue of $g_1^{MC}+g_2^{MC} < g_1^V+g_2^V$ is equivalent to $\frac{g_1^V+g_2^V}{[g_1^V+g_2^V+\frac{1}{3}G(3y_3)]}G(2y+ y_3) < g_1^V+g_2^V$
Factorizing gives the following condition $(g_1^V+g_2^V)^2+(g_1^V+g_2^V)(\frac{1}{3}G(3y_3)-G(2y+ y_3) > 0$
A sufficient condition is: $\frac{1}{3}G(3y_3) > G(2y+ y_3)$.
For a given y, it is clear that due to the convexity of y_3, there exists a cutoff point y_3^* such that $G(3y_3) > 3G(2y+ y_3)$
The following claim makes stock of the above reasoning

Claim 4. *In case of an increasing income stream within the year, $y_1 = y_2 < y_3$, for y_3 big enough, there will be a welfare gain at each subperiod starting from the first month including the full year to switch from the Vickrey mechanism to the monthly compensated one. By continuity it is true for y_2 slightly larger than y_1.*

We shall keep in mind that we have the intuition that the result is more general than that but now on we do not have a more general proof.

Case 2 Decreasing income streams $y_1 > y_2 > y_3 = 0$
This situation features the case of an individual which is employed in the first part of the year, then become unemployed and receives the employment benefits to end the year with no income. The increasing ranking of income denoted $y_{[i]}$ is the opposite of the calendar ranking. That is $y_{[1]} = y_3, y_{[2]} = y_2$ and $y_{[3]} = y_1$.
It follows from the definitions that $g_{[3]}^{MC} < g_{[3]}^V$. We immediatly deduce that it must be true that $g_{[1]}^{MC}+g_{[2]}^{MC} > g_{[1]}^V+g_{[2]}^V$. To apply the mathematical theorem, we must also have that $g_{[1]}^{MC} < g_{[1]}^V$ that is, $g_3^{MC} > g_3^V$.
Be definition we know that $g_3^{MC} = 0$. We must prove that $g_3^V < 0$.
It goes back to the computation of $G(y_1+y_2)-\frac{2}{3}G(\frac{3}{2}(y_1+y_2))$ which amounts to compare $\frac{3}{2}$ and $\frac{G(\frac{3}{2}(y_1+y_2))}{G(y_1+y_2)}$
If we assume in addition that $G(0) = 0$, then convexity implies that $G(\frac{3}{2}(y_1+y_2)) > \frac{3}{2}G(y_1+y_2)$. We can then state

Claim 5. *Assume that $G(0) = 0$. In case of a decreasing income stream within the year, $y_1 > y_2 > y_3 = 0$ there will be a welfare gain at each subperiod starting from the first month including the full year to switch from the monthly compensated mechanism to the Vickrey one. By continuity it is true for y_3 close to 0.*

We have dealt with the case where y_3 is small or very large. It remains to deal with the case of y_3 is between y_1 and y_2. We will consider the case where $y_3 = \frac{y_1+y_2}{2}$. Indeed, it is an interesting case because it corresponds to the minimal value of λ as a function of y_3 for a given y_1 and y_2. It is when the correction brought by the monthly compensated mechanism is minimal with respect to the monthly mechanism.

Non-monotone profiles

We are going to deal with two profiles, case 1 where period 2 is the peak, $y_2 = Max(y_1, y_2)$, and case 2 where period 2 is the dip, $y_2 = Min\ (y_1, y_2)$.

Case 1: Period 2 is the peak

Period 1 is then the worst-off period for the taxpayer. By definition, $g_1^{MC} < g_1^V$. The next poor period is period 3. Let us compare the tax payment for this period. $g_3^{MC} = \frac{1}{3+\lambda}[G(3y_3)] = \frac{1}{3+\lambda}[G(\frac{3}{2}(y_1 + y_2))]$

Now let us compute g_3^V. $g_3^V = G(y_1+y_2+y_3) - \frac{2}{3}G(\frac{3}{2}(y_1+y_2)) = G(\frac{3}{2}(y_1+y_2) - \frac{2}{3}G(\frac{3}{2}(y_1 + y_2)) = \frac{1}{3}[G(\frac{3}{2}(y_1 + y_2))]$

We conclude that $g_3^{MC} < g_3^V$ and therefore $g_1^{MC} + g_3^{MC} < g_1^V + g_3^V$. The second partial sum of taxes for monthly income ranked in increasing order is lower for Monthly compensated scheme than for Vickrey. We can then state

Claim 6. *When $y_1 < y_3 = \frac{y_1+y_2}{2} < y_2$, the taxpayer is better of with the Monthly compensated scheme than with the Vickrey mechanism and this is true for any subperiod starting from the first month including the full year.*

Case 2: Period 2 is the worst-off period.

By definition, period 1 is the best-off period and it turns out that $g_1^{MC} < g_1^V$. We derive that $g_2^{MC} + g_3^{MC} > g_2^V + g_3^V$.

From the previous derivation of the above claim, we know that $g_3^{MC} < g_3^V$. Therefore, it must be that $g_2^{MC} > g_2^V$. Then the conditions of the theorem applies to the benefit of the Vickrey mechanism.

Claim 7. *When $y_2 < y_3 = \frac{y_1+y_2}{2} < y_1$, the taxpayer is better of with the Vickrey scheme than with the Monthly compensated mechanism and this is true for any subperiod starting from the first month including the full year.*

It appears that there is no global winner nor looser when comparing Vickrey and the Monthly compensated mechanism. The discussion below will pave the way to hint that the income configuration when the Monthly compensated mechanism dominates are those for which the taxpayer appears as the most constrained by the imperfect financial market.

2.4 Discussion

We will discuss five points. The first two are related to a less crude representation of preferences of individuals. They care about consumption and leisure and they adapt their behavior to the tax changes. We introduce them in the analysis in turn. We then discuss the negative income tax, the convexity assumption of the tax schedule and the implementation of the monthly compensated tax scheme.

Borrowing and saving If an individual can fully borrow or save within a year, then it is clear that what matters is the total disposable income over the year. The four systems are then equivalent in terms of consumer welfare and the discussion vanishes, except that we can say that with the monthly compensated schedule, the need of precautionary saving weakens since the profile of disposable income displays less variability than with the current system. Our results are worth it for individuals with no or very small saving. It is then a result that can be useful for developing countries and that matters much for poor households in rich and developed country. It is common for poor household that the beginning of the month is easier than the end because they have spent most of their wage or their social welfare benefits during the month (see Hastings and Washington (2010)). We can extend the validity of our results in a framework when the household can save but not borrow (or at a much higher rate). We will prove below that we are back to the framework that we have considered above. We will prove it on the basis of a simple example with two periods and a zero interest rate.
Let us call c_1 and c_2 the consumption levels for these two periods. What matters for the household is the intertemporal utility of consumption streams $U = u(c_1) + u(c_2)$. We will look at the expected utility denoted $E(U)$ at the beginning of the year when the taxpayer does not know what would be the income stream during the year.
There are two cases. In the first case where $y_1 > y_2$, the individual can save in the first period and then the optimal equal consumption plan between the two periods can be achieved. In that regime, the consumption in each period is given by the average income over the year, that is, for the full year we get $2u(\frac{y_1+y_2}{2})$ as the annual utility. In the second case where $y_1 < y_2$, the individual cannot borrow and then the consumption of her first period is constrained to be $c_1 = y_1$ and the consumption of the second period is then $c_2 = y_2$. Therefore, the intertemporal utility is given by $u(y_1)+ u(y_2)$.
Combining both elements and introducing the probability of the two events, the expected

utility reads:

$$E(U) = \Pr(y_1 < y_2)[u(y_1) + u(y_2)] + \Pr(y_1 > y_2)[2u(\frac{y_1 + y_2}{2})]$$

The above theorems are related to the first part of the expected utility, $[u(y_1) + u(y_2)]$. The second part of the expected utility is constant for the four tax schemes in discussion. We conclude that the results remain valid when the taxpayer is not allowed to borrow at the same conditions as she saves.

Provided that the consumer starts the new year with almost no saving – which occurs in the US at least for the average people in the bottom quintile – an increasing income sequence within a year is a sequence where the absence of a perfect capital market bites the most. It is the case where the individual will benefit the most of consumer credit since by assumption it cannot draw on her precautionary savings. It is here when the monthly compensated system will help and we recall that, in these circumstances, it dominates the Vickrey mechanism. Of course, the reasoning depends on the assumption that the accounts are cleared at the start of the year which can be viewed as an hoc assumption. Here, we are in some sense trapped by the annual fiscal framework.

We do not introduce a monthly discount rate in the intertemporal utility. The monthly discount rate will be very low if any and it can be argued that many people have a spending behavior as if they have a higher marginal utility in let say December, July and August than in March or November. A low discount rate will not be enough to invalidate the above results. It will just make the results more difficult to prove.

Labor supply We already argue in the introduction that caring about the variability of earnings within a year does make sense if this variability is not the result of a choice. We can easily think of situations where the individual prefers to some extent to gather her hours of work rather than spreading them out. The summer vacations are an example of corner solutions for leisure. Many professors prefer to concentrate their teaching duties on one semester. Many pilots and stewarts also prefer to travel with little rest for a while followed by a long period of leisure. The same goes for seasonal workers in seaside or ski resorts. Even if the change of the tax base does not stem from the fact we wish to improve the situation of these individuals, it is important to check that the new tax configuration will not have adverse effect on their behavior and welfare.

The utility will be of the form $U(c + v(l))$ with v can have some convex parts, in such a way that the individual is choosing a corner solution. For instance take the case of US university professors with a 9 month contract. Does the monthly compensated system will make them more inclined to accept a work during the summer?

The answer is not obvious and depends on their knowledge of the tax system. We will say that people are myopic if they only look at the monthly marginal tax. The monthly marginal tax rate will be lower with the monthly compensated system than with the current system. TConsequently, the substitution effect will pushed toward working more each month! As illustrated in Figure 1, the decrease of marginal tax rates will be higher for very active months than in rather inactive months. By definition, the income effect would be zero. So we conclude that in the myopic case, people will work more each month and even more the loaded months. Now, it is also possible that the rational university professor will only contemplate the annual tax schedule which has not changed by definition and then decide not to change her behavior. In all cases, we expect that the magnitude of the behavioral reaction will be small if the actual choice is a corner solution.

Negative income tax The results were obtained for an income tax which does not include transfers and benefits. The case of a negative income tax can be analyzed along the same lines and all the results hold. The main difference is that λ is now negative. Indeed we still have

$$\sum_1^T \frac{G(Ty_t)}{T} \geq G(\sum_1^T y_t))$$

but assuming that $G(Ty_t)$ and $G(\sum_1^T y_t))$ are negative, the value of λ which will make both sides of the inequation equal is negative (or alternatively we will have $T - \lambda$ with $\lambda > 0$).

$$\sum_1^T \frac{1}{T-\lambda} G(Ty_t) = G\left(\sum_1^T y_t\right)$$

In the similar figure as Figure 1, the chord will be always above the function since the tax schedule remains convex. However the amount of benefits transferred to poor people are now lower with the monthly compensated tax than with the equal payment system. We then have to adjust with a negative λ and it turns out than the poor months will be more heavily subsidized than the months when the incomes are higher because the gap

$$\frac{1}{T-\lambda} G(Ty_t) - \frac{1}{T} G(Ty_t) = G(Ty_t)(\frac{\lambda}{(T-\lambda)\,T})$$

will be the higher the tax amount $G(Ty_t)$ is far from 0, meaning that t is a bad month. The smoothing effect of the monthly compensated tax will still operate and the results remain valid in the benefit side as well as in the tax side.

Convexity We assume from the outset that the tax schedule is convex. Many applied works have shown that the effective marginal tax is in fact decreasing on the bottom part of the income distribution in many countries because of the phasing out of the benefit system. In some cases, Diamond (1998) has shown that the static optimal marginal income tax rate should follow a U-shape, a feature also observed in many countries (see Diamond and Saez (2011) and Mankiw et al. (2009).) It adds an additional layer of complexity and it is difficult from a theoretical view point to figure out whether adopting the monthly compensating scheme will be good or harmful for the taxpayer welfare. It militates for empirical studies and it is what we are doing in the next section. The only thing that we can add is that on the income range for which the marginal tax rate will be decreasing, switching to a monthly compensating scheme will be harmful for benefit recipients. The proof of this statement works exactly on the same way as the proofs or our results. By the way, it is not fully sure that in a dynamic context with poverty traps and risk the subsidization of earnings should phased out at a relatively high rate

Implementation On those 4 tax schemes, only the current and the Vickrey system are implementable on the spot taking account the monthly available information. The equal payment and the monthly compensated tax needs for the government to foresee incomes before their realisation. If it is indeed impossible to do it without error, it is possible for the tax authorities to forecast the current variability of income for each taxpayer or for each taxpayer type. Indeed we think that a local analysis can be performed to compute the adjustement parameter, λ, as a function of the degree of convexity of the taxation scheme (the relative Arrow-Pratt degree of risk loving, $\frac{G"(y)}{G'(y)}y$) and a measure of risk, the standard deviation or the coefficient of variation. Once the formulae will be established, it remains to estimate the within-year SD for different types of taxpayers. The available information will be the past information that the tax authorities have, the characteristics of the taxpayer (education, type of job, sector, gender, age etc.) and why not the information that the taxpayer will be able to provide about the variability of income she foresees for the coming year. An individual forecasting error will be made for sure, but the good thing will be that the (positive or negative) adjustment at the end of the fiscal year will likely be much less big than it is actually. It means that in average the tax payment will be more accurate each month than now. An exploration on actual data is then needed to evaluate the heterogeneity dimension of taxpayers in terms of the adjusment parameter λ. This is the purpose of the next sections.

3 Data & French tax system

We first give some information about the French tax system and compare it to some other systems. We then move to the data and show an estimate of the between-month variabilility.

3.1 Tax Schedules: From theory to practice

In the theoretical section, the general shape of G was very general and stated to be convex for the welfare gains results. Obviously the precise shape of the tax function would be of primary importance for the matter discussed, weather in terms of gain or loss, and even in a more significant way for the size of the gains. G could be seen as a specific tax such as income tax or as the effective tax (i.e the sum of all taxes and benefit one is entitled). Even though effective taxation is the salient point for public economist to work on, it should be clear that since all taxes are not based on the same temporality, a static view point can overwrite some information and can lead to misleading conclusions. We see as as first step to focus on a simulation which only involves the income tax schedule.

Piecewise linear tax scheme Most countries (to the notable exception of Germany) have piecewise linear income tax schemes.

A piecewize linear tax scheme is defined as a sequence of (usually) increasing marginal tax rate, [8]:

$$0 < m_0 < m_1 < ... < m_p$$

and a sequence of thresholds specifying the bands of taxable income to which the respective rates apply.

$$0 = \beta_0 < \beta_1 < ... < \beta_p$$

If $y \in [\beta_k, \beta_{k+1}]$, then the tax liability is :

8. as defined in P.J. Lambert *The distribution and redistribution of income, third edition* P.181

Table 1.1 – France 2009 Income Tax Schedule

from 0 to 6011 euros	0%
from 6011 to 11991 euros	5,5%
from 11991 to 26631 euros	14%
from 26631 to 71397 euros	30%
from 71397 to 151200 euros	41%
beyond 151200 euros	45%

$$s(y) = \sum_{j \leq k-1} m_j(\beta_{j+1} - \beta_j) + m_k(y - \beta_j)$$

It is clear that if one's income stays between two tax brackets, the taxpayer is comparable to one facing a flat tax, and all the characteristics concerned by the above paragraph still holds. So with a piecewise linear tax scheme, one would need to have large enough variation in income to be concerned by a change in tax frequency concerning the amount paid.

France tax system France has an annual income tax that most taxpayers pays on a monthly basis (one tenth of the tax based on last year income for most fiscal household). [9] It consists of a tax applied to a fiscal household. A fiscal household is an entity based on family situation: married couples or under civil union [10] will constitute one unit, single constitutes one fiscal household and couples without civil union will form two fiscal households.

France Income tax consists of a piecewise linear tax scheme composed in 2009 of 5 tax brackets.

Thus in the formalised version of the piecewise linear tax scheme

- $\vec{m} = [6011, 11991, 26631, 71397, 151200]$, and,
- $\vec{\beta} = [0, 5.5, 14, 30, 41, 45]$

To compute tax liability, for a single without kid we just have to apply taxable income to the tax scheme.

9. In fact, there is several systems among which the taxpayer can choose. A three-time payment of the tax (in February, May, and September), a monthly payment of the tax, or a monthly payment of the tax consisting of 10 payments from January to October that correspond to one tenth of last year due tax. If the due income tax is greater for one year than the preceding year, additional payment are required in November and December. More than two-thirds of households choose that later option.

10. *Pacte civil de solidarité* (Pacs)

$$\text{Final tax} = G(\text{taxable income}) = \sum_{j \leq k-1} m_j(\beta_{j+1} - \beta_j) + m_k(y - \beta_j)$$

Joint taxation consist of a system called *fiscal shares*[11]. A certain number of fiscal shares are attributed to each fiscal household based on its composition: 1 share for a single, two shares for a couple under civil union. Then each dependent child gives additional shares: 0.5 for each two first childs, 1 share for each child after the second one.[12] We then divide taxable income by the number of fiscal shares and we refer to it later on as normalized tax base. The piecewise linear scheme is then applied to the normalized tax base and finally the obtained amount is multiplied by the number of fiscal shares to obtain the tax liability.

$$\begin{aligned}\text{Final tax} &= G\left(\frac{\text{taxable income}}{\text{fiscal shares}}\right) \times \text{fiscal shares} \\ &= \sum_{j \leq k-1} m_j(\beta_{j+1} - \beta_j) + m_k\left(\frac{y}{\text{fiscal shares}} - \beta_j\right) \times \text{fiscal shares}\end{aligned}$$

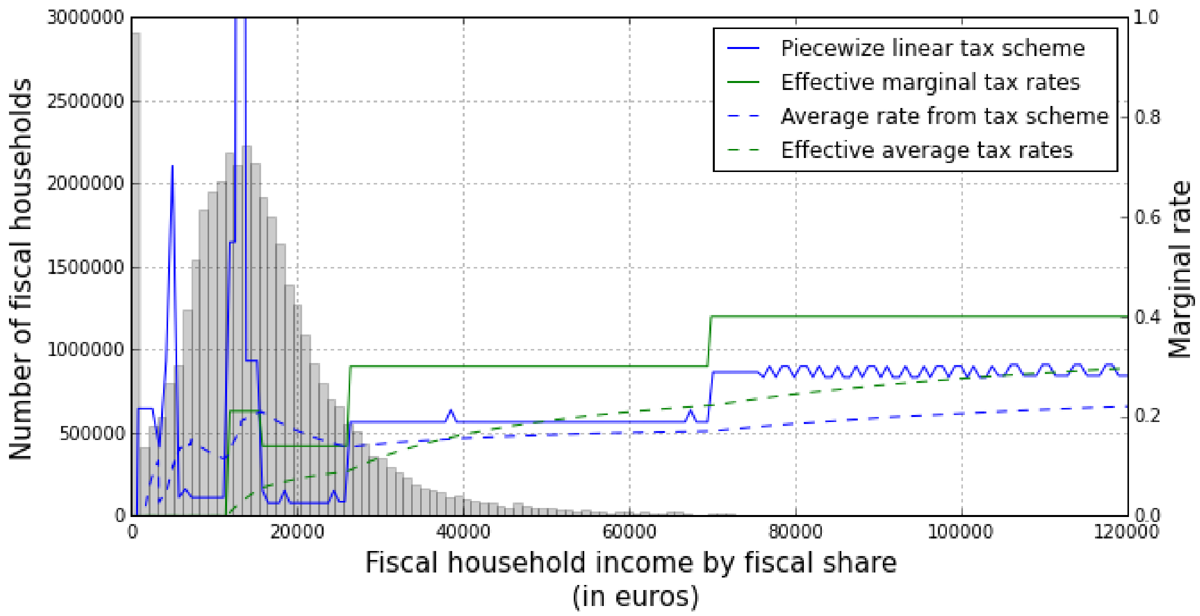
There exists also a mechanism called *la décote* which is a tax break for household paying a small amount of tax. This mechanism doubles the marginal tax rates in the two first brackets. It does not take family situation into account appart from being in couple or not. This mechanism introduces a non-convexity in the tax schedule. Another source of local non-convexity is that for a tax due lower than €62 the taxpayer does not have to send a check to the tax authorities.

France has also many benefits that mainly concerns households exempted to the income tax, and that do not have a smooth or convex shape of the effective MTR.

As we can see on Figure 1.3, on the range €10,000 to €30, 000, there are 4 tax brackets where there is only 2 from €30, 000 to €120, 000. With the introduction of benefits to this analysis and their high number into the analysis, the number of tax-brackets soar at the very bottom of the distribution as we can see on Figure 1.3 effective MTRs (which is for single individuals). The inclusion of family support benefits, local taxation, "social tariffs" for telephone and electricity utility services, Universal Health Care Cover, etc, would even make the picture more complicated.[13]

11. *Parts fiscales* in French
12. There exists a certain number of exceptions and special case, single parents benefit from an additional half-fiscal share, there exist specific rules for disable people, etc.
13. See Anne and L'Horty (2012) for more information about the diffent benefits (monetary or in kind) depending of the administrative level.

Figure 1.3 – 2009 French Income Tax, and Individual Income Distribution.



External Validity France has thus many benefits that imply non-convex effective MTR, and income tax that embodied a tax break increasing the MTR at the beginning of the income tax. It is the case for most OECD countries. For instance US has EITC that increase marginal tax rate at the beginning of the piecewise tax scheme. UK has also a working tax credit and income support that gives decreasing marginal tax rate at the beginning of the income distribution. Both UK, and US also have means tested benefits with phasing out implying high effective MTR, and diminishing MTR. Thus as in France, households in UK and US are likely to face both locally concave or convex effective tax schedule. Even if the labor market and tax institutions of every country are specific, we believe that some of the conclusions of our simulations for France can be extended to other OECD countries.

Figure 1.4 – UK scheme from Brewer et al. (2010) .

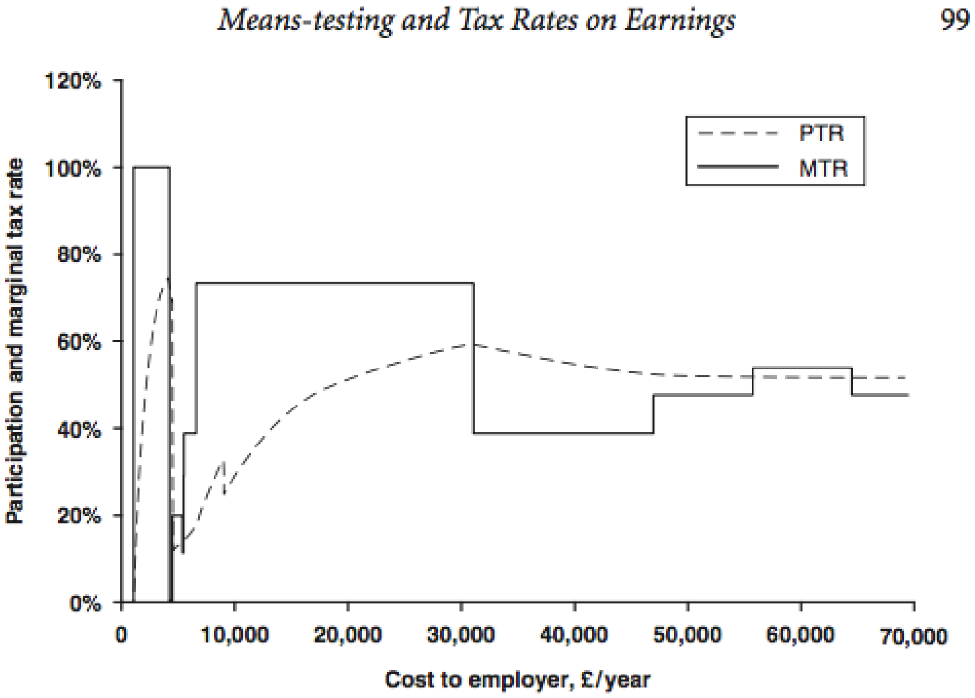
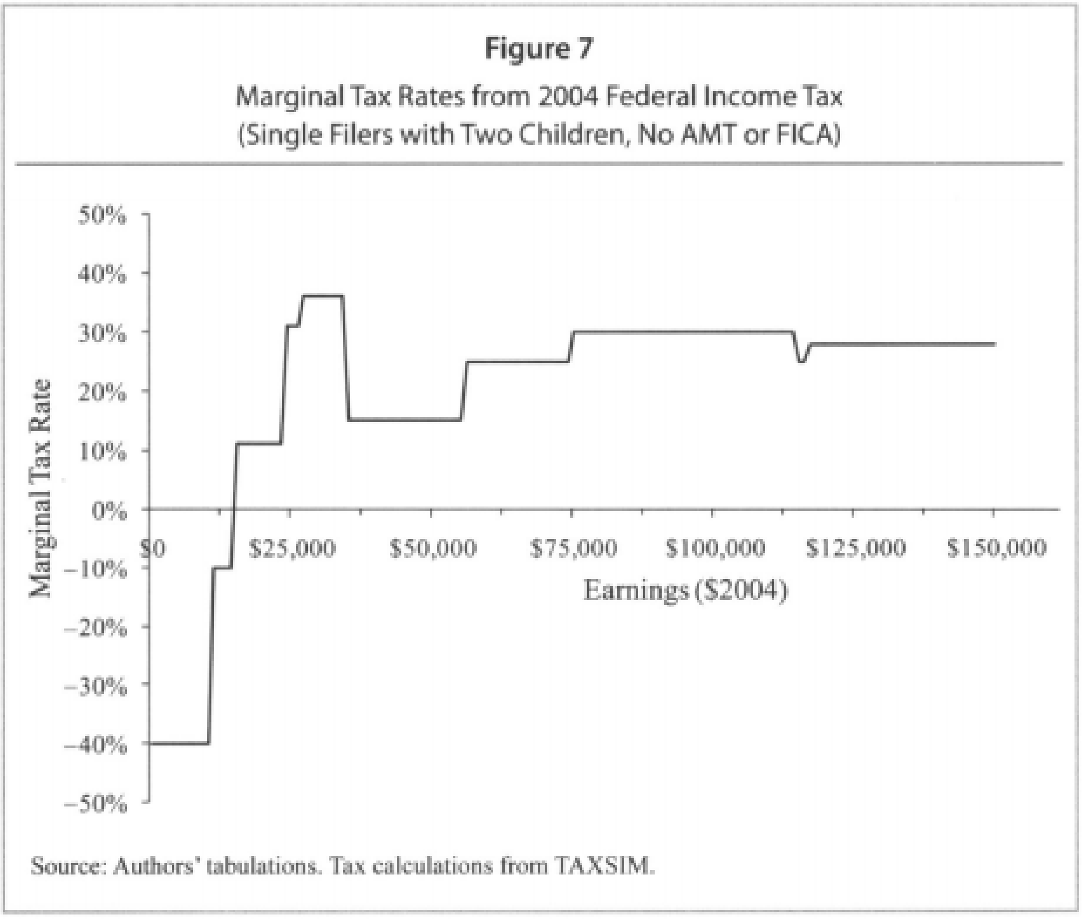


Figure 1.5 – 2004 US tax scheme from Eissa and Hoynes (2008)



3.2 Descriptive statistics

To our knowledge, France does not have yet available database that allows for the monitoring of the income tax at a monthly scale. We dodge that difficulty by resorting to an administrative database which coupled detailed information on the labor force and tax files.[14] We here explain how we infer monthly income from French labor survey matched with tax returns. Our attempt to deal with the earning time scale can to some extent be compared to the practices in the British Household Panel Survey (see (Jenkins et al., 2000, p. 4-5)).

From the labor force survey, we have individual declared income by categories over the year. Work related categories are labor income, unemployment income, and retirement income. We have for each individual its monthly situation (employed, unemployed, retired, student, inactive).

In order to infer a monthly income for each individual, we equally split income-tax returns into the months for which an individual was in the corresponding category. For example, employment income is allocated to months where the individual was declared employed, unemployment income to months where the individual was unemployed, and retirement income to the months where the individual was retired. If an individual declares for a given month that she was a student or inactive, the inferred income is zero. Other incomes (capital incomes, etc) are equally split over the year. .

Without saying, our method is far from perfect. For those reasons, descriptive statistics and results of the simulations should be taken with a piece of salt and just as a rough estimation of the impact of a change of the tax system toward a monthly compensated tax. In following sections, except when specified, the observations are weighted such that it represents French population in 2009. Technical details concerning the method are in the appendix.

Income Distribution and Variations Over Months Figure 1.6 shows aggregate income per month, that is of a bit more than €60 billions. The sources of income are steady, to the exception of November due to a higher number of declared retired persons in November 2009 in the French labor survey[15].Figure 1.7 represents a simplified version of the possible transitions, such that taking a job that we define as not having a work

14. The official name of the survey is *enquête sur les revenus fiscaux et sociaux* (ERFS)

15. Usually, retirement takes place in September and they can be a delay between the retirement date and the month when the person receives her first pension benefit.

Figure 1.6 – Aggregate Disposable Income by Months.

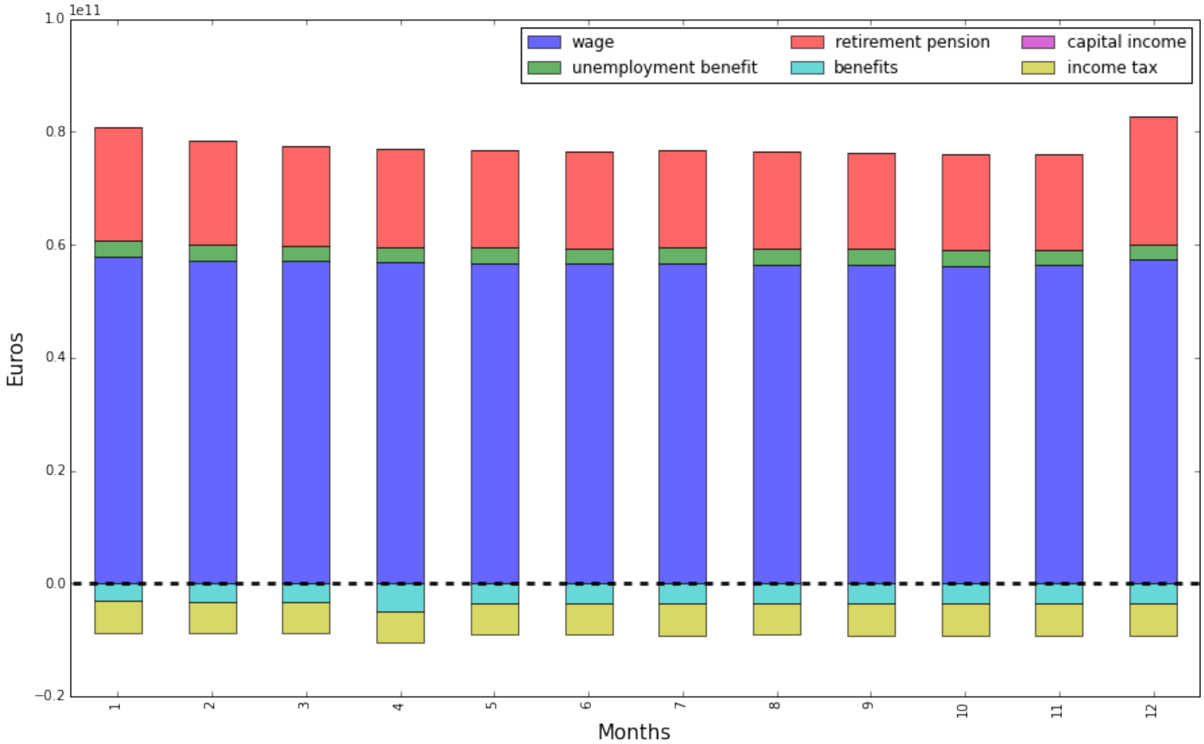


Table 1.2 – Share of Type of Transitions

Job loss	Job taking	Retirement
44%	48%	8%

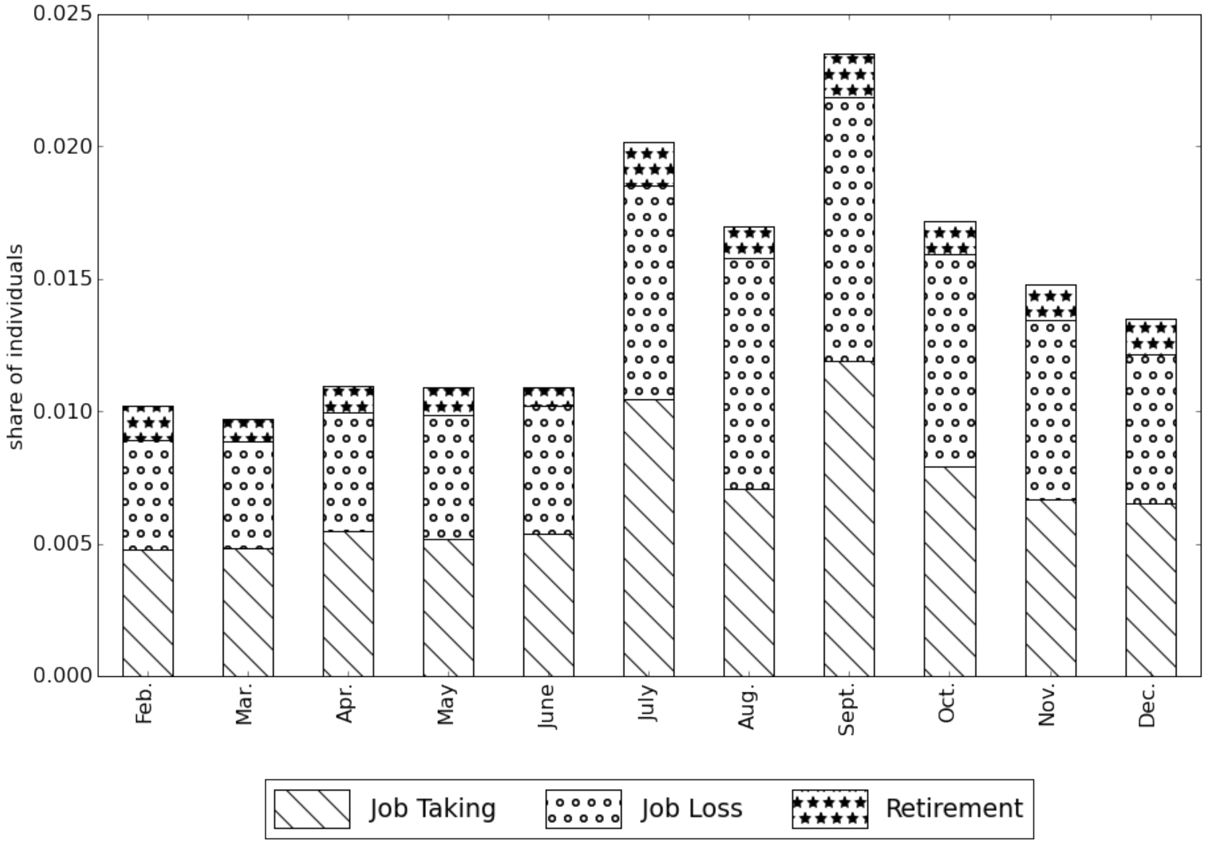
activity last month to having a work activity on the concerned month. Job loss is defined as switching from being employed to unemployed, student or inactive. Retirement is defined as switching from employed or inactive to retired. [16]

We see that on average 1.4 % of the individuals has a change of situation each month. From those 1.4%, 44% are job losses, 48% are job taking, and 8 % are people that get retired.

Figure 1.8 represents the CDF of individual maximum variation of income within the year (the difference between lowest and highest income). With the assumptions we made, 86 % have a constant income over the year, the remaining share having a variable income. 5 % has a variation that is higher than 2000 euros. After some data cleaning to remove most obvious cases of bad correspondence between income and status, we obtain less impressive variations as in Figure 1.9, where only 2 % has an income variation over € 1000.

16. Since we have 5 types of situation (employed, unemployed, inactive, retired, student), we can thus have $5 \times (5 - 1) = 20$ different types of transition.We simplify here those transitions into 3 categories to have a clearer view of the transitions. A more complete description of the transitions are provided in the appendix.

Figure 1.7 – Aggregate Monthly Transitions



	No Variation	Job Taking	Retirement	Job Loss	Sum of Variations
Feb.	79609	381	102	328	811
Mar.	79646	384	66	324	774
Apr.	79547	434	80	359	873
May	79553	411	84	372	867
June	79552	427	57	384	868
July	78832	823	128	637	1588
Aug.	79076	561	95	688	1344
Sept.	78575	937	127	781	1845
Oct.	79062	626	100	632	1358
Nov.	79248	530	106	536	1172
Dec.	79350	516	104	450	1070
Total	872050	6030	1049	5491	12570

Figure 1.8 – Infra-annual Variation of Income.

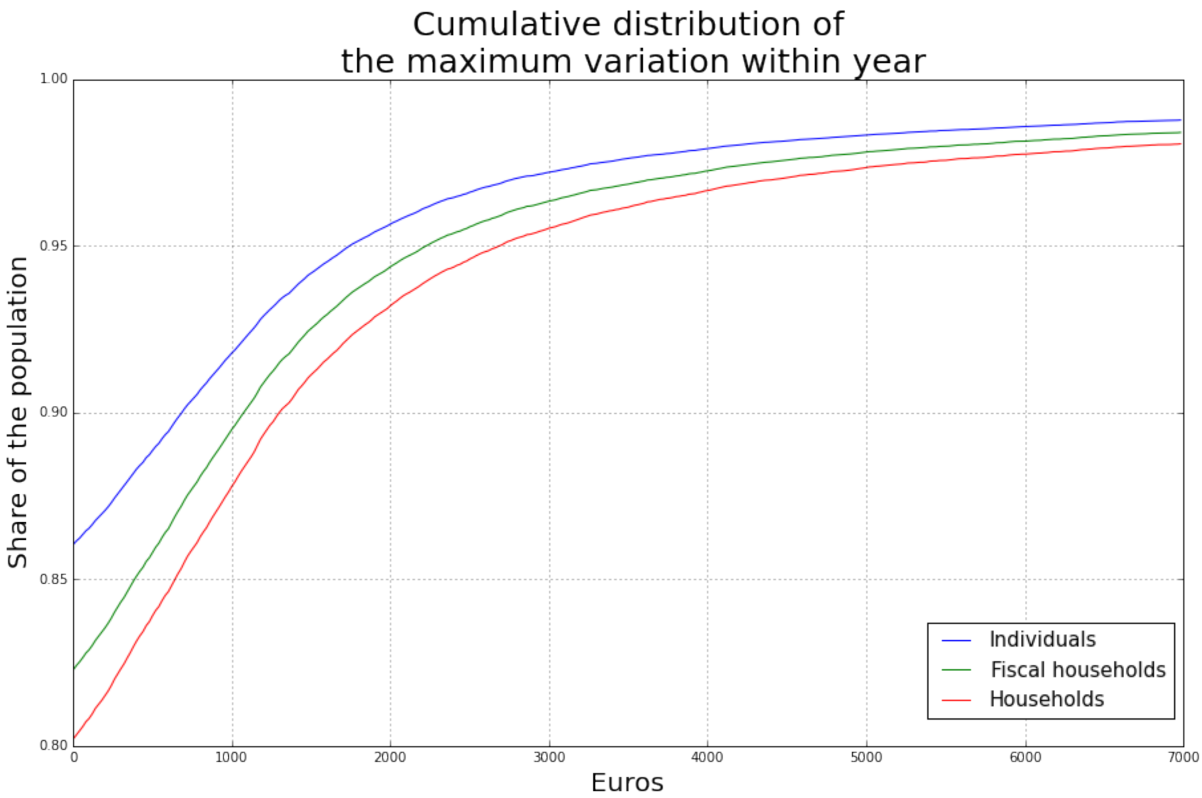


Figure 1.9 – Infra-annual Variation of Income Corrected.

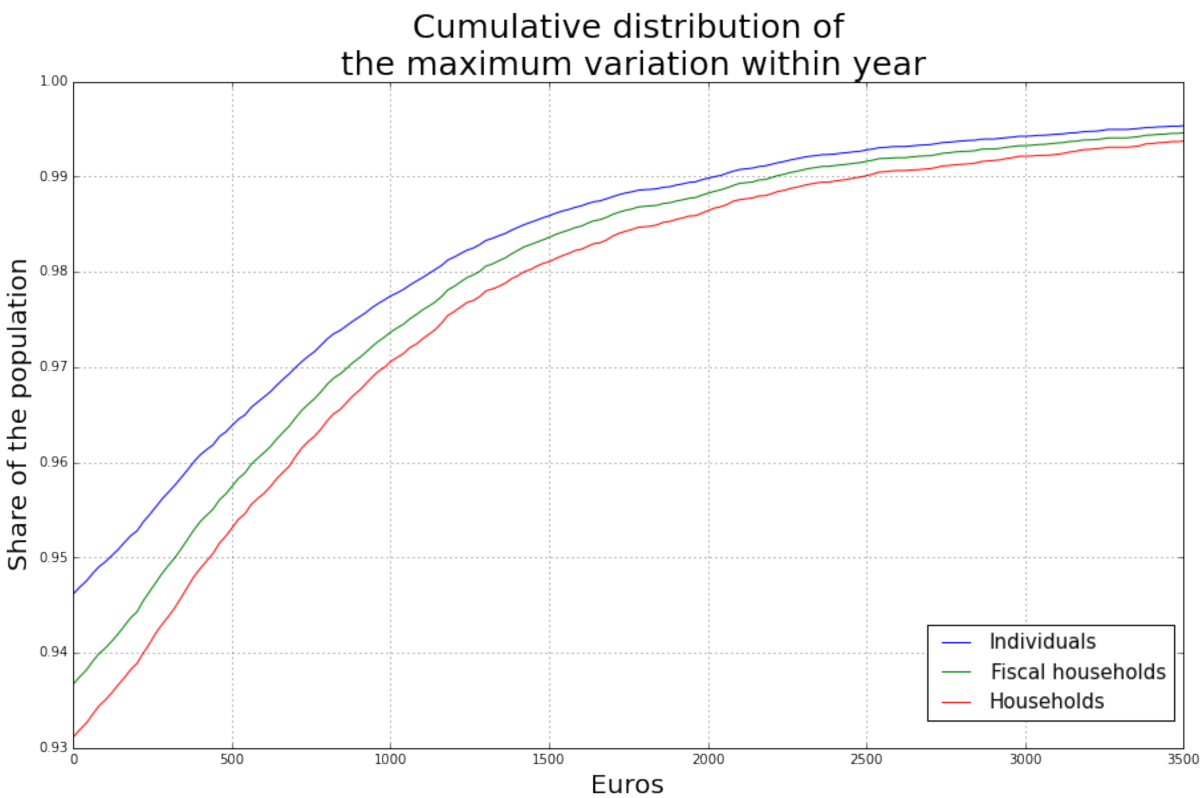
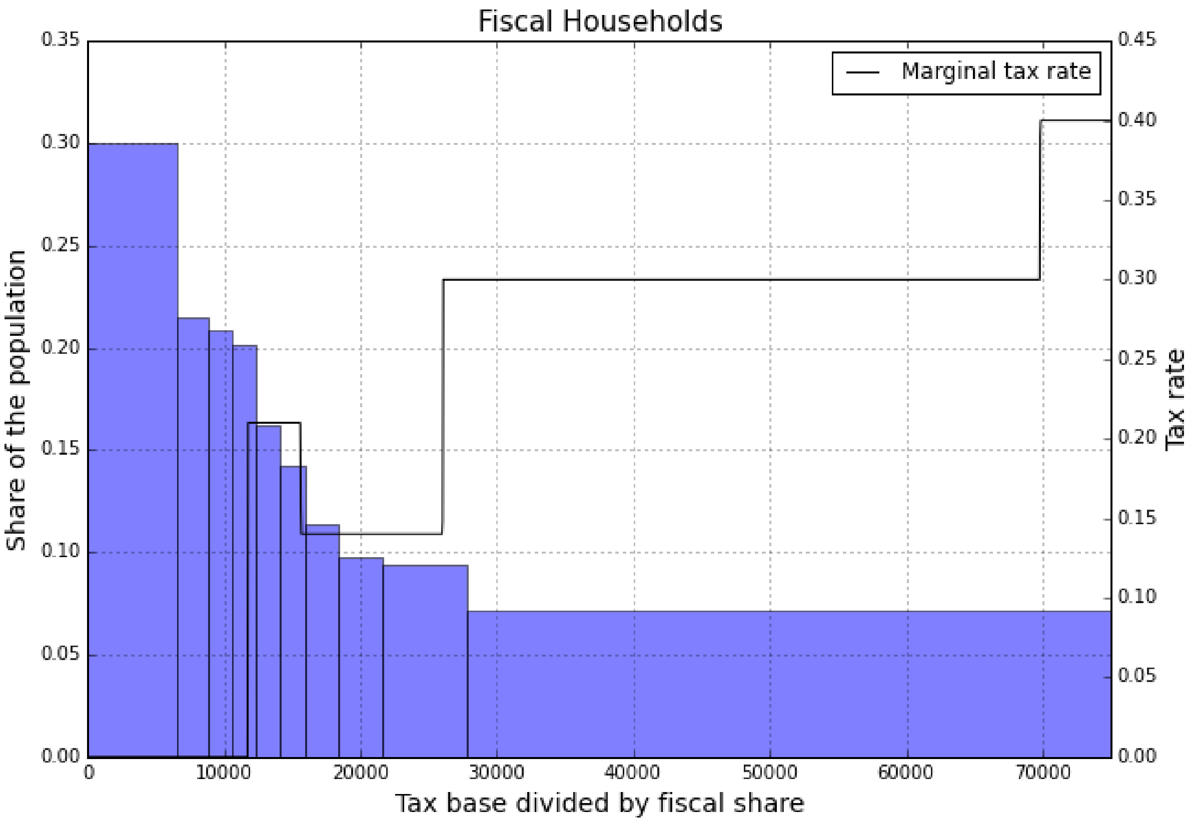


Figure 1.10 – Share per decile of individuals having more than a 20% gap between the worst month and the best month. .

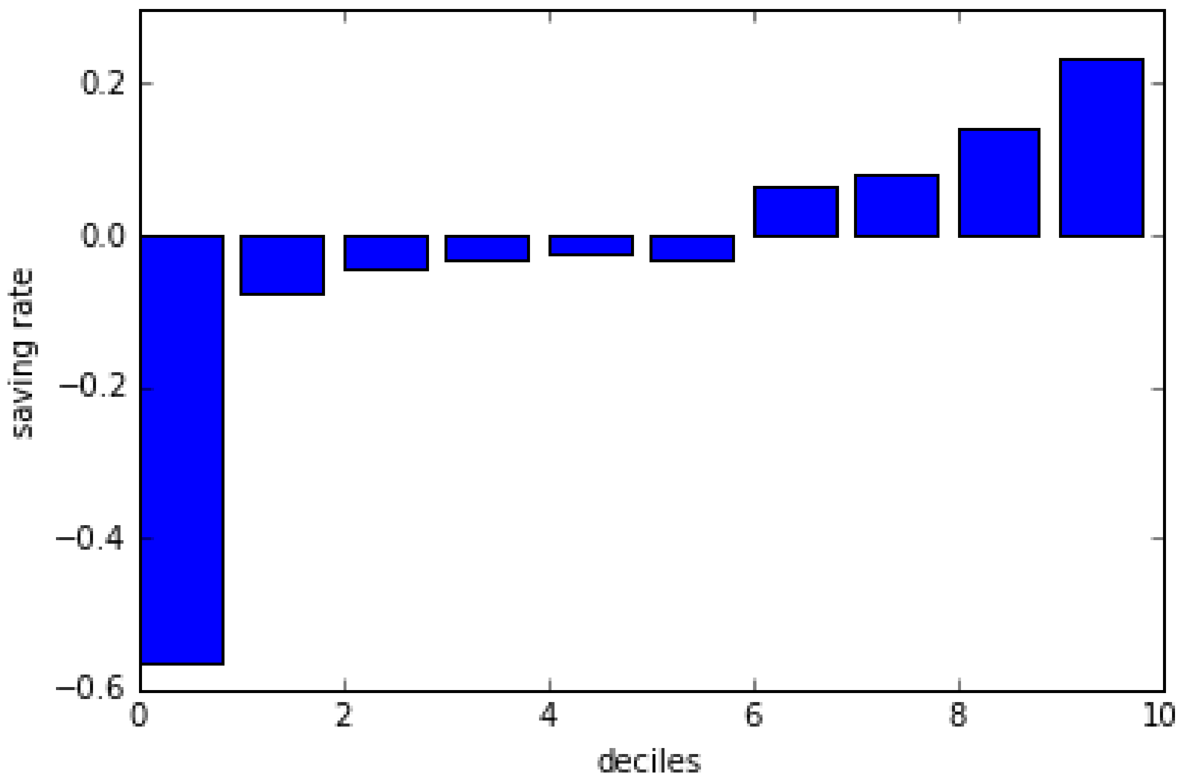


We can see that a significative share of individuals face a variation in income during the year. The French tax system being piecewise linear, a change in income does not necessarily mean a change in the tax amount since a fiscal household would have to change of tax bracket to face a difference in the tax amount. Joint taxation also takes its part on that dimension since it is the average of incomes that are applied to the tax scheme.[17]

Figure 1.10 shows that most population concerned by between-month income variation is at the bottom of the distribution, where the income tax scheme is concave. Figure 1.10 shows the share per decile of people that have more than 20% of income variation between the worst month and the best month.[18] The income limits of deciles are showed on the horizontal axis in terms of normalized tax base. The MTR represents the MTR of a tax-unit composed by one individual. The 22.5 % MTR spike at the beginning of the income range is due to a tax break called *"la décote"* and that –similarly to EITC– creates diminishing MTRs at the beginning of the tax-schedule.

17. More precision on the joint taxation system in France in appendix
18. Here the graphs do not change much after data cleaning.

Figure 1.11 – Mean saving rate by decile (French household family survey).



We see that 10 % of the population face the 30% marginal tax bracket or a higher marginal tax. If we assume that those tax-units do not move drastically their month-to-month income (from one tax bracket to an other), it means that most tax-payers in the last decile will likely face a flat-tax scheme. However, the other 90% of the population do not face a convex tax scheme: they might pay less tax with a monthly payment! Moreover those having the smallest income are the one that are the most likely to have variations in income. Thus the poorest are the one facing the most risky labor demand, and those variation are large enough to change the tax bracket they face.

These populations are also on average negative savers as showed by Figure 1.11. Thus marginal propensity to consume is very high for those populations. The focus group faces most variation and poor savings. This population also faces the highest number of potential tax backets, and thus potential effects of disposable-income variation.

4 Simulations

We are performing a simulation exercice where the benchmark is the equal payment system who will face three challengers, the Vickrey system, the monthly system and the monthly compensated system.

Simulation Hypothesis We use the microsimulation software *OpenFisca*[19] to simulate a increase in the frequency of the tax from an annual to a monthly one. We did that by changing all the tax formulas by making them working on a monthly period instead of an annual one, multiplying all the inputs by 12, and dividing the output by 12. Details and the code of the reform are available on GitHub.

Switching from the actual system (that has many complexities that will not be described here) to a monthly system without compensation increases the simulated income tax revenues from 48 billion euros for 2009 to 54 billions. To put the income on a monthly basis would generate a gain for the Treasury of 6 billion euros.

We then calculate the compensating term λ for each household. 53% of the sample has a λ equal to 0, 93 % is very close to zero ($|\lambda| < 0.001$). This difference between those two numbers is mainly explained by small rounding differences (usually a cent of euro). We represent the distribution of λ on Figure 1.12, λs equal to zero are taken out for a matter of scale. We see on Figure 1.12 that a small part of the λ are negative. This is due to the non convex part at the beginning of the tax scheme.

One should note that the French income tax being piecewise linear, having income that varies is not sufficient for a change in the income tax. One would need to change tax bracket in order to change the income tax with a monthly basis. French tax schedule having quite large and few brackets, one would need big variation in income in order to observe a significant difference. It is even more true that France has a joint taxation (which double the length of the tax brackets).

To summarize, we could say that a significative part (around 7 %) of the population would face a variation of their income tax if it is put on a monthly basis.

19. Openfisca registers many intricacies of the French tax system. The drawback is that so far the calibration to macro data is not very accurate.
http://openfisca.org/en/

Figure 1.12 – λ Distribution

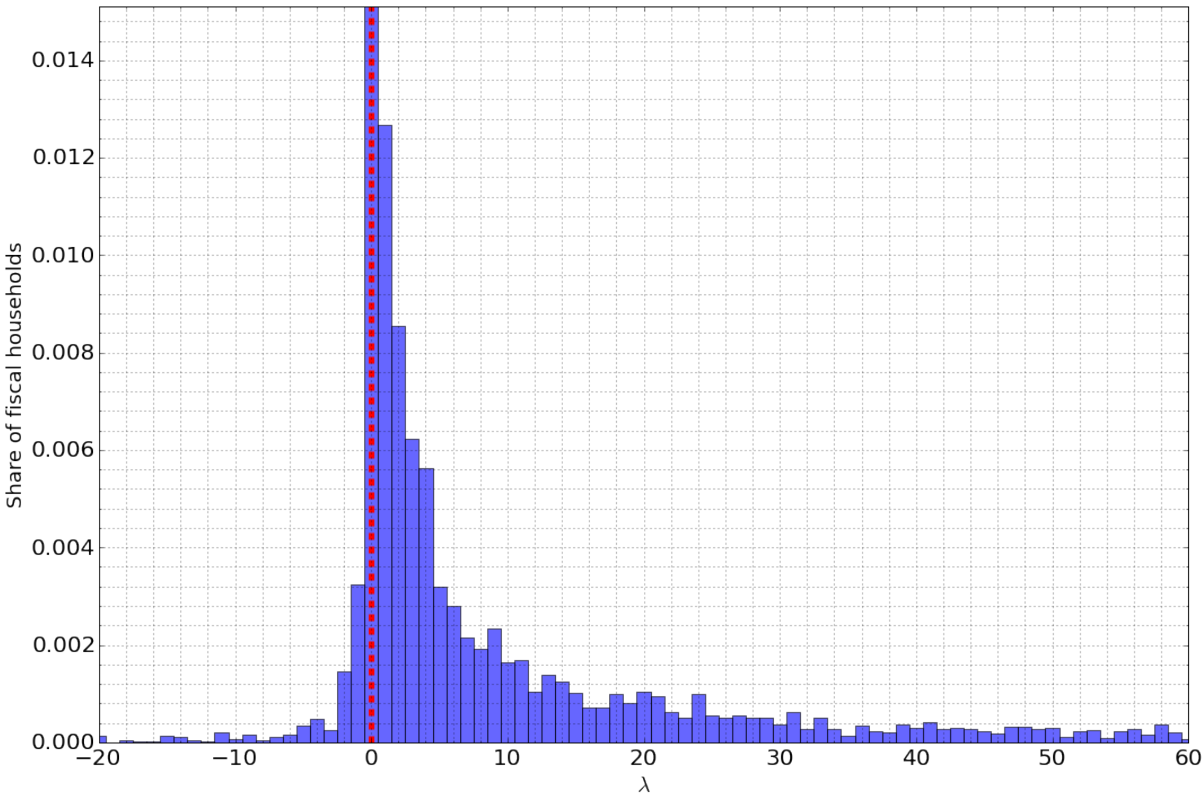
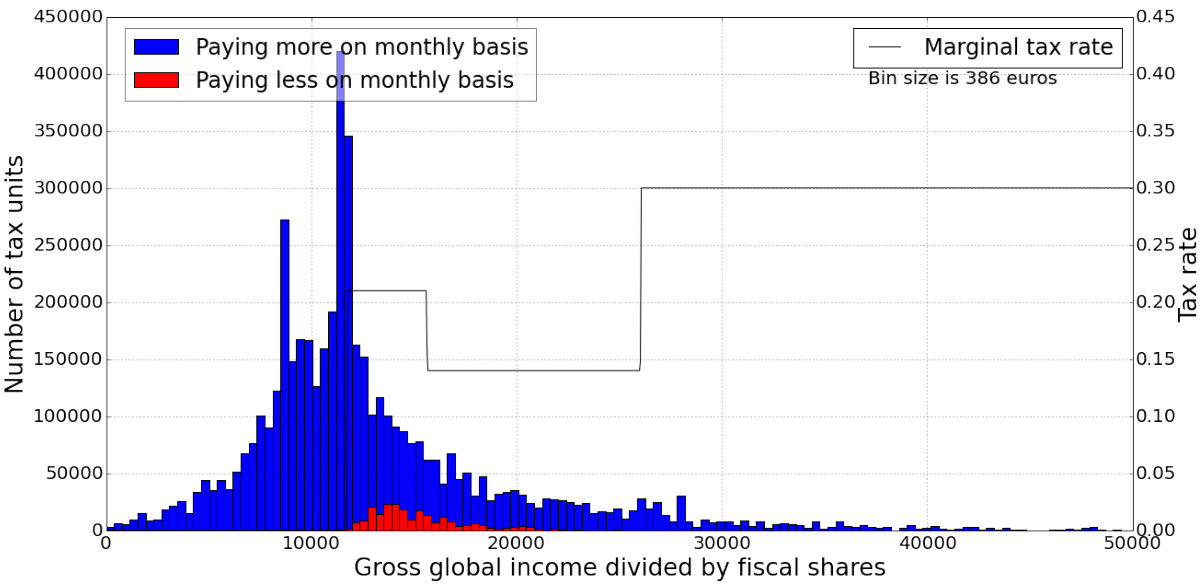


Figure 1.13 – Winners and Losers with Monthly Tax.



Winner/Losers. Figure 1.13 shows the number of monetary winners and losers among fiscal households according to their normalized tax base. [20] when we implement the monthly tax system instead the equal payment system. We see that losers (in blue – or light grey) represent the vast majority (more than 95%) with respect to winners (in red– or black). As expected, we see that the taxpayers that pay less on a monthly basis are the one located around the concave part of the tax scheme: those whose some monthly income belongs to the 22.5% tax bracket. There are also winners because of the threshold exemption which also introduces a small non-convexity.

Welfare Analysis. To estimate the welfare gains and losses, we need to estimate a utility function. The theory of equal sacrifice provides a sound theoeretical basis to estimate such a utility function. Young (Young (1990)) provides a method to test the theory of equal sacrifice against data. It shows that the fit is not that bad on various examples, including the US income tax. We did it on French data and we used the estimated utility function to calibrate the welfare changes.
The yearly disposable income z is obviously computed as

$$Z = \sum_{1}^{12} z_t = \sum_{1}^{T} y_t - g_t(y_t)$$

The best fit for an utility function defined on yearly basis we obtain is

$$U(Z) = -\left(Z\right)^{-0.89}.$$

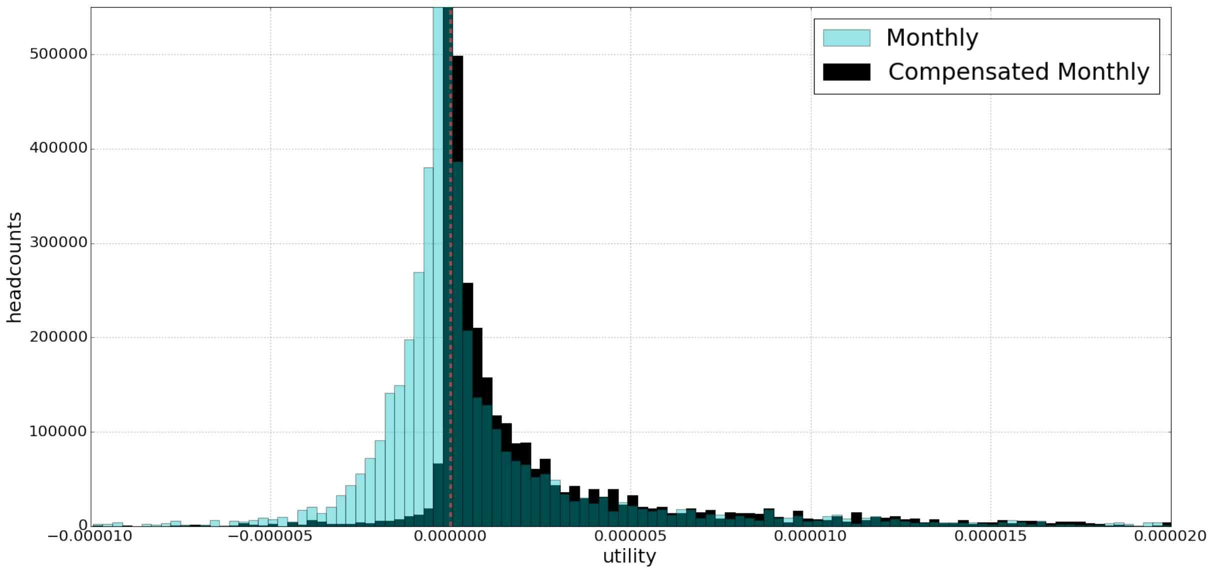
We define the utility function to a monthly basis as

$$u_t(z_t) = \frac{-\left(12z_t\right)^{-0.89}}{12} \tag{1.6}$$

in order the sum over the year gives the yearly utility U.
Figure 1.14 shows all losers and winners by utility points bins gains or loss. Utility gains with the monthly tax scheme are in cyan and dark green while the utility gains with the compensated monthly tax scheme are in black and dark green.
We see as expected that there are losers (10% of the sample) and winners (7.4%) with the monthly tax scheme. The former concerns taxpayers that have higher amount of tax to pay and benefit less from income smoothing over the year. With the monthly

20. In order to make them comparable we divided the taxable income by the number of fiscal shares (such that they are normalized to face the same tax schedule).

Figure 1.14 – The distribution of utility gains and losses for the monthly and monthly compensated schemes vs equal split



compensated tax scheme, almost people are net gainers from the reform. For the few losers (2%), there are two reasons which approximatively are equally important. For 50% of them, their income falls down on the concave part of the tax scheme, and for 50% of them because of the collection threshold of the tax.

Comparison with Vickrey tax scheme We have implemented Vickrey tax scheme as defined in Equation 1.3 with the reference period being year 2009 and the sub-period span being the month. In Figure 1.15 we can see the difference in utility of the monthly compensated tax scheme and the Vickrey tax scheme viz the equal payment scheme. The grey colour shows the overlap between the two histograms; the black is specific to Vickrey and the cyan to the monthly compensated.

The first message is that the two distributions are quite close and both mechanisms have similar impacts in terms of providing a smoothing income. Both mechanisms make the individuals happier compared to the equal payment scheme but the proportion of winners is higher with Vickrey than with Monthly compensated (13,4% againts 9,2%). In addition on average Vickrey compensation scheme leads to higher utility gains than the monthly compensated tax scheme. However, a higher fraction of the population has a loss in utility with the Vickrey tax scheme (6.2%) compared to equal payment than with the monthly compensated one (2%). These people are taxpayers that earn less at the beginning of the year than at the end. It is an echo of the results found in the theoretical section.

Figure 1.15 – The distribution of utility gains and losses for the Vickrey and monthly compensated schemes vs equal split

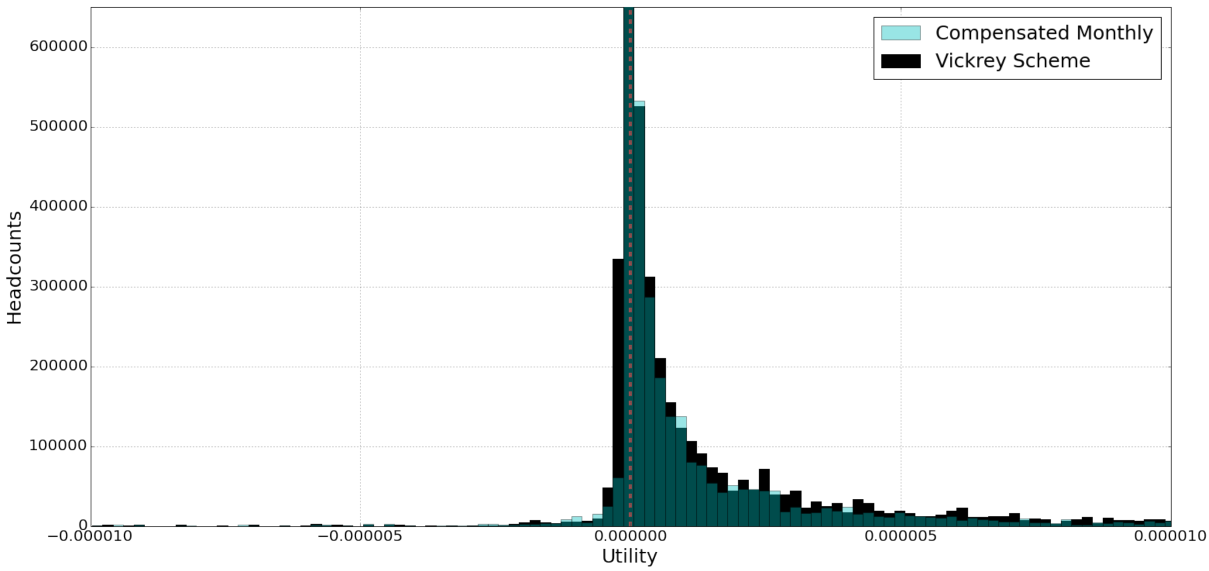


Table 1.3 – Utility with the different tax schemes

	Without equivalent scale				With equivalent scale			
Tax scheme	Equal split	Monthly	Compensated	Vickrey	Equal split	Monthly	Compensated	Vickrey
Aggregate	-4206.78	-4195.98	-4194.63	-4178.36	-7599.73	-7582.93	-7579.59	-7552.6
Average	-1.2529 $\times 10^{-4}$	-1.2497 $\times 10^{-4}$	-1.2493 $\times 10^{-4}$	-1.2444 $\times 10^{-4}$	-2.2634 $\times 10^{-4}$	-2.2584 $\times 10^{-4}$	-2.2574 $\times 10^{-4}$	-2.2494$\times 10^{-4}$

Table 1.3 computes the average utility for the different tax systems. Average utility U is of $-1253 * 10^{-7}$, $-1250 * 10^{-7}$, $-1249 * 10^{-7}$, $-12444 * 10^{-7}$, for respectively the annual basis tax, the monthly tax, the monthly basis compensated tax, and the Vickrey scheme. Mean utilitarian gains of an increase in frequency is of $3 * 10^{-7}$, and gain from an increase with compensation is of $4 * 10^{-7}$, while the Vickrey scheme entails a gain of $9 * 10^{-7}$ utility points.

In order to take into account the effect of joint taxation, we also implement the OECD equivalent scale to compute utility. The ranking of tax systems is similar.

So the message that comes out of this simulation is the following. The monthly compensated mechanism is more inclusive (less losers) but the gains are more modest than with Vickrey. We conclude this empirical section as well as the theoretical section that this is a closed contest between Vickrey and Monthly compensated payment system. It is too close to call.

5 Conclusion

In this article the within-year frequency of the tax and the tax basis for a monthly payment were under scutiny. We have proven given some standard hypothesis that it can be Pareto-improving to adopt a monthly tax base for the monthly payment. We have then tried to confront our theoretical framework to reality by implementing our prescriptive reform to the French income tax.

We have shown that there is a mismatch between our framework where the income tax convex and reality in developed countries such as US, UK and France: taxes on income are not convex and it has some adverse implication in terms of disposable income in a dynamic setting: convex tax schemes promote steady incomes and tax more heavily varying income, while concave tax schemes subsidize varying income. The dataset we used shows that most varying incomes are located at the bottom of the distribution, where precisely the income tax-benefit system is not convex.

We have then run the microsimulation model *OpenFisca* to estimate the impact of a switch from a between-month equal split system to monthly compensated based system. We have quantified monetary gains and loss for taxpayers and identified losers and winners. We have then performed a welfare analysis based on the equal sacrifice principle to determine losers and winners in terms of utility of the switch.

The main results is that in average the Vickrey performs better. The embodied insurance mechanisme works better whatever the convexity of the tax scheme, whereas that of the Monthly compensated supposes the convexity of the tax scheme. In a true sense, this latter mechanism is penalized by the lack of convexity in the bottom part of the income distribution. However, a weakness of the Vickrey systeme has been revealed both by the theory and by the data. It works less well for increasing income stream within a year. This configuration is unfortunately that for which the lack of precautionary saving is the most detrimental.

Those results are driven by within-year income variability. Most income variability studies in developed countries look at year to year incomes, to the notable exception of Hills et al. (2006) who looks at week-by-week effective disposable incomes of 93 poor families over a year in the UK.[21] Hills et al. (2006) emphasize that over nine tenth of those families has monthly income that vary over 10% of their average income[22] and half of the families in

21. We can also note Jenkins et al. (2000) who studied the difference between snapshot of current income vs. synthesize annual income on the observation of the distribution of income, their findings is that it has nearly no impact.

22.

the sample has nothing left over for savings, and a quarter for which outgoings exceeded income. Literature on saving behavior –always yearly based– underline that bottom of the distribution has very high marginal propensity to consume.[23] Those facts suggest that a large parts of the bottom of the distribution cope with whatever is their monthly disposable income and gives credit to our "no-saving" framework. Poor savings and income variability can have huge impact on citizen well being, this suggest that the tax-benefit scheme should be studied in a non purely static models with those effects in mind.

Similarly to Brewer et al. (2010)[24], our public prescription is that bottom of the distribution, tax-benefits should be based on high-frequency in order to smooth disposable income. As we have shown, this is compatible with not increasing the size of transfer payments to the bottom part of the distribution.

Increasing tax frequency could allow for a decrease of the size of the refund which can have some macroeconomic consequences. Such situation has been empirically studied by Shapiro and Slemrod (1993, 2003, 2009) that study the impact on aggregate demand of the US tax-refund.

Those issues open avenues for further research that should be investigated. Optimal taxation is for most contributions developed in a static framework. Studying the incentives and its impact on the optimal tax scheme in a dynamic setting might lead to different public policy prescriptions as the one prescribed by actual models.

Only seven of the 93 families had incomes fitting our "highly stable" pattern, that is, varying less than 10 per cent either way from their annual average. Only a third had income in at least eleven periods within 15 per cent of their mean, and within 25 per cent of it in any other periods.

23. Carrolls, etc, choisir les bonnes références.

24. " The assessment period and timing of taxes and transfers In most countries, individual income taxes are assessed on annual income, and transfers often assessed on a monthly basis (in the UK, weekly). Standard economic models predict that families should budget over long time periods, by borrowing (or using credit) and saving. If families have fluctuating incomes but are able to smooth consumption over time by borrowing and saving, then income assessed over a longer period of time is a better measure of economic welfare or well-being than income assessed over a short period of time. In reality, costs of using financial services and other credit market failures, low levels of literacy, numeracy and financial education, and self-control problems with savings all create significant departures from the standard model. These departures are likely to be more prevalent amongst low-income families, and tend to lead to such families budgeting consumption over short periods of time, such as a month or a fortnight. It therefore seems desirable to operate transfers for low-income families on a **high-frequency basis**, and operate taxes on higher incomes on a lower frequency, such as annual."

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Chapter 2

A Direct Measure of Inefficiency within Couples: Tax Optimization in French cohabiting couples [1]

1. This chapter is a collaboration with Olivier Bargain, Damien Echevin & Nicolas Moreau

The literature on household modelling usually assumes the efficiency of household decisions while testable conditions often depend on auxiliary assumptions or are not suited to detect inefficient behavior. In this paper, we suggest a direct measure of inefficiency in cohabiting couples regarding a decision repeated each year: tax filling. In France, cohabiting couples with children are registered as two separate tax units but must allocate each child to only one of these units for the purpose of tax rebates. Using tax registers and simulations for the years 2013 and 2014, we find that around 25% of all of cohabitant couples do not allocate children optimally in their tax returns, which is a direct evidence of inefficiency. We discuss several pathways: cognitive aspects (transaction costs, 'simple rule' bias and inertia) and non-cooperative behavior (related to the lack of binding agreement, or potential asymmetry of information, between partners). We find traces of heuristics (like equal split, when the number of children is even); transitions point to a large degree of inertia and confirm the existence intertemporally efficient and inefficient types; inefficient couples tend to separate more and to marry less in the subsequent period.

Key Words : efficiency, non-cooperative model, income taxation, learning, tax returns.
JEL Classification : D13, D61, H31

1 Introduction

The economic literature has suggested many representations of household behavior. Modelling partners' interactions and collective choices is useful to analyze the effect of policy changes on household decisions and/or to carry out welfare analysis at the individual level. The primary question in this endeavor pertains to the type of core assumptions that need to be made and to whether these assumptions can lead to testable conditions. The most general model so far, the 'collective approach', simply assumes the efficiency of household decisions (Chiappori et al., 1988) This assumption is rationalized by an (unspecified) cooperation process or, alternatively, by an indefinitely repeated interaction of non-cooperative couples that eventually lead to efficiency (Folk theorem). Most of the literature has focused on strategies to derive testable conditions stemming from this assumption (see surveys in Vermeulen (2002) or Donni and Chiappori (2011)).

Early tests in the literature involved cross-derivatives of male and female Marshallian demand function (demand of commodities or leisure, cf. Browning and Chiappori (1998) and

Chiappori et al. (1988)) or proportionality conditions using distribution factors (c.f. Bourguignon et al. (2009)). These types of test necessarily depend on auxiliary assumptions including functional forms, separability assumptions,[2] and the exogeneity of distribution factors.[3] Arguably, part of these limitations are lifted by the nonparametric approach to test the collective model, as suggested in Cherchye et al. (2007, 2009) and subsequent contributions. However, measurement errors are not systematically taken into account in this approach. Also, price variation may be seen as a limited and too general source of variation to identify heterogeneous types. Furthermore, recent studies question the power of these tests against inefficient alternatives, i.e. whether these tests have the ability to identify inefficiency (Naidoo, 2015)). Most testable conditions are necessary (but not sufficient) for efficiency, which makes that other decision-making process – such as non-cooperative behavior leading to inefficient outcomes – cannot be detected by these tests (see the enlightening discussion of (Baland and Ziparo, 2017).[4]

The present paper suggests an alternative approach based on simple observational information about couples' behavior. We directly check the inefficiency of couples regarding a particular decision: tax filing. We exploit the fact that in France, dependent children give right to a reduction of the tax burden through a system of 'family ratio'. We focus on cohabiting couples with children, which are defined here as unmarried couples or couples not in a civil union (civil unions give the same tax rights as marriage). Cohabiting partners are interesting for us as they represent two different tax units, i.e. they must fill two tax returns, while children must be attached to one or the other parents for tax rebate purposes. Each child can be allocated to only one of the parents, so every year, parents must choose an allocation that is often non-neutral for tax payments. There is usually a sub-set of allocations that minimize the overall tax liability of the household. Failing to choose such an allocation is a direct evidence of inefficiency: in such a repeated game (tax filing is done every year), parents could commit to side-payment so that the one not benefiting from child tax rebates is compensated by the other.

Using tax administrative data for the year 2013, we also use exact household information

2. The sharing rule interpretation leading to many of the tests requires separability between male and female utility functions, for instance by positing egoistic preferences or 'caring' preferences à la Becker

3. These factors are assumed to affect intra-household decisions only through the Pareto weights on spouses' utility (see Bourguignon et al. (2009)).

4. These authors offer a comprehensive review of the limitation of the efficiency assumption in the context of poor countries but many of their arguments are actually relevant, at least to some extent, in rich countries (in particular the role of time and uncertainty, the limited commitment problem, and the possibility of asymmetric information between spouses). The ability to perform meaningful tests is discussed in Dauphin et al. (2018).

(including partners' earnings and household characteristics) to simulate household tax liability for all possible allocations of children and in particular to determine the optimal one. We also recover information about how children were actually allocated and, hence, can identify inefficient couples. The external validity of this measure is not low since cohabiting couples with children become a very standard household type. In the recent years in France, the majority of births have taken place outside marriage. Arguably, many couples tend to get married after the birth of their first child, but not all. A relatively large fraction of cohabiting parents remain in free or civil unions afterwards. Precisely, French families (counting 13.7 million children under 18) comprise 50% of married couples, 20% of unmarried couples (our sample), 20% of single parent families and 9% of blended families (married and non-married couples having children from past relationships), according to the French Statistical Institute (INSEE, 2011). [5] We first document how French cohabiting couples depart from optimality: we find that around 30% do not minimize tax payments and a non-negligible fraction can make rather large errors. [6]

Arguably, these couples may be efficient in other domains of life but not in filing tax form, possibly due to cognitive biases (using simple rules) or non-cooperative behavior (a lack of binding agreement between partners). While testing these different explanations is beyond what can be done with our data, we provide further characterizations that draw from these interpretations of inefficiency. We find traces of heuristics (like equal split, when the number of children is even, or putting all children on the main earner). The portrait of non-optimizers shows that durable couples tend to allocate children more optimally while those who sub-optimize in other domain (e.g. do not enter a civil union while they would gain much from it) tend to misallocate. Transitions between 2013 and 2014 show limited signs of learning effects and confirm the existence of (intertemporally) efficient and inefficient types (in similar proportions as in the static characterization). Finally, we find that large inefficiencies in 2013 are associated with higher moves towards separation (and lower transitions towards marriage or civil union) the following year. This is suggestive evidence of the role of non-cooperation as a primary mechanism for tax inefficiency.

5. Out of wedlock births accounted for 11% of all the births in 1980, 20% in 1990, 43% in 2000, 54% in 2010 and 59% in 2017 (INSEE, civil registries). In the US, in comparison, they represented around 42% of all births in the recent years (National Center for Health Statistics). Note that married couples still tend to have more children (85% of the 18-39 years old couples) than those in a civil union (54%) or simply cohabiting (51%).

6. A similar exercise by Stöwhase (2011) tests inefficiency regarding couples' choice upon tax classes on wage income in Germany. The author finds that 20% of the couples do not minimize their tax payment. A major difference is that inefficiency is temporary in this case while in ours, fiscal loss is definitive

Our contribution is clearly positioned in the literature on intra-household decisions. Our result is original for several reasons. First, we provide some evidence that is directly based on observable behavior and does not depend on auxiliary assumptions. Second, as noted above, the literature has focused on efficiency tests but has not provided ways to detect inefficient behavior, which is what we measure here. Third, past studies tend to test a uniform behavior while heterogeneity prevails in the real world. This is precisely what we document in this paper.[7]

Fourth, our results bear a strong analogy with the rejection of productive efficiency found in the literature but in the context of a rich country. Finally, our results indicate that models positing efficiency (collective models) are not suitable for a fair fraction of the population, but also (trivially) imply a rejection of the unitary model. Indeed, if partners pool their income, they must aim at maximizing household disposable income and must optimize the way they allocate children for tax declarations. So far, the best evidence against the unitary model was the rejection of income pooling following a wallet-to-purse transfer induced by a policy reform (cf. Lundberg et al. (1997)).

2 Empirical Approach

2.1 Data

We rely on an administrative dataset, namely the *Echantillon Démographique Permanent* (EDP), which combines different civil state registers (birth, death and marriage registers, elector registers), tax returns, payslips and census information. We focus primarily on the year 2013 for our main results while additional results also rely on 2014. The EDP is designed as a random sample of the population based on birthdate, comprising 2.7 million individuals in 2013. Ideally, we would like to follow couples over many years to check the extent to which inefficient behavior is persistent or not. We could avail of only two years, 2013-2104, for which detailed tax returns were available and for which we could perform tax simulations. Note that social security numbers are used in the EDP to link individuals over time so the two-year sample is a panel.

The first step of our work pertains to data preparation and selection using the different datasets matched in the EDP. We identify cohabiting couples with children as follows (see also Costemalle (2017)). A household is defined as the people living in the same dwelling.

7. In that sense, our work is related to theoretical contributions based on continuum of types between cooperative and non-cooperative couples (e.g. Cherchye et al. (2015), d'Aspremont and Ferreira (2018)).

We select household comprising two adults who are not married nor in a civil union, and who live with children. Because of complex tax rules in the case of dependent children above 18, we exclude households with older children. To verify that the adults form a cohabiting couple, we use civil registers and recover for each child the birth dates of the parents, which we can match with the birth dates of adults living in this household. In this way, we directly eliminate stepfamilies, which are subject to other tax rules and would bias our measure of tax optimization. We obtain a baseline sample of 51,190 cohabiting couples with children under 18 for the year 2013, described in Table 2.A1 in the Appendix. For some of our estimations, we want to include education levels, which are drawn from the Census. The sample in this case is smaller (32,292 couples in 2013) and, because of the Census sampling design, biased towards areas of less than 10,000 inhabitants. [8] We keep in mind this limitation when using the sample for regressions including education information. In Table 2.A1, we compare it to the baseline sample: many socio-demographic variables are significantly different, but this is mainly due to the fact that samples are large and mean difference tests very precise; it seems in fact that differences are relatively modest.

2.2 Tax Rules and Simulations

The French tax system is composed of a withholding flat tax (the so-called CSG/CRDS, which represents of 8% of labor income in 2013) and a progressive income tax. We focus on the latter, which is shifted in time: the tax on incomes of year t is subject to declaration and payment in year $t + 1$. This progressive income tax is joint for married couples or couples in a civil union: they represent one tax unit (with all their dependent children) and their all their incomes are jointly taxed. Things are different for cohabiting couples. They represent two tax units and each of them must fill a tax form. When children are biological descendants of both cohabiting partners, a decision must be made, for each child, on whether this child is attached to the man's or to the woman's tax unit. This decision can change every year, i.e. the question is asked at each new tax declaration, even if the family configuration has not changed. The general rule to account for children is the family ratio scheme (Quotient familial). This system is a concrete application of

8. The Census is collected over a period of five years. It is exhaustively collected for places of less than 10,000 inhabitants once every five years while 8% of the localities of more than 10,000 inhabitants are randomly drawn and interviewed each year. We manage to match our selected households with Census data from 2010 to 2014, which provides education information for 100% of the areas of less than 10,000 inhabitants and for $1 - 0.92^5 = 34\%$ of the population living in larger localities.

the equal sacrifice principle (Young, 1987).

Formally, for a tax unit i, the progressive tax schedule $t()$ is applied to an equivalent income $\frac{y_i}{s(k_i)}$, which is the taxable income of that unit, y_i, deflated by an equivalence scale. The total tax liability of this unit is then calculated as $T_i = s(k_i) \cdot t(y_i/s(k_i))$. The equivalence scale $s(k_i)$ depends on the number of dependent children attached to this unit, k_i. This scale represents a number of adult-equivalents, or "fiscal shares", calculated as 1 for the cohabiting adult (or 2 for partners who are married or in a civil union) plus 0.5 for the first and second child attached to the unit, and plus 1 for each additional child. Hence, for a cohabiting partner i, the explicit scale is $s(0) = 1$, $s(1) = 1.5$, $s(k_i) = k_i$ for $k_i \geq 2$. The weight of children does not depend on any other characteristics (like age) than the birth order. The maximum relief a taxpayer may obtain through the application of this system is fixed at p=2,000 EUR per half fiscal share in 2013, i.e. it is simply $p \cdot \frac{s(k_i)-s(0)}{2} = p \cdot (\frac{s(k_i)}{2} - \frac{1}{2})$ for each cohabiting parent. Cohabiting couples make two tax payments $T_i, i = f, m$ (tax paid by the female and the male respectively), so that the household total tax liability is $T =_f +T_m$.

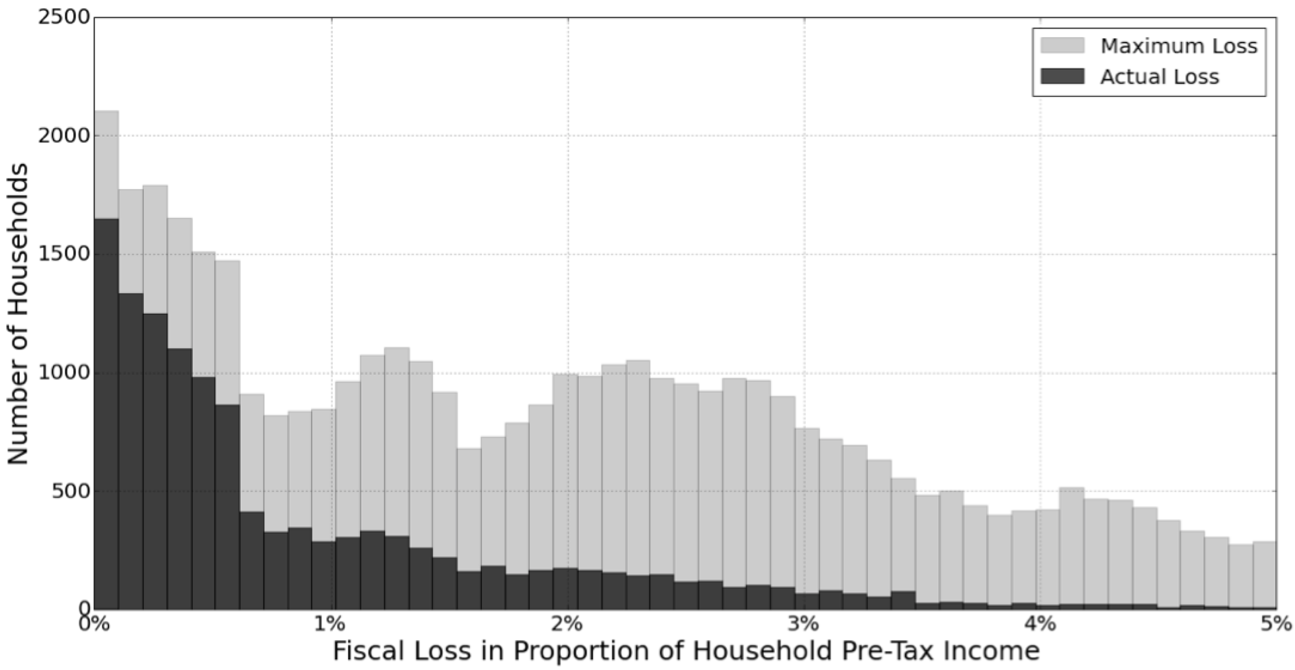
We rely on the a simplified version of the tax simulator OpenFisca. Taxable income is recovered from the EDP.[9] Demographic information, i.e. the number k_f (k_m) of children attached to the father's (mother's) tax unit, is also available in the tax registers. The tax simulator is used calculate, for each cohabiting couple with children, the household tax liability T for all the possible allocations of the $k = k_f + k_m$ children to the parents $i = f, m$. From these calculations, we define the sub-set of optimal allocations of children, among the $k + 1$ possible allocations.

We can compute the maximal loss from non-optimization. It is calculated as the difference between the worst allocation and the optimal allocation. Losses are potentially high. The average difference between the best and worst allocations is 2.1% of taxable income or 750 euros per year. To put it in perspective, note that the average amount of tax paid under the progressive tax system is 6% of taxable income in France in 2013. In Figure 2.1, the light grey bars show the distribution of maximal losses expressed in percentage of

9. It contains detailed information on individual income according to 7 categories including labor income and various forms of capital income, which can be used for the application of more specific tax rules, which we do not detail here. OpenFisca, which is a microsimulation model used by various administrations in France and which provide very accurate calculations of tax and benefit instruments for actual households in administrative data. As we are only interested in the income tax, we only use the formulas that correspond to the core of the French income tax. We do not take into account tax credits as it is neutral in the choice of income allocation. Tax reductions are not taken into account as the information is limited in the EDP; although tax reductions can change the optimal allocation, it is unlikely to do so for large amounts of taxes.

household pre-tax income. For a majority of cohabiting couples, the allocation choice of children is far from being neutral. It turns out that half of them could experience a loss up to 1.7% of income (which corresponds to 610 euros) and around 70% could lose more than 1% of income (which corresponds to around 350 euros on average).

Figure 2.1 – Actual and Maximum Fiscal Loses from Non-Optimization



Source: authors' calculation using EDP data. Sample of cohabiting biological parents of children under 18. Selection for the graph excludes 11.3% of couple who cannot optimize (the tax liability is the same whatever the allocation of children to one or the other parent).

From fiscal data, we observe the actual choice made by cohabiting partners. Hence, for each household, we can determine whether it optimizes or not, i.e. whether it picks one of the child allocations that lead to the minimal tax liability. We can also compute actual losses, i.e. the gap in tax payment between the actual decision and the optimum. The distribution of actual losses is shown in dark bars in Figure 2.1. We comment this results hereafter. Note at this stage that the distribution of actual losses follows somehow the non-linearity and discontinuities of the maximum loss profile, which are generated by various tax rules.

Table A.2 in the Appendix suggests a decomposition by demographic groups (number of children k). For each group, it shows how the number of optimal allocations is distributed, between polar cases (i.e. 'only one allocation is optimal' to 'all the $k+1$ allocations are optimal'). Note that some of our results will be derived for the sub-group of couples for whom there is a margin of optimization. This group of potential optimizers (**PO**) excludes those located on the diagonal, i.e. those for whom all allocations are optimal (which represent 11.3% of our selected sample: 8.9% for whom tax liability is zero whatever children allocation and 2.4% for whom all allocations lead to the same strictly positive income tax level). Results focusing on the PO will induce a slight bias against large families: as can be seen in Table A.2, the proportion of those who do not need to optimize increases with families of 3 and more (14.3% for 3 children, 24.7% for 4, 34.1% for 5 and more). This pattern is simply explained by the fact that when a partner becomes non-taxable, because the assignment of one or two children has reduced enough the per-adult equivalent income of his/her tax unit, it is not necessary to allocate more children to him/her. We will also consider a sub-sub-group comprising those with only one optimal allocation among all possible allocations. The first column shows that they represent a large majority of cases for families with 3 children or less. Arguably, this selection of potential optimizers with a unique optimum (**POU**) will be biased towards smaller families.

3 Conceptual Background and Potential Channels

It is interesting to discuss the channels underlying potential tax return inefficiencies. Such a discussion will lead to suggestions about the informal checks that can be conducted in our empirical analysis. Not choosing the right child allocation – i.e. not minimizing tax liability – is clearly suboptimal and may be due to transaction costs (time to learn about the optimal allocation), cognitive biases (adoption of simple rules) or limited commitment problem within couples. We present in turn each of these channels.

The first pathway pertains to the question of whether a couple understands the tax rules and, then, undergo transaction costs to optimize. Arguably, the 'family ratio' system exists for decades and is very popular among French citizens as a large tax advantage for families with children. It was initially popularized as a contributor to the relatively high fertility rate in France compared to neighboring countries (Landais, 2004). Note that people are explicitly asked in their tax declaration how many dependent children they have and, in the case of cohabiting partners, are reminded that each child can be allocated only once (i.e. to only one of the two tax units).[10] Then, the question is whether families can easily know what to do best. If we consider the case of couples with

10. Failing to do so is considered as tax fraud, and an official letter would prompt that couple to correct and jointly inform the authorities about who benefits from the child allocation.

dependent children in 2013, they are young enough to be internet users and to be familiar with administrative information online, i.e. the tax authority website "impots.gouv.fr". In 2013, this website has been visited 103,1 million times, mainly to use the tax simulator (27.7 million simulations performed). The latter allows tax payers to simulate the tax amount they have to pay, asking them the same information as on tax forms (including child allocation) and processing it with exact tax rules. One may still argue that it can be cumbersome for cohabiting couples with a large number of children to simulate all the k+1 possible allocations – and we expect more inefficiency in this case – but certainly not for small families. In any case, we cannot rule out that transaction costs of that sort can explain sub-optimal decisions in some households, especially if the gains from searching the optimum are perceived as being rather small compared to the opportunity cost (of time) of doing so. In what follow, we will test whether inefficiency is correlated with family size or proxies for cognitive skills (like holding a higher degree). More likely, sources of error related to cognitive biases may be due to specific heuristics applied in the case of tax filling. It is possible that people do not take an all-inclusive view of their finances (Thaler, 1999)), so that mental accounting and 'focusing illusion' biases may offer an explanation for apparently irrational behavior. People may decide complex matters like tax by responding to the most salient or obvious aspect of a choice set or decision problem (Chetty et al., 2009; McCaffery and Baron, 2004). Fairness considerations also matter and may conflict with efficiency when thinking about tax design (McCaffery et al., 2003). In our context, the idea that both partners should benefit from the tax relief provided by children may prevail over a precise calculation of the optimal allocation. For instance, they may exert some sense of fairness attached to 'equal split', for those with 2 or 4 children – a bias that we can easily check in our empirical application.

This particular setting is more than an individual cognitive bias: it is a coordination problem where two partners are potentially unable to go beyond symbolic aspects. It may also be the case that they do not redistribute resources efficiently, so that we face a classic problem of dynamic non-cooperative behavior (Chiappori and Mazzocco, 2017). This third type of explanation is easily described: an efficient decision would involve an optimal allocation of children to tax units coupled with a side-payment from the partner who benefits the most from child tax relief to the other partner. This may not happen because of heuristics and symbolic reasons, as emphasized above, or due to a lack of binding agreement between partners regarding the possibility to make these compensating transfers. Assume spouse m earns more than spouse f and try to convince her to associate all the children to his tax unit by promising to transfer some of the optimization gains. For instance, assume that partner m's (f's) pre-tax income is 200 (100) and his (her) tax liability is 100 (10) due to progressivity. He obtains a larger reduction (16) than her (10) if children are attached to his tax unit (rather than hers). In the former case, he transfers half of the gain, while in the latter, she makes no transfer (she's already poorer). This is summarized as:

Outcomes for *(f,m)*	Initial situation (no children)	Choice 1: all children allocated to her	Choice 2: children allocated to him
Gross income	100, 200	100, 200	100, 200
Tax liability	10, 100	**0**, 100	10, **84**
Net income	90, 100	100, 100	90, 116
Net, after transfer	90, 100	100, 100	98, 108
Total net income	190	200	206

The optimal choice is number 2 (children attached to him). She could accept it – even though the transfer does not make her as well off as with choice 1 – if she considers that they both win compared to the situation before the child was born (possibly taken as reference point) and win equally (+8 each). Conversely, she may ex ante refuse the arrangement 2, as she anticipates that redistribution will not be enough (he might actually promise more than half of the gain but agreements are not binding). She could then argue that choice 1 is neutral for him (compared to before the child arrived) and he might accept, especially if he already does not redistribute much of his own resources to her. [11]

This example may characterize well the situation just after the arrival of the first child, which may be efficient or not, as described above. Renegotiation can take place the year after, at the next annual tax declaration. [12] Whether inefficiency is persistent or not can

11. This type of inefficiency may materialize even more if there is asymmetrical information, which increases the limited commitment problem. Efficiency in collective models is based on the assumption of perfect information, yet recent evidence show that it is limited (Baland and Ziparo, 2017). For instance, he may prefer choice 1 (she makes a gain of 10) rather than going into computation in search of an optimum, because these calculations would imply revealing exactly the large unbalance in net incomes between them and possibly lead to redistributive pressure. Another reason is that even in a situation with infinitely repeated interaction, the folk theorem shows that almost every allocation situated between a non-cooperative Nash outcome and the Pareto efficient outcome could be stable. In other words, (infinitely) repeated interaction does not necessarily lead to efficient behavior (c.f. Baland and Ziparo (2017)).

12. The first year, a sequential game may also take place where one partner is taken by surprise, i.e. m fills his tax form first, leaving f facing this choice (see experimental evidence on "who holds the mouse", in

be checked over two years in our setting. It may last because of inertia in household decisions. Also, while the literature indicates that inefficiency especially concerns non-repeated, one-off decisions (for instance, location choices, as exemplified in Pollack et al., 2013), lasting inefficiency for decisions that are regularly repeated, like tax filling, seems a stronger case of non-cooperation.[13] Strong disagreements may results in separation, or less chances of more engagement (marriage), which is something we will test hereafter.

Finally, remark that several studies reject the efficiency of household decisions for the allocation of productive inputs, in the context of developing countries – for instance Udry (1996), Duflo and Udry (2004) and Apedo-Amah et al. (2017). We can actually make an analogy to this literature if the process of allocating children to the man or the woman is a particular form of production decision, affecting the resources controlled by each partner, and requiring some cooperation if the couple wants to maximize total resources. Even if the household is efficient for consumption decisions, this previous, productive step may fail to provide overall efficiency.[14] We now move to the empirical part in order to measure the rate of rejection of such a 'productive efficiency'.

4 Results

4.1 Main Results

Inefficiency rates. The main results are provided in Table 2.1. We consider the whole selection of cohabiting couples with children under 18, the sub-group of PO and the sub-sub group of POU. In each of these three nested samples, we report the distribution of cohabiting couples by family size (column 1), the number of non-optimizers (column 2) and their proportion (column 3). We find a non-negligible rate of inefficiency: there are

De Palma et al. (2011)). Whatever the dynamic decision-making process, it is possible that a suboptimal allocation be chosen that reduces the tax paid by one spouse while the other is not fully compensated.

13. Tax payments are made in three installments in February, May, September (for 40% of French taxpayers) or monthly (for 60% of them). Early payments in the year are based on past-year information. The tax declaration (including child allocation) is made in May/June, leading to adjustment in payments (i.e. in the September installment or in the monthly installments following the tax declaration).

14. Other forms of inefficiency involve imperfect risk sharing (Dercon and Krishnan, 2000; Robinson, 2012), strategic appropriation of resources (Anderson and Baland, 2002), lying and hiding (Ashraf, 2009), strategic use of violence (Bloch and Rao, 2002). As investigated in Baland and Ziparo (2017), potential explanations pertaining to the role of time and uncertainty, the lack of commitment, the role of irreversible decisions and asymmetric information between spouses, among other things that applied to both poor and rich countries. The literature also highlights under-contribution to public goods through the use of experimental games between spouses (Hoel, 2015). Theoretically, a few papers try to restore some of the efficiency thanks to love or caring (Browning and Ejrnæs, 2009; Cherchye et al., 2015). Experimental evidence often points to inefficient decisions, see the recent survey of Munro (2018).

24.8% of non-optimizers overall, 28% among those who can optimize (PO) and 29.1% among those with only one optimization possibility (POU). The average loss among non-optimizers is around 320 EUR, which corresponds to 0.9% of pre-tax income on average (or 14.9% of average tax payment). Since these overall figures may hide a tiny bias against large families, as described above, we also comment on the inefficiency rate by family type. We see that for small families, the proportion of non-optimizers (e.g. 28.4% in couples with two children) increase mechanically when focusing on PO (31.5%) and increases still when looking at POU (34%).

The rate of non-optimization for POU literately explodes in larger families but these are not so relevant because moving to POU considerably reduces sample size in their case. An interesting pattern, both for the baseline selection or the sub-groups PO and POU, is the fact that inefficiency rates are larger for families with an even number of children (2 and 4). A possibly explanation is the use of simple allocation rules like 'equal split' (we come back to this point in our interpretations below).

These results can be mitigated if we look at large income losses. Table 2.1 reports the number (column 4) and proportion (column 5) of couples who commit large optimization errors (i.e. large inefficiencies), defined as income losses larger than 1%. This proportion is around a third of all inefficiencies, i.e. 8.2% of cohabiting couples, and increases naturally when looking at PO (9.3%) and POU (9.5%). We find the same pattern as above: (large) inefficiency rates are bigger for families with 2 and 4 children.

Table 2.1 – Rate of Non-Optimization (and Large Non-Optimization) by Demographic Groups

Family type	# cohab. couples	# non-optimizer	% non-optimizer	# loss > 1% of income	% loss > 1% of income
All households					
1 child	27,316	6,147	0.225	1,534	0.056
2 children	20,411	5,787	0.284	2,280	0.112
3 children	2,399	454	0.189	222	0.093
4 children	909	296	0.326	175	0.193
5 children+	41	7	0.171	3	0.073
Total	51,190	12,703	**0.248**	4,221	0.082
Potential Optimizers (couples who can optimize)					
1 child	24,211	6,147	0.254	1,534	0.063
2 children	18,358	5,787	0.315	2,280	0.124
3 children	2,055	454	0.221	222	0.108
4 children	684	296	0.433	175	0.256
5 children+	27	7	0.259	3	0.111
Total	45,411	12,703	**0.280**	4,221	0.093
Potential Optimizers with a unique optimal allocation					
1 child	24,211	6,147	0.254	1,534	0.063
2 children	16,527	5,617	0.340	2,184	0.132
3 children	1,457	406	0.279	197	0.135
4 children	271	195	0.720	133	0.491
5 children+	6	4	0.667	2	0.333
Total	42,480	12,375	**0.291**	4,054	0.095

Source: authors' calculation using EDP data, 2013. Sample of cohabiting biological parents of children under 18. The sub-sample of *potential optimizers* exclude those for whom all allocations are optimal. Within this group, we consider a sub-sub-sample of *potential optimizers with one optimal allocation* , i.e. among all possible allocations, one dominates the others.

The proportion of actual losses can be compared to the distribution of maximal losses. The distribution of actual losses is represented by the dark bars in Figure 2.1. It shows a high mass of error at lower levels, between 0.1 and 0.5% of income. The density of errors then decreases regularly from 0.6% to around 5% of income. Additional statistics are as follows. We have seen that 70% of the PO (cohabiting couples who can optimize) have their worst allocation exceeding 1% of income. In fact, 13% of the PO choose this allocation (9.3% of the baseline sample), i.e. commit what we have defined as a large inefficiency.

Table 2.2 – Distribution of Optimizers by Demographic Groups and Allocation Type

	# children:				Population-weighted mean
	1	2	3	4	
(a) Effective allocation (distribution across allocation types)					
All on man	0.59	0.44	0.58	0.14	0.52
All on woman	0.41	0.18	0.13	0.03	0.30
Equal split		0.39		0.80	0.17
Most on man			0.18	0.03	0.01
Most of woman			0.11	0.01	0.01
(b) Random Allocation (distribution across allocations types)					
All on man	0.50	0.33	0.25	0.20	0.41
All on woman	0.50	0.33	0.25	0.20	0.41
Equal split		0.33		0.20	0.14
Most on man			0.25	0.20	0.02
Most of woman			0.25	0.20	0.02
(c) Optimal Allocation (how often each allocation type is optimal)					
All on man	0.70	0.59	0.74	0.70	0.66
All on woman	0.41	0.22	0.22	0.33	0.32
Equal split		0.48		0.61	0.20
Most on man			0.14	0.15	0.01
Most of woman			0.16	0.16	0.01
(d) Sub-optimal Allocation (how often each suboptimal allocation is chosen)					
All on man	0.29	0.17	0.12	0.00	0.23
All on woman	0.24	0.10	0.06	0.01	0.17
Equal split		0.26		0.78	0.12
Most on man			0.13	0.02	0.01
Most of woman			0.08	0.01	0.00
# obs.	27,316	20,411	2,399	909	

Source: authors' calculation using EDP data, 2013. Sample of cohabiting biological parents of children under 18. For each family size, the table shows (a) how *effective allocations* are distributed across allocation types, (b) how *random allocations* would be distributed across allocation types, (c) how *optimal allocations* are distributed (since several allocations can be optimal, the probabilities vertically sum to more than 1 in this panel). Panel (d) is different as it shows, for each family size and allocation type, the proportion of couples making an error by following this particular allocation type (for instance, among couple with one child for whom it is not optimal to put the child on the father, 29% do so and hence commit an error).

Patterns of inefficiency. Beyond mean rates of inefficiency, we suggest more analysis in Table 2.2 (we focus on families of 1-4 children since larger families are very few). Panel (a) shows the distribution of actual allocations, by family size and type of chosen allocation ("all children on father", "equal split", etc.). Panel (b) shows the distribution in case of random allocations. Chi-squared tests of (a) versus (b) indicate that effective allocations deviate significantly form random allocations (all p-values are 0 for all family sizes). For instance, in couples with one child, 59% of them put the child on the father's tax return, which is significantly different from a random allocation of 50% in this case.

For each allocation type and demographic group, panel (c) reports how frequently this allocation is optimal. These frequencies vertically sum up to more than 1 because several allocation can be simultaneously optimal. For this reason, the panel (c) is not directly comparable to (a) and (b), but gives useful indications. For instance, in couples with one child, it is more often optimal to put the child on the father's tax unit (optimal for 70% of the couples) than on the mother's (41%). Importantly, actual allocations tend to deviate in this direction compared to the random allocation, as seen above. For families with four children, our conjecture of a bias associated to the simple 'equal split' rule seems to apply: this equal allocation is chosen in a majority of cases (80%) while it is not so often optimal (61%).

Other biases may be at work but not visible in these results. For instance, putting all the children on the father, as main earner, may be another heuristics. Yet this choice may effectively be often optimal at the same time. In order to detect the influence of 'simple rules', we extract information on the frequency of typical errors in panel (d). For families with one child, the first row shows that among all the couples for whom it is non-optimal to put the child on the father, 29% choose to do so. This type of error seems also present in families of two and three. In couples with four children (and to a lesser extent with two), we observe very suggestive evidence of the 'equal split' bias. As discussed, this simple and apparently fair rule may not be simply a form of heuristic but also a sign of cooperation failure between partners.

Profile of the non-optimizers. To carry on this descriptive analysis of tax sub-optimization, we suggest a simple regression of the non-optimization status on basic characteristics. Results are reported in Table 2.3. The first two columns focus on our baseline sample (we have obtained very similar results using PO and POU samples, and we simply provide specific comments below in case of significant differences). Consistently with the risk of choosing 'equal split' in the case of an even number of children (as documented in Table 2.1), families with two and four children have a significantly larger probability of making an optimization error overall, or a large error in particular, relatively to the omitted group (i.e. those with one child). The age of the older child seems to be a good marker of a couple's duration and, hence, its chances of reaching efficiency through cooperation and coordination. It also corresponds to the time during which the cohabiting couple faces an optimization problem in terms of child allocation, hence the time to learn about tax rules or the possibility to simulate tax liabilities under different allocation scenarios. Controlling for parents' age and the number of children, the older child's age is indeed correlated negatively and significantly with the probability of missing the optimal allocation. Maybe counter-intuitively given the previous argument, older couples are more likely to be inefficient overall (but not to commit large errors). The chances of optimization error increase with the couple's income, essentially because low-income couples correspond to more salient situations (the wife is more frequently out of the labor market in poorer households while her partner is tax liable only if the children are not allocated to him). The probability of large errors, on the other hand, is decreasing with income, which may be related to the fact that rich families tend to more systematically optimize their finance. Another source of tax optimization is, for cohabiting couples, the option to enter a civil union. As said, it allows them to benefit from the tax treatment of married couples without the need to get married. We find that those who would gain much to do so, and do not, are also more likely to sub-optimize child allocation.

Table 2.3 – Profile of the Non-Optimizers

Table 3: Profile of the Non-Optimizers

	Binary Dependent:		Binary Dependent (sample with education var.):	
	Non-optimizer	Non-optimizer (loss >1%)	Non-optimizer	Non-optimizer (loss >1%)
# children: 2 (ref: 1)	0.0580***	0.0530***	0.0519***	0.0526***
	(0.0043)	(0.0026)	(0.0055)	(0.0032)
# children: 3 (ref: 1)	-0.0249***	0.0302***	-0.0324***	0.0258***
	(0.0082)	(0.0058)	(0.0101)	(0.0069)
# children: 4+ (ref: 1)	0.0797***	0.0957***	0.0969***	0.1045***
	(0.0118)	(0.0099)	(0.0155)	(0.0136)
Age of older child	-0.0048***	-0.0033***	-0.0050***	-0.0040***
	(0.0008)	(0.0004)	(0.0010)	(0.0006)
Mean age of parents / 100	0.3277***	0.0048	0.2592***	0.0284
	(0.0469)	(0.0246)	(0.0522)	(0.0311)
Annual income	0.0851**	-0.1155***	0.3351***	-0.1063***
	(0.0357)	(0.0087)	(0.0387)	(0.0114)
Squared annual income	-0.0040	0.0035	-0.0906***	0.0039
	(0.0121)	(0.0022)	(0.0282)	(0.0041)
Tax gain from marriage/civil union	0.2137***	0.2908***	0.1983***	0.2946***
	(0.0049)	(0.0040)	(0.0062)	(0.0051)
At least a Master degree: both parents			-0.1069***	-0.0453***
			(0.0122)	(0.0065)
At least a Master degree: the father			-0.1010***	-0.0502***
			(0.0124)	(0.0071)
At least a Master degree the mother			0.0131	-0.0010
			(0.0093)	(0.0050)
Constant	0.0495***	0.0349***	0.0215	0.0321***
	(0.0111)	(0.0067)	(0.0160)	(0.0089)
adjusted-R2	0.06	0.22	0.06	0.22
# obs.	51190	51190	32292	32292

Source: probit estimations using EDP data, 2013, and authors' calculation of tax optimization. Sample of cohabiting biological parents of children under 18.

The last two columns show the result of regressions conducted on the smaller sample containing education variables. For the common set of covariates, these results are very comparable to those on the whole sample, despite the aforementioned bias towards small areas. In order to check for cognitive skills, we add education variables. It turns out that in couples where both parents hold a master degree or a PhD (or when the father holds these higher degrees), optimization errors are less frequent, which may relate to the ability of more educated couples to understand tax rules and optimize.[15]

15. Alternative estimations including a dummy for locality size – hence to account for the sampling

A detailed breakdown of the causes of inefficiency is beyond the scope of the present paper and would probably require experimental evidence. Nonetheless, we can provide suggestive evidence about potential cognitive biases (sub-section 5.2) and non-cooperative behavior (sub-section 5.3) in what follows, drawing from the discussion of section 3.

4.2 Transition patterns, Learning and Inertia.

We first present the transition patterns in terms of tax optimization behavior. We characterize transitions between 2013 and 2014 using panel information for those who remain cohabitants and experience, in both years, the problem of allocating children to two tax units.[16] To clarify the analysis, we focus on couples with a fixed number of children over the two years, which have only one optimal allocation in both years (this optimal allocation may change). The subgroup with these characteristics represents 24,514 households, i.e. a large enough group – even if more specific than the baseline – to derive interesting observations.

Transitions are reported in Table 2.4. We first distinguish optimizers and non-optimizers in 2013, which are in very similar proportions as in baseline results for POU (c.f. Table 2.1), namely 71% and 29%. The second column splits these groups according to whether the (unique) optimal allocation has changed over time or not. Reasons for a possible change comprise a change in earnings (due to events such as job loss, wage rise, retirement, etc.) and small tax reforms that have taken place between the two years.[17] We observe that only a minority of couples have experienced changes that are large enough to affect the optimal choice.

bias in this smaller sample – give similar results.

16. In other words, those who get married or enter a civil union in 2014 are not in the picture. If these new unions are seen as a form of tax optimization, and a reflection of cooperative behavior, then the characterization that follows concerns a slightly different group from our initial 2013 sample, i.e. a group by definition less likely to coordinate well.

17. These reforms include change in tax bands (i.e. an uprating of 0.8%, which is lower than wage inflation and hence may generate a little bit of 'bracket creep'), a change in the maximum tax relief due to the family ratio system (namely a decrease of p from 2000 to 1,500 EUR per half fiscal shares) and a small change in the tax credit mechanism that benefits to couples with low tax liability (décote fiscale).

Table 2.4 – Transitions for Demographically Stable Couples (Only One Allocation is Optimal each Year)

Choice in 2013	Optimal allocation in 2014 compared to 2013	Choice in 2014	
		Optimize	Do not optimize
Optimize (17,382; 70.9%)	Has changed (2,420; 14%)	494 (a) 2.0%	1,926 (b) 7.9%
	Stays the same (14,962; 86%)	**14,692 (c) 59.9%**	270 (d) 1.1%
Do not optimize (7,132, 29.1%)	Has changed (2,221; 31%)	1,855 (a*) 7.6%	366 (b*) 1.5%
	Stays the same (4,911; 69%)	413 (c*) 1.7%	**4,498 (d*) 18.3%**
		71.2%	28.8%

Transitions between 2013 and 2014, using EDP data and authors' calculation on tax optimization. Sample of cohabiting biological parents of children under 18, with stable demographics (number of children), potential optimizers with only optimal allocation in each year.

Then, we study the optimizing behavior in 2014. The proportion of non-optimizers is similar as in 2013 (28.8%). The different cells in the last two columns suggest a breakdown across the different situations (all frequencies sum up to 1). The largest groups are composed of couples whose unique optimal allocation has not changed over time and who remain optimizers (group c, 59.9%) or non-optimizers (group d*, 18.3%). By definition, all couples in group c make the same decision upon child allocation as in the previous year. In group d*, 99% have also not changed their decision, so that inertia may play a role, in addition to the cognitive biases or non-cooperative behavior that explained non-optimization in 2013 and may persistently explain it in 2014. Non-optimizers represent 23.4% of the group c+d* characterized by stable optimal and actual allocations: this intertemporal rate of inefficiency shows only a small improvement compared to the static rate for 2013 (29%).

Two other cells with constant optimal allocations concern those who change their child allocation and, hence, for whom we expect a majority of learners (it may be learning on how to optimize tax or how to improve cooperation/coordination in their couple's decisions overall). This indeed the case, as the proportion of those switching to optimization (group c*) is much larger than those moving opposite direction (group d).

There is a much larger group with these patterns of transitions – learning or deteriorating – in the case of a change in the optimal allocation (groups a* and b). In this case, the numbers of transitions each way are relatively similar because both groups a* and b are 'involuntary movers': both are actually composed at around 98% of couples who did not update their child allocation between the two years while the optimal allocation has changed. Group a* who seems to improve in 2014 may have just experienced lucky inertia or may have been close enough to the right allocation in 2013 while it now fully optimizes in 2014. Additional calculations indeed show that the average fiscal loss of group a* in 2013 was much smaller than the average loss. [18]

5 Noncooperation

We finally check whether the lack of cooperation possibly revealed by tax inefficiency is associated with specific time trends in marital status. As discussed in section 4, it is expected that non- cooperative couples tend to marry less and to separate more. We start from our initial sample of potential optimizers in 2013 (45,411 observations) and check their marital transition between 2013 and 2014, i.e. whether each couple has stayed unmarried, got married, got in a civil union or separated. Since only large non-optimization losses may reveal non-cooperative behavior, we focus on losses above 1% of income (the basic non-optimization definition does not yield results that are as compelling as what follows).

We find that the rate of new marriage in 2014 among those who optimized in 2013 is 10% larger than among those who did not optimize, while the rate of separation is 32% lower. To go beyond basic statistics, and to control for household characteristics that could possibly affect these trends, we estimate a multinomial logit with the four categories

18. Similarly, group b seems to deteriorate but may have experienced unlucky inertia or switched from optimization in 2013 to a slight sub-optimization in 2014. Additional calculations show that the fiscal losses of group b in 2014 was also a bit smaller than average. Note also that those who face a new optimum and need to make a change to reach it (a and b*) are the counterparts of the two main groups (c and d*) but cannot benefit from lucky inertia. The former (a) are optimizers who adjust their choice to the new optimum. The latter (b*) constantly opt for a suboptimal allocation: among them, 75% are subject to inertia but not a lucky one (their choice is suboptimal in both years).

of transitions in marital status between 2013 and 2014 (the omitted category is status quo). We control for the basic covariates previously used in the profile of non-optimizers. Remember that we conduct these estimations on the PO sample but sensitivity analyses are discussed hereafter.

Results in Table 2.5 are striking, even if merely suggestive and descriptive: being non-optimizer in 2013 is associated with significantly higher chances of separation in 2014 and significantly lower probabilities of marriage or civil union. The table reports marginal effects: the change in marital status probability corresponds to 0.6 percentage points in the case of separation, -0.9 points for marriage and -0.6 points for entering civil union. Other variables are interesting. Larger families tend to get married more than those with one child but not to get a civil union. Couples' duration (as proxied by the age of the older child) is associated with higher chances of separation and lower chances of getting in a civil union. Richer couples seem more stable as they tend to separate less and marry/unionize more. The existence of a fiscal gain from marriage/civil union has an effect on all transitions other than the status quo, but it is especially large for the chances of getting a civil union and, to a lesser extent, of getting married.

Sensitivity checks are reported in Table 2.C1 in the Appendix. We alternatively use the baseline selection, the subsample of PO (i.e. the baseline estimates from Table 5), the nested sample of POU: all three samples yield similar results. Then we focus on the smaller sample containing education variables, which we now control for. Estimates lead to the very same conclusions. The last row shows the regression where we vary the non-optimization definition and lower the loss level at 0.5%, i.e. non-optimizers are those who loss more than 0.5% of annual income. The correlation with marital transitions is arguably smaller (and become insignificant in the case of marriage) but points to the same type of interpretations.

Table 2.5 – Correlation between Change in Marital Status in 2014 and Non-optimization in 2013)

Sample	# obs	Covariate of interest	Controls	Prob. of Separation	Prob. of Marriage	Prob. of Civil Union
Baseline selection	50424	Loss > 1% of income	Baseline	0.005 * (0.003)	-0.010 *** (0.003)	-0.008 *** (0.002)
Potential Optimizers	45,191	Loss > 1% of income	Baseline	0.006 ** (0.003)	-0.009 *** (0.003)	-0.006 ** (0.003)
Potential Optimizers with a Unique optimal allocation	42269	Loss > 1% of income	Baseline	0.006 ** (0.003)	-0.010 *** (0.003)	-0.006 ** (0.003)
Potential Optimizers, subsample with education	29,284	Loss > 1% of income	Baseline + education	0.005 * (0.003)	-0.013 *** (0.004)	-0.007 ** (0.003)
Potential Optimizers	45,191	Loss > 0.5% of income	Baseline	0.004 ** (0.002)	-0.003 (0.002)	-0.004 * (0.002)

Multinomial Logit estimation of change in marital status between 2013 and 2014, using EDP data and authors' calculation on tax optimization. Sample of cohabiting biological parents of children under 18. We report only the coefficient on the non-optimization status in 2013, defined as misallocation of children to tax units resulting in a loss > 1% or 0.5% of household income. Baseline controls as in Table 5. Std. Err. in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

6 Conclusion

We suggest a direct measure of cohabiting couples' inefficiency for a repeated decision that affect the budget constraint, namely tax optimization via the optimal allocation of children to tax units. We find a non-negligible fraction of non-optimizers in both years (29.1% in 2013 and 28.8% in 2014). We find traces of heuristics (like equal split, when the number of children is even, or putting all children on the main earner). The portrait of non-optimizers shows that durable couples tend to allocate children more optimally while those who sub-optimize in other domain (e.g. do not enter a civil union while they would gain much from it) tend to misallocate. There is little learning and much inertia: 81.8% of the couples stay in the same optimization status over both years (61.9% optimizers, 19.8% non-optimizers). When the optimum is stable, persistence is even higher, with 96.6% of stable statuses (73.9% optimizers, 22.6% non-optimizers) – in the remaining 3.7%, a majority (60%) seems to learn, i.e. start to optimize. When the optimum changes, the transition pattern reveals a majority of new situations of optimizations (40%) or of non-optimization (41.5%), which again reflects inertia because most couples do not change their choice and hence get lucky or lose the optimum (in both cases, they gravitate close to the Pareto frontier as fiscal loss is minimum). Finally, we find that large inefficiencies in 2013 are associated with higher moves towards separation (and lower transitions towards marriage or civil union) the following year. This is suggestive evidence of the role of non-cooperation as a primary mechanism for tax inefficiency.

Further work should look at the dynamic over several years in order to check if inefficient couples eventually improve upon learning or cooperation and eventually achieve efficiency. To decipher the mechanisms at work in the group of inefficient couples, new research could suggest experiments with real couples or with pairs of individuals, playing tasks that mimic real-world decisions regarding tax filling and a (productive) allocation problem (see the lab-in-the-field experiment of Apedo-Amah et al. (2017) , regarding productive decisions upon resource allocation in the context of a poor country).

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Appendix

2.A Descriptive Statistics

Table 2.A1 – Descriptive Statistics

Marginal Effects	Prob. of Separation	Prob. of Marriage	Prob. of Civil Union
Large non-optimization (a)	0.006 **	-0.009 ***	-0.006 **
	(0.003)	(0.003)	(0.003)
# children: 2 (ref: 1)	-0.002	0.012 ***	-0.003 *
	(0.002)	(0.002)	(0.002)
# children: 3+ (ref: 1)	-0.002	0.016 ***	-0.010 **
	(0.003)	(0.003)	(0.004)
Age of the older child	0.001 **	0.000	-0.002 ***
	(0.000)	(0.000)	(0.000)
Mean age of parents	-0.0004 ***	-0.002 ***	-0.001 ***
	(0.000)	(0.000)	(0.000)
Annual income (c)	-0.003 ***	0.003 ***	0.005 ***
	(0.001)	(0.001)	(0.000)
Income diff. between partners (c)	0.002 ***	0.000	-0.003 ***
	(0.001)	(0.001)	(0.001)
Tax gain from marriage/civil union (b)	0.003 *	0.007 ***	0.014 ***
	(0.002)	(0.002)	(0.002)

Multinomial Logit estimation of change in marital status between 2013 and 2014, using EDP data and authors' calculation on tax optimization. Sample of cohabiting biological parents of children under 18 and who are potential optimizers in 2013 (i.e. exclude those for whom all allocations are optimal). All the covariates refer to the situation in 2013 (non-optimization, family composition, etc.). # obs: 45,411. Std. Err. in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

(a) Dummy =1 if large non-optimization (i.e. misallocation of children in tax returns leads to a loss larger than 1% of household income).

(b) Dummy =1 if marriage or entering a civil union would lower the couple's tax liability.

(c) Income variables are deflated by 10,000

2.B Distribution of Optimal Allocations by Family Size

Table 2.B1 – Distribution of Optimal Allocations by Family Size

	Baseline sample	Sub-sample with education	Difference	p-value
Taxable income	35,406	35,439	-34	0.841
	(25,692)	(19,234)	(156.05)	
Taxable income - father	20,589	20,652	-63	0.607
	(19,456)	(12,981)	(112.31)	
Taxable income - mother	14,816	14,787	29	0.742
	(13,441)	(11,068)	(85.57)	
Age - father	35.0	35.3	-0.3	0.000
	(7.0)	(6.8)	(0.05)	
Age - mother	32.7	33.0	-0.3	0.000
	(6.4)	(6.2)	(0.04)	
Number of children	1.56	1.58	-0.02	0.000
	(0.71)	(0.69)	(0.00)	
Mean age of children	3.7	4.0	-0.2	0.000
	(3.2)	(3.2)	(0.02)	
Age of the oldest child	4.5	4.8	-0.3	0.000
	(3.69)	(3.67)	(0.03)	
Age of the youngest child	3.0	3.1	-0.2	0.000
	(3.06)	(3.08)	(0.02)	
# obs.	51,190	32,292		

Sources: EDP data, 2013, and authors' own calculation

2.C Marital Status Change and Large Non-Optimization

Table 2.C1 –
Marital Status Change in 2014 and Large Non-Optimization in 2014:
Sensitivity Analysis

Number of children	Number of optimal allocations							Group size	Group size (%)
	1	2	3	4	5	6	7		
1	0.886	0.114						27,316	0.534
2	0.810	0.090	0.101					20,411	0.399
3	0.607	0.144	0.106	0.143				2,399	0.047
4	0.298	0.175	0.160	0.120	0.248			909	0.018
5	0.146	0.098	0.268	0.122	0.024	0.342		41	0.001
6	0.076	0.047	0.057	0.170	0.151	0.160	0.340	106	0.002
Group size	42,470	5,457	2,466	478	242	33	36	51,182	1.000
Group size (%)	0.830	0.107	0.048	0.009	0.005	0.001	0.001	1.00	

Source: authors' calculation using EDP data, 2013. Sample of cohabiting biological parents of children under 18. The number of possible allocation is "number of children + 1". Hence, the sub-sample of 'potential optimizers' (those for whom not all allocations are optimal) excludes the diagonal (in blue). We will also consider the sub-sub-sample of `potential optimizers with one optimal allocation' (i.e. those in the first column).

Chapter 3

Rich households taxable income and lowerings of the child tax break ceiling:

A French natural experiment.

This chapter evaluates the taxable income behavioral reactions of French high-income households to a tax change. I focus on a 2013 tax reform creating a unique framework that allows controlling for position in the income distribution. With this framework I temperate the *mean reversion bias* and the *change in the distribution bias* usually associated with the assessment of elasticities with panel data. I can do so because the reform treats differently households based on income but also family composition. The analysis is conducted with a recently released big administrative panel dataset. I run a *triple-difference* regression on the change in taxable income depending on the group an high-income household belongs to: the untreated (no effect), the ones facing only a change in their disposable income (pure income effect), and those facing a change in marginal tax rate and disposable income (income and substitution effect). Quite surprisingly and contrasting with the rest of the literature, I find that the income effect strongly dominates the substitution effect, that women react less than men, and that a significant part of the effect is driven mainly by workers nearing retirement by reacting on the extensive margin.

1 Introduction

The question of households behavioural responses to income taxation is central for the public debate as it determines the magnitude of the potential redistribution a society can have.

Behavioral reactions linked to changes in the income tax function is subject to a wide range of estimates and faces numerous methodological issues. As modifications of the tax schedule applies to a certain part of the income distribution, there is thus no available counterfactual as a tax-unit with same income characteristics as a tax-unit facing a tax change will also face that tax change. The tax rate being determined by the taxable income, and the taxable income one will choose being determined by the tax rate, both the tax rate and the tax base being determined simultaneously, the analysis will thus be always constrained by an endogenity issue.

An other challenge is to decompose behavioral reactions between income effect and substitution effects. In the labour demand framework, an increase in the marginal tax rate (MTR) of an individual can have two immediate effect : i) the price of leisure decreases with respect to consumption, ii) the disposable income of the individual will be lower. As the relative price of leisure decreases, the individual faces an incentive to substitute disposable income (by working less) and consume more leisure, this effect is known as the substitution effect. The decrease of the disposable income causes the individual to want to work more since the marginal utility of money will be higher than previously. This effect is known as the income effect/ These two effects are usually difficult to disentangle as a change in MTR also affect (if not at the very beginning of the tax bracket) her disposable income. It is indeed possible to have variability between tax-unit at the beginning of a tax bracket, but when assessing the change in taxable income the impact in change of disposable income is small compare to the change in net-of-tax rate (1-MTR). Moreover, the identification issue is still present as tax-units at the beginning of a changing tax-bracket (with a small variation in disposable income) cannot be directly compared to richer tax-units (with a large variation in disposable income) as the substitution and income effect is not necessarily the same between those two groups.

The motivation of the article is to solve those issues for households by relying on a specific reform of the French tax system.

The behavioural response of tax-units such as households and invidividuals relative to income taxes has been studied extensively studied, both from a theoretical and from an empirical point of view. The preferred empirical method consists in estimating elasticities of income with respect to the net-of-tax rate. Both the labour economics and the public finance literature rely on this method.

Those two large fields had been extensively surveyed by Blundell and MaCurdy (1999), Keane (2011) in the labor literature and Saez et al. (2012) for the taxation literature. Both report estimates that vary substantially in magnitudes between studies. They generally conclude that individuals do not react to income taxes, to the exception of married women with children. [1]

The two strands of literature address differently the endogeneity issue. The labor literature usually relies on structural assumptions on tax-units utility functions, and the tax literature usually relies on difference-in-differences setting and uses different types of instrument to solve the endogeneity issue.

The approach taken by the labor literature is to make assumptions on the utility function and then calibrate a static model given those hypotheses and as a consequence tackle the endogeneity issue. One of the possible problems with those models, as shown by Bargain and Peichl (2013), is that the evaluation of the labor response is very sensitive to modeling choices. [2]

The difference-in-differences approach taken in the tax literature exploits changes in tax schemes to evaluate net-of-tax rate elasticities of taxable income. This literature is known as the Elasticity of Taxable Income (ETI) literature. The endogeneity is tackled with the predicted net-of-tax income in the absence of tax reform as an instrument. However instrumenting with the counterfactual income tax leaves two sources of bias: the *change-in-the-distribution bias* and the *mean reversion bias*. These two sources of bias have been defined precisely in Weber (2014).

The change-in-the-distribution bias reflects the fact that the part of the distribution that is concerned by a modification of the tax schedule may be on a different trend, that is not due to the tax reform. The solution to this issue proposed by Auten and Carroll (1999) is to introduce base-year income controls, and the common practice is to do so by introducing income splines (or other types of income polynomials). However, this control

1. However Blau and Kahn (2007), and Heim (2007), shows that there exist a trend in women's labor elasticity which is decreasing in the US, and for which estimates are becoming very close to those of men, and the conclusion made on women's behavior up to the beginning of the years 2000 may not hold anymore.

2. Bargain and Peichl (2013) shows that previously used continuous labor supply models Hausman (1981) leads to higher elasticities estimates compared to more recent and new standards discrete-choice models. Löffler et al. (2014), show that the discrete-choice models are highly sensitive to changes in the underlying predicted-wage distribution.

threaten identification by absorbing much of the independent variation in tax rates. It implies that estimating elasticities based on one tax reform (only two years of data) is not feasible. Elasticities must thus be assessed over multiple tax reforms to have the necessary variability between position in the income distribution and tax reforms impacting different positions in the income distribution.

The reversion of the mean phenomenon accounts for the fact that households can have unusually low or high incomes in a period. This can be due to changes such as job-loss that are not related to any change in the tax incentive scheme. If I select households based on their position in the pre-reform income distribution before, the resulting estimates will be biased. For instance, individuals that lose their jobs (unrelated to any tax change) that were on the income tax bracket that had an increase in its MTR will be seen as reacting strongly to the tax reform and will thus induce an upward bias in the assessed elasticities. The inverse reasoning is valid for top income earners that had exceptional income (e.g. independent traders). Weber (2014) defines mean reversion effect as a transitory income that impact income independently of any behavioral reaction and is a noise of mean 0 that is applied to t-1 income. Several solutions have been proposed by the literature to control for such effect, Auten and Carroll (1999) did so by trimming the sample (but Kopczuk (2005) shows that the estimations are very sensitive to the choices made), Gruber and Saez (2002) did so by including income splines but it mixes assumptions about what is due to change in the distribution and mean reversion, Weber (2014) propose to take several years of lag to capture the variance in income, Kopczuk (2005) use log income spline both on income and on transitory income.

Gruber and Saez (2002) introduced a methodology to disentangle substitution effects and income effects by introducing an income effect parameter in their estimation. They find that the income effect is negligible, suggesting that the compensated elasticity is equal to the uncompensated elasticity. As a consequence most studies only report the uncompensated elasticity.

In this article, I implement on the following identification strategy. I use a triple-difference setting of the variation of taxable income. I rely on a large administrative panel dataset recently enriched with fiscal data. The triple-difference setting relies on a specificity of the French taxable income. France has a very particular tax-system that embeds a so-called *family ratio scheme* mechanism (Quotient Familial). The family ratio scheme mechanism divides the taxable income of a fiscal-household before applying it to the piecewise linear

tax scheme.[3] Such a characteristic leads some households earning the same income to have different MTR due to different family compositions. Piketty (1999) emphasized that fact, and leads him to propose a triple-difference estimator that allows the estimation of the households elasticity by controlling not only for the trend associated to a specific family composition but also the trend associated to a specific location in the income distribution to assess the eslasticities. The family ratio scheme mechanism embodies a triple-difference framework in its inner nature. Any modification of the income tax scheme will impact households differently based on their family composition, and being impacted is thus conditional to a specific location in the income distribution. As many studies rely on that specific characteristic of the French income tax to use an extra source of variation to identify some effect,[4] I am not aware of other studies (excluding the one of Piketty) that relies on a triple-difference estimator.
What I propose is a bit different, instead of working with elasticities I will work on the absolute variation of the taxable income. I will focus on a tax reform that has a very particular property. This tax reform will create three separated groups, a group that is unaffected by the tax reform, a group that faces an increase in MTR. An increase in MTR corresponds to an increase in the relative price of consumption with respect to leisure, which would induce both a substitution and an income effect. If a household works less, the income effect dominates, if a household work more the income effect dominates. The third group faces a lump sum increase in their income tax, and will thus generate a *pure income effect*. That specific structure of the reform will allow evaluating the mean impact on the reform in absolute value. That income tax reform affected only the last decile of the income distribution, which represents households earning more than 72 000 €. I am focused on the group of households earning between 50k€ and 200k€ who are married couples or couples under civil union (PACS).

The empirical analysis leads to three main results. First, there are very large income effects for households concerned by a lump sum increase in income tax. For households facing a change in MTR, the income effect dominates the substitution effect to the exception households impacted by the tax reform at the very top of the income distribution, which happened to be those with five children or more. Second, the behavioral reaction of men is greater than the one of women, both at the extensive or intensive margin. Third, older households reacts more on the extensive margin by delaying their retirement date.

3. A comprehensive review of that mechanism can be found in Carbonnier (2016) (in French)
4. Carbonnier (2014), Cabannes et al. (2014) , Carbonnier et al. (2014), Sicsic (2018)(mimeo)

This article contributes to the litterature by providing a clear quasi-natural experiment to assess the income effect linked with a change in income tax and by showing large income effect associated with a tax reform. It is also the first to exploit the triple-difference setting with individualized pannel data (as Piketty (1999) did it with aggregated data). The paper is organized as follows. Section 1 presents the Institutional background and the implications of the tax reform on household's disposable income. Section 2 presents the empirical approach. Section 3 presents the results. The final section concludes.

2 Institutional Background

The reform I use is a lowering of the maximum fiscal gain per child implied by the quotient familial. Roughly speaking that lowering implied that the annual maximum tax reduction implied by the 2 first children dropped from 2336 euros to 1500 euros per child, and from 4672 to 3000 for the third child and above. In order to have a more precise explanation of the reform, I feel that I have first to explain the joint taxation mechanism used in France (the "quotient familial").

The family ratio scheme (FQ) ("Quotient familial" in French) is a mechanism that decreases the tax base amount. For a single without child the income tax function is:

$$T_i(y) = t(y_i),$$

where t is a piecewise linear function, y is the income that constitutes the tax base. For different familial structure, the tax function is:

$$T_i(y_i, s_i) = t\left(\frac{y_i}{s_i}\right) \times s_i$$

where s_i is the number of fiscal share with respect to the structure of the fiscal household. The action of dividing the taxable income by s_i before applying the linear function, the re-multiplying the output by s_i constitutes the FQ mechanism. It is the core of the joint taxation system in France.

Table 21 – Number of fiscal shares
for a married couple or a couple under civil union

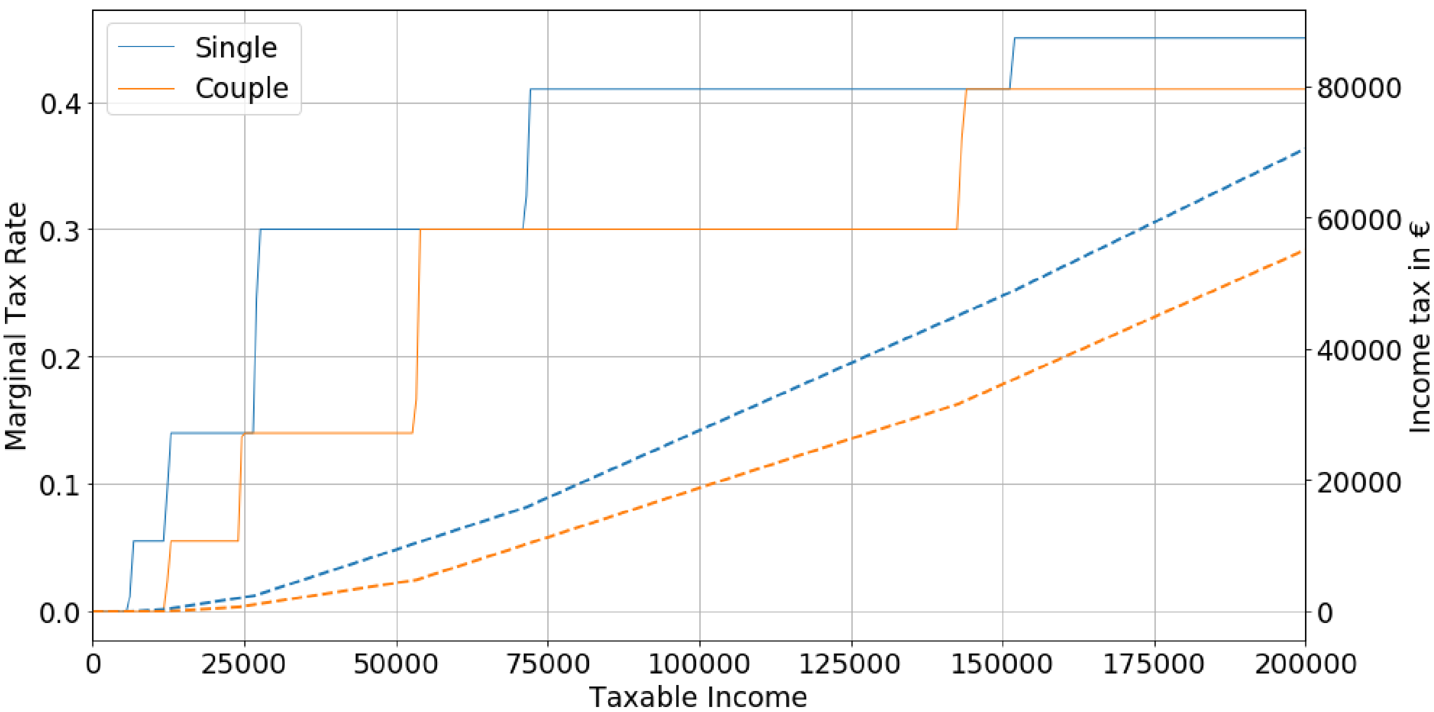
Number of children	Fiscal Shares
0	2
1	2.5
2	3
3	4
n children ($n \geq 4$)	1+n

Table 21 shows the number of fiscal share per number of children, one should note that the number of fiscal shares is half a fiscal share for the two first child, and one full fiscal share starting at the third child and over. As married couples and couples under civil union face exactly the same fiscal reform and that no difference is made in the analysis, I will, when writing about married couples imply the it is for not only married couples, but also for couples under civil union.

Such a mechanism implies that each bracket of the marginal tax rate (MTR) scheme of a fiscal-household that has n fiscal shares is n times larger than the MTR of the single with one fiscal share. As the total income tax is the result of the integral of the MTR scheme, the fiscal gain derived from children is the difference between the integral of the MTR scheme of a couple without children and the integral of the MTR of the couple with n child.

Figure 21 illustrate that fact by comparing single individuals and married couples income taxes.[5]

Figure 21 – French income tax for a single and a couple



Plain lines represent the marginal tax rate (left scale), I see that for the global income of the household, each tax bracket of the couple is twice the size of the single, including the zero (or exemption) tax bracket. Dashed lines (right scale) represent the income tax liability. The first tax bracket that has a MTR of 5.5% starts at 5,963 €, while it starts at 11'926 € for married couples. The second tax bracket (14% MTR) starts at 11'896 € for the single while it only starts at 23 792 € for the married couple.[6] The span of

5. This graph has been generated with the microsimulation software OpenFisca, the code used to produce all the graph in this article can be found at `www.github/adrienpacifico/qf_lowering`.

6. $27792 = 5963 * 2 + (1896 - 5963) * 2$

the first bracket is thus of 5'933 euros for a single, 11'866 € which is twice the single tax bracket span size.

Fiscal gain to children: Following the previous reasoning, tax brackets of a couple with children will be larger than the one of a couple without child.[7] As the total income tax function is the integral of the MTR function, the fiscal gain to of n children is simply the area between the marginal tax rate of a couple and the marginal tax rate of a couple with n children.

Figure 22 – French income tax for a couple wiithout children, and a couple with one child

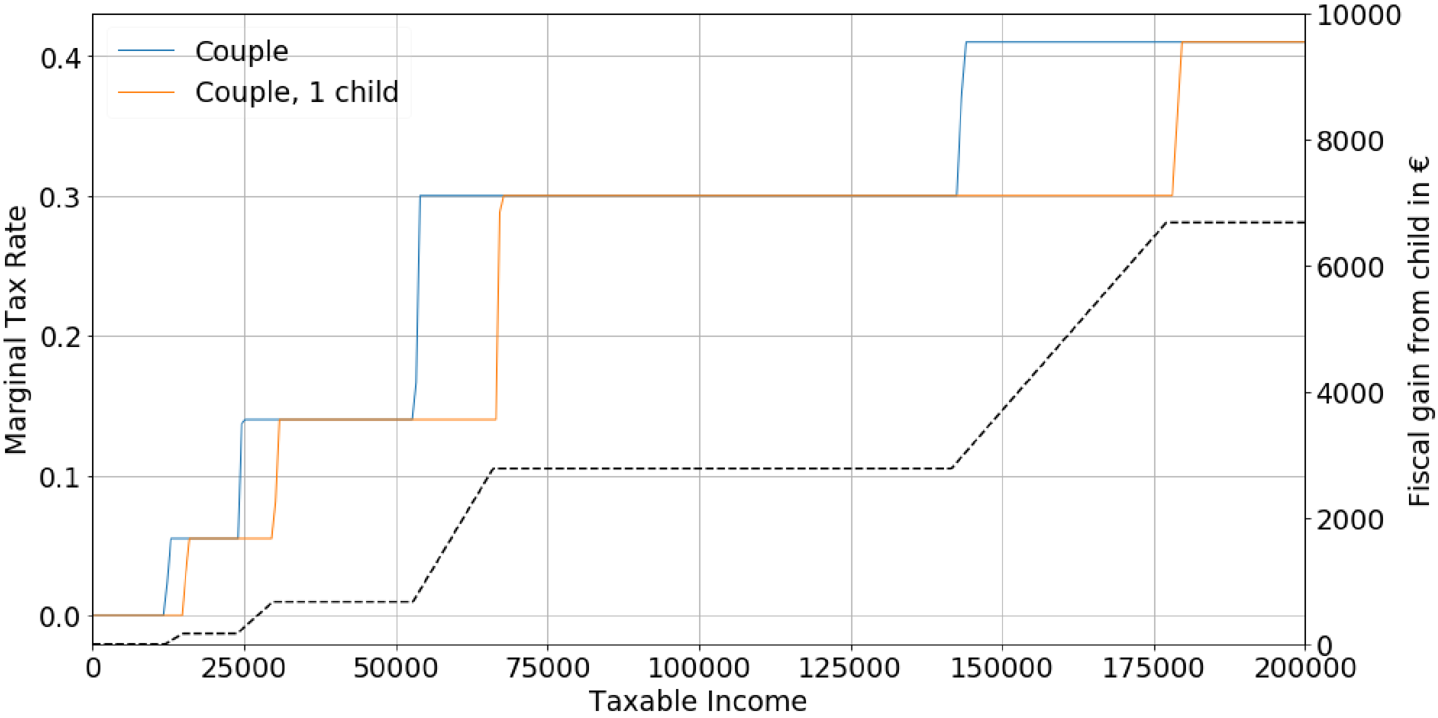


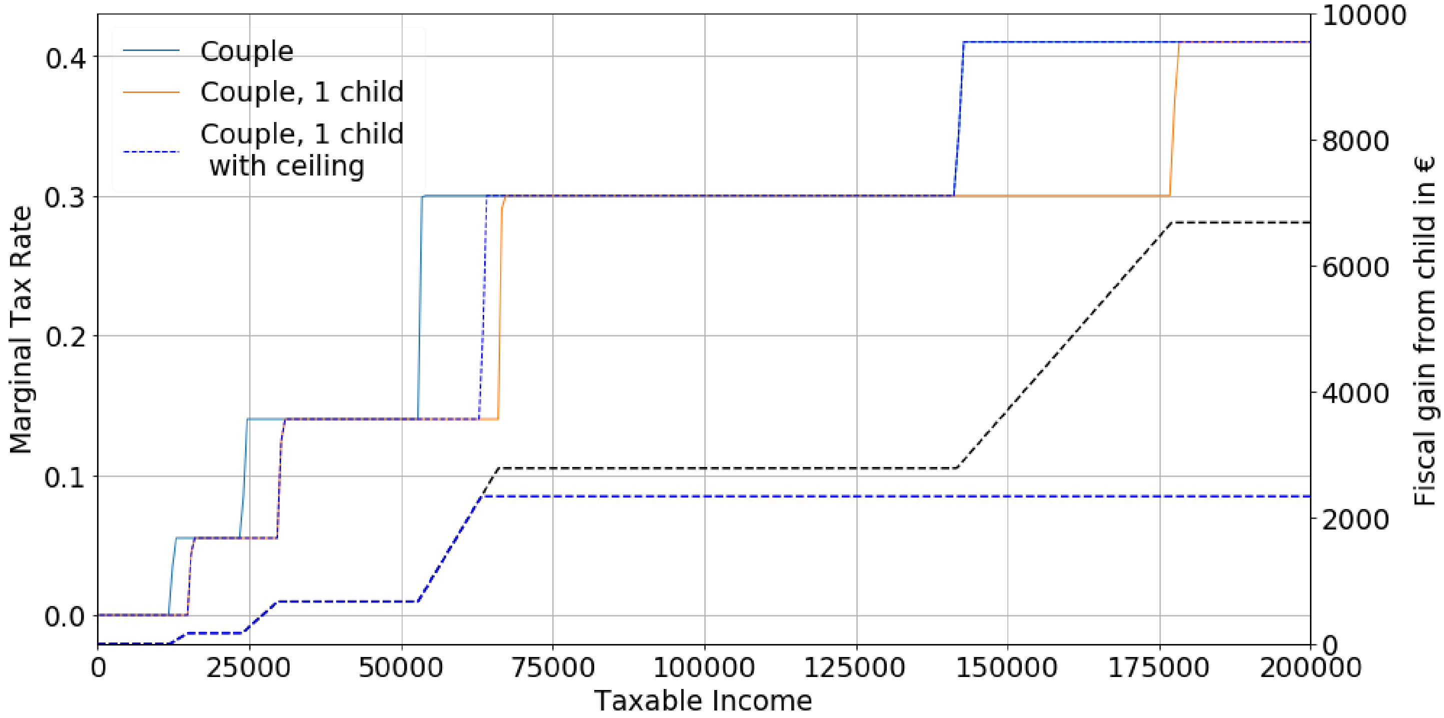
Figure 22 shows in plain line the MTR for a couple and a couple with one child. I see that each tax bracket is 1.25 times larger. The fiscal gain that is derived from the child is simply the area between the two MTR curves.[8] The dashed line represents the fiscal gain due to the presence of a child in a fiscal household. I clearly see that the fiscal gain increases only when the two marginal tax rates are not the same, i.e. when the family ratio scheme put the household on a lower tax bracket.

However as the children tax break can be very large as the number of children increases, the fiscal gain per half fiscal share is however bonded by a ceiling.

7. 25% larger for one child, 50% for two, twice larger for three, and $\frac{n+1}{2}$ times larger for households with $n \geq 3$ children. This is just the result of the ratio $\frac{\text{Number of fiscal shares with children}}{\text{Number of fiscal share without children}}$.

8. Or more specifically the difference between the integral of the couple MTR and the integral of the couple with n child integral

Figure 23 – French income tax with the tax child break ceiling



This ceiling is a fixed amount per half fiscal share. That amount was of 2336 euros in 2011.

During its presidential campaign that started in March 2011, François Hollande who was seen as very unlikely to win the presidential campaign did not make any announcement about a possible change in the children tax break associated with the family ratio scheme. He won the left-wing primary election in October 2011, and it is only in January 2012 that he released a set of 60 presidential propositions where he made an ambiguous claim about a change in the tax break related to children. [9] In May 2012 he won the presidential election against former president Nicolas Sarkozy with 51.62% of the votes. It is only as late as in September 2012 that the reform of the threshold of the family ratio scheme has bee announced, then voted in December 2012.

The French income tax voted in December 2012 is applied to income earned during the year 2012 (the fiscal rules are thus known by the tax-payer after she has earned her income). As some anticipated behavior could have happened during 2012 about the lowering of the family ratio scheme reform, I claim that anticipation of the tax reform during the year 2011 is extremely unlikely: François Hollande was not seen as a potential winner of the presidential election before October 2011, the potential reform was not announced before

9. He stated "I'll leave unchanged all the resources allocated to the family policy. [...] I'll make more just the family ratio scheme by lowering its ceiling for richest households, which will concern less than 5% of the fiscal-households"

2012, and he only had a narrow victory.

I thus take 2011 taxable income as the pre-reform period. The reform consisted of lowering the family ratio scheme ceiling from 2336 euros to 2000 euros. A year after a new lowering of that threshold from 2000 to 1500 euros happened and was announced as a permanent reform. As the reform was announced in September 2013, to embody fully the effect of the reform I will take 2014 income as the post-reform year.

These two fiscal reforms have overall lowered the maximum child tax break ceiling from 2336 euros to 1500 euros, and in order to use a classical before and after the reform analysis, I will consider from now on that it constitutes a unique fiscal reform.

Figure 24 – Income tax wich maximum child tax break before and after the reform

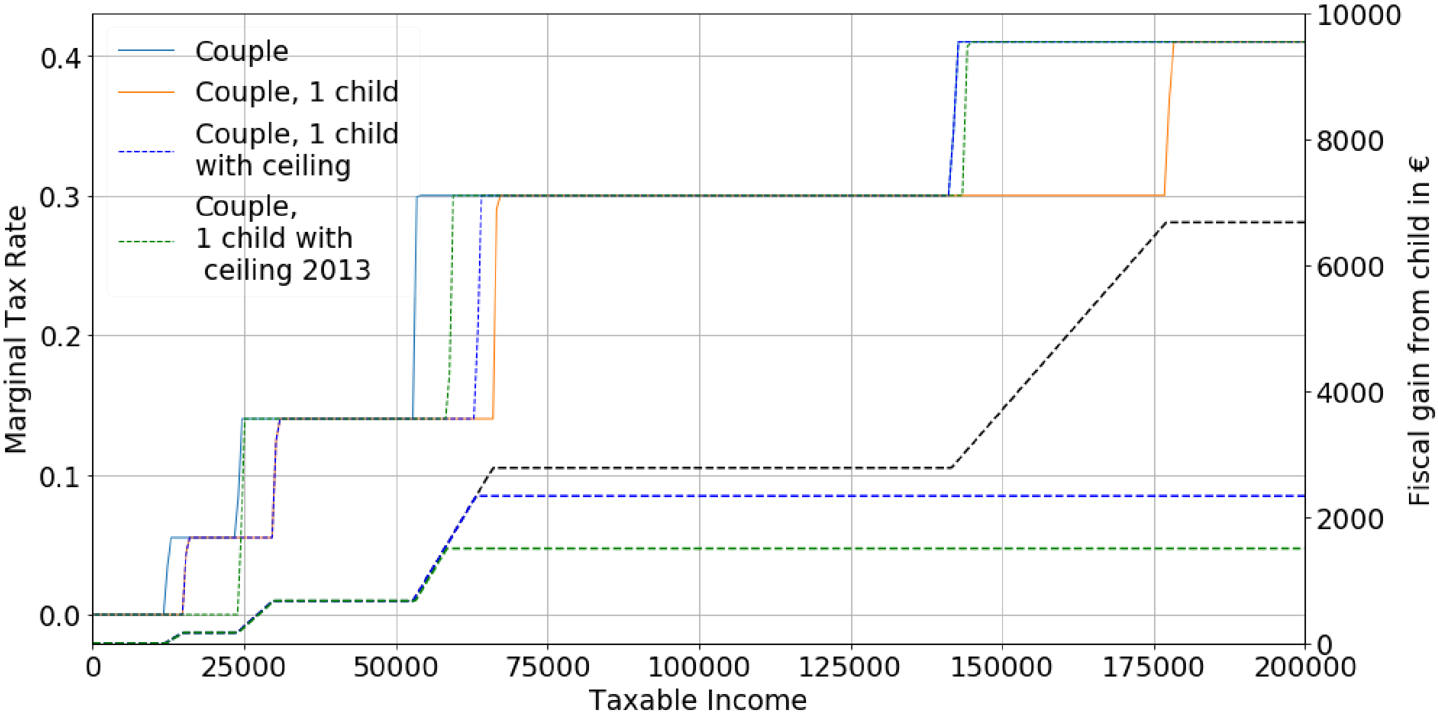


Figure 24 shows the ceiling before the reform, and after the reform: it limits the fiscal gain derived from children to 2336 euros in 2011 for couples earning more than 68 000 euros, and to 1500 euros in 2013 for couples earning more than 63 000 euros. What is important here is to see that the impact of reaching the ceiling, is that a household jumps to the marginal tax rate it would have face without children (here the 30% tax bracket). The consequence is that there exists an income threshold at which the 2013 ceiling constraint is saturated and a threshold at which the 2011 ceiling constraint is saturated. This threshold is different for each family composition.

Figure 25 – Qf advantage from 1 to 5 children.

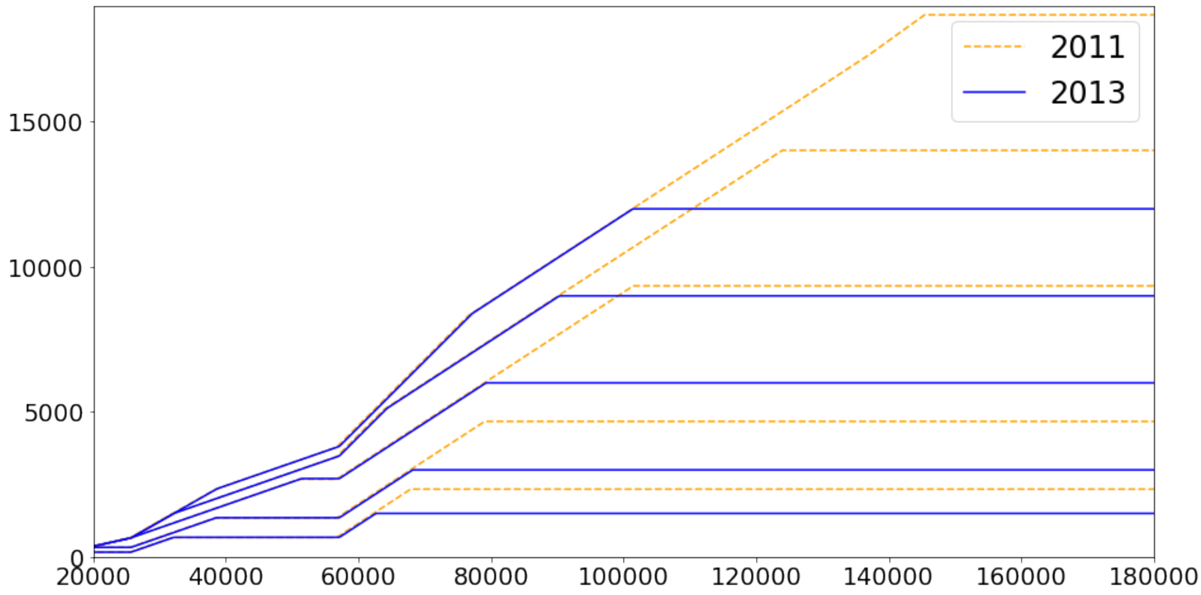


Figure 25 shows the children fiscal gain for families from bottom to top of 1 to 5 children. Households have been affected in three ways. Households for which the fiscal advantage per child was lower than 1500 euros are unaffected. Households for which the fiscal advantage per child was between 1500 euros and 2336 euros (or twice that amount over 3 children) face a change in their marginal tax rate. Households for which the fiscal advantage per child was over 2336 euros faced a lump sum loss in disposable income of 836 € per child. The maximum fiscal loss that households can have are far from negligible since it represents up to 1.2% of the disposable income of a family with one child, and respectively up to 2.2%, 3.4%, 4.1%, 4.8%, 5.4% respectively for households from 2 to 6 children. [10]

As the fiscal advantage increases with income, there exists an income threshold at which a household will attain the ceiling. This thresholds is specific for each family composition, and since the ceiling has been lowered between 2011 and 2014,

Table 22 – Income triggering FQ threshold based on taxable wage

Number of children	2011	2014	Span	Maximum Fiscal Loss
1	67,856	62,519	5,337	836
2	78,895	68,140	10,755	1672
3	101,426	79,166	22,260	3344
4	123,756	90,221	33,535	5016
5	145,188	101,272	43,916	6688
6	159,477	112,324	47,153	8360

10. see Figure 3.E1 in appendix.

Table 22 shows the location of those thresholds in 2011 and 2014. Fiscal loss is computed by multiplying the number of fiscal shares by the difference between 2336 and 1500 €. For a given family composition, households being below their 2013 threshold are unaffected by the reform. Households being between 2013 and 2011 thresholds face a change in their marginal tax rate. Households being over 2011 thresholds face a lump sum decrease in their disposable income.

One condition to evaluate correctly the impact of a reform is that it is not polluted by other reform taking place at the same time that concerns our population of interest. I am interested in the lowering of the family ratio scheme threshold, a first reform that could pollute our estimation are modifications in the piecewise linear tax scheme.

Table 23 – Piecewise linear tax scheme

	2011		2012		2013		2014	
	Rate	Threshold	Rate	Threshold	Rate	Threshold	Rate	Threshold
0	0	0	0	0	0	0	0	0
1	0.055	5,963	0.055	5,963	0.055	6,011	0.14	9,690
2	0.14	11,896	0.14	11,896	0.14	11,991	0.3	26,764
3	0.3	26,420	0.3	26,420	0.3	26,631	0.41	71,754
4	0.41	70,830	0.41	70,830	0.41	71,397	0.45	151,956
5			0.45	150,000	0.45	151,200		

Table 23 show the evolution of the marginal tax scheme over our period of interest. Two modifications have happened, the first one is the introduction of a new top tax bracket for single's tax-unit earning over 150 000 euros, and the second one is the suppression of the 5.5% tax bracket.

The introduction of a 45% tax bracket doesn't really concern our analysis because I focus on married couples earning from 50 to 200k€, their maximum equivalised taxable income will thus be 100k€ and are thus too poor to be concerned by that reform. Thus suppression of the 5.5% tax bracket has been concomitant to the decrease of the 14% tax bracket threshold, the resulting total impact for households that have an equivalised income of 11'896 euros or greater is of 18 €, [11] and represent a negligible amount of the disposable income of our concerned households (less than 0.01%).

Many other small modifications have taken place during that period (such as very small inflation adjustments of the income tax brackets), but always account for less than 0.02% of disposable income, and I thus choose to consider them as negligible. [12]

11. (11896-5963)*0.055 - (11896-9690)*0.14
12. An interactive graph that displays that information that is accessible at the following link :

Another tax reform that could cause a potential bias is a change of tax base for capital income that happened in 2013. [13] Luckily I have a specific variable for the specific income that was concerned by that tax scheme. [14] I ran the estimation with and without households that had income concerned by that specific tax regime in 2011, the results are all very similar and are provided in the appendix.

Even if the number of tax bracket changes over time, I can see that the 30% tax bracket starts, to the exception of small inflation adjustment, remains the same over the period. The impact of the reform mainly concerns households that will switch from the 14% tax bracket to the 30% tax bracket or that already were on the 30% and that faced a lump sum loss.

3 Empirical Approach:

To study the impact of the lowering of the maximum child tax break that happennend in 2012 and 2013 I use the **Echantillon Demographique Permanent** (EDP) the first release of which was in 1999 but that was enriched in March 2017 with new administrative data sources from which I use tax returns pieces of information and pay slips. The database contains over 2.47 million households in 2014 and 2.38 million households for the year 2011.

I choose to focus my analysis on married couples and couples under civil union as it is the most standard family composition in France. I thus select this population of interest and I am left with 1.19 million households and 1.16 million that I can observe in 2014 and 2011. There exist two forms of civil contract in France: civil partnership (PACS) and marriage. As there is no difference in the fiscal rules applied to married couples and couples under civil partnership, I will for a matter of convenience I refer to them as married couples.

Singles represent a smaller share of the population and the tax reform implies different thresholds and effect than the one that applies on couples, although the same methodology as the one that I apply on married couples.

Cohabitants are also less common than couples under civil union, the analysis of the reform on those couples would be more complex as cohabitants can choose to allocate their fiscal shares on one of the two fiscal units that compose the household. Moreover,

https://adrienpacifico.github.io/docs/bokeh_graph.html

13. The so called "fin du prélèvement forfétaire libératoire" reform.
14. ZIMPVALM in the database

even if that complexity is taken into account, the limitation in the number of concerned households would probably be too small to derive any conclusion.

From those, I end with only 812 000 households present in both years in the database. The attrition of the 350000 households has many factors such as the death of the taxpayers, dissolution of marriage, change of address and so on.

3.1 Data-Selection

Income Span When it comes to identifying behavioral income reaction to a tax change, the biggest challenge is that the level of income tax is determined by the income itself and the two variables are thus endogenously linked.

I assume that belonging to a specific income span implies to be treated by the reform. As it is usual to instrument the counterfactual MTR in the literature by running a 2SLS estimation, this method, however, needs to have access to more than two years of data with multiple tax reforms over the period.

As I want to analyze the impact of one tax reform I cannot do so.

There have been other tax reform that change the fiscal gain to children over the period, but none of them concerned households earning more than 50'000 euros. I then choose to limit the analysis to households earning less than 200'000 euros per year. First for those households well over the last percentile of the income, distribution the number of observations is small, second they are more likely to be able to do income shifting through many channels, third they are less impacted by the reform since for most households the impact of the reform is maximum for households earning less than 100'000 euros.

As emphasized by Kopczuk (2005), estimations are very sensitive to data-selection and data-trimming. As the estimation does not fully concerns the very end of the income distribution I am not upward bounded by the richest household of the distribution.

What I do is to select households that its taxable income located between 50'000 euros and 200'000 euros either in 2011 or in 2014. [15] By doing so I avoid the mean reversion bias. Indeed since I control for the position in the income distribution, differences in trends between high-income earners and low-income earners will be captured which will cancel out the change in distribution bias. By selecting households that were in the 50-200k euros range in either 2011 or 2014 I claim that I control for the remaining mean

15. To be fairly explicit a household earning 40k€ in 2011, and 55k€ in 2014 will be in the sample. A household earning 170k€ in 2011, and 220k€ in 2014 will be in the sample, a household earning 30k€ in 2011 and 45 k€ in 2014 will not be in the sample.

reversion. Indeed if households face reversion of the mean, by selecting households that were earning between 50-200k euros in 2011 or in 2014, since mean reversion is defined as mean zero shock at each period, if an household face an income shock unrelated to the tax reform that lead it to goes from 150'000 euros to 300'000 euros, it is euqually likely that an other household has an unrelated to the tax reform shock from 300'000 euros to 150'000 euros one I controlled for the position in the income distribution. Thus the effect of mean reversion will be canceled out.
If I selected households that were on the 50-200k income span only in 2011, households that have transitory shock that leads them to be above the 200k threshold will not be compensated by those who were earning more than 200k euros in 2011 but that has negative transitory income shock. This would lead to overestimating the impact of being over the 2011 maximum child tax break threshold.
The same reasoning can be applied to households that leave the 50-200k income span for an income lower than 50k euros. To one exception, taxable income is bounded and cannot be lower than 0. This would be a problem as it is not clear that households whose earning falls to zero would be canceled out by households that have income that goes from zero to income in the 50-200k range. To cancels out this problem, I trim the sample based on change in earnings such that no households get a null income in the sample. This leaves out 4% of the sample (2% at the top and 2% at the bottom).

I then take the taxable income present in the database at the tax-unit level and sum them to obtain taxable income.
For now on I will consider that the effect of the reform corresponds to a specific treatment. Households that did not face a change in their income tax are untreated. Households for which the two thresholds are treated with Treatment 1, and the treatment is a change in MTR. And households that are over the 2011 threshold are treated with Treatment 2, and they face a lump sum loss in their disposable income.
The repartition of households in those three groups is reported in Table 31.

Table 31 – Number of concerned households

Number of children	Treatment 0	Treatment 1	Treatment 2	Total
0	43960	0	0	43960
1	16110	3324	11638	31072
2	49720	11142	20033	80895
3	21930	4747	5084	31761
4	3571	774	651	4996
5	578	113	42	733
6	159	18	5	182
Total	136028	20118	37453	193599

I see that the non-treated represents 193599 households which represent 56% of the sample. Households facing a change in MTR represent 20118 households (14% of the sample), and households that face a lump sum change represents 37453 households (28% of the sample). I see that the number of households 6 children in the first treatment is of 18 households and only 4 in the second treatment. Such small numbers would likely leads the estimates to be driven by outliers or be subject to micronumerosity/partial colinearity and should be taken with caution. Although all the regression has been run with an iteratively reweighted least squares estimations to control for the impact of potential outliers and leads to very similar results

3.2 Tax base and tax computation

The database contains pieces of information at the fiscal household level and at the individual level. [16] To compute the tax base I use a simple rule of thumb: I sum the 7 categories of income present in the database at the household level. I, however, apply the 10% deduction for professional expenses on labor and retirement income. [17] [18]

Once the tax base determines, I compute the tax liability by applying OpenFisca income tax formulas.

16. When aggregated individual income match households income, with some exceptions due to tax deductions that are sadly not documented by the data producer (one example is for rented furnished flat: individual income is twice the household income due to a 50% tax rebate on flat rented furnished that is taken into account at the household level but not on the individual level.).

17. The 10% tax deduction is computed by taking into account the different thresholds that can lead to a taxable income reduction greater or smaller than 10%. I took formulas from the OpenFisca microsimulation software

18. However taxpayers can choose to deduce their real expenses to reduce their labor income tax base. Although it was a major concern to me that this may lead to overestimating the tax base, I provide evidence in the appendix that the impact is likely to be minor.

3.3 Descriptive Statistics

The set of administrative databases and administrative surveys provide a very rich set of variables. Those variables do not always cover fully the population. A set of descriptive statistics for each treatment group are reported in Table 32.

Marginal Tax Rates: The tax reform implied a change in marginal tax rates for households that are between the 2011 and 2014 thresholds.

Figure 31 – MTR before and after the reform

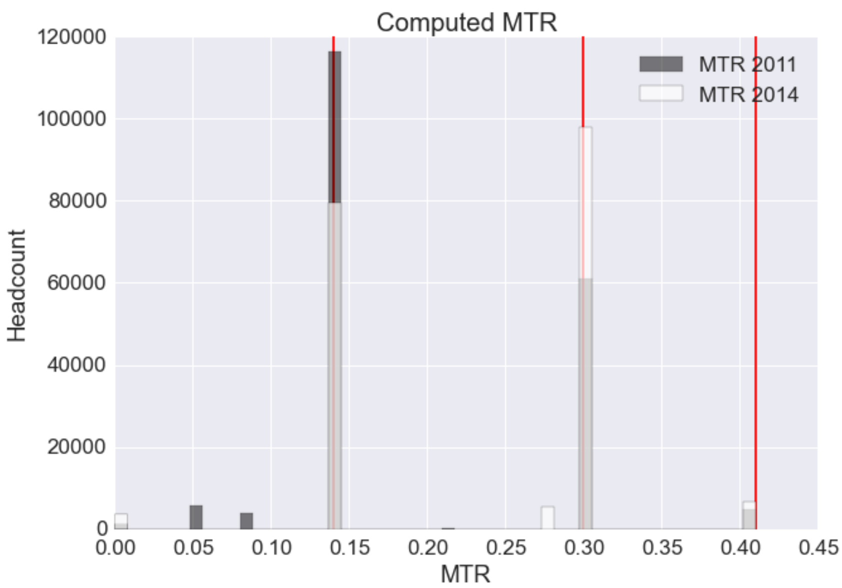


Table 33 – Effective statutory rates before and after the reform.

	Effective		Counterfactual: 2011 tax on 2014 income
MTR	2011	2014	2014
0 %	00.65	01.88	0.00
5.5 %	03.03	00.00	0.84
8.25%	02.06	00.00	0.69
14 %	60.12	41.12	55.40
21 %	00.05	00.00	0.05
28 %	00.00	02.89	0.00
30 %	31.47	50.60	38.63
41 %	02.54	03.45	3.65

Table 33 and Figure 31 shows the MTR households were subject to in 2011 and 2014.[19] If I ignore the changes due to the suppression of the first tax bracket and the implicit tax

19. I computed those rates by taking the taxable income for a given year

Table 32 – Summary statistics

	All	Treatment 0	Treatment 1	Treatment 2
Taxable income	66018	55611	71816	100704
Δ Taxable income	6222	6647	5305	5174
Father is working 2011	0.866	0.840	0.932	0.9260
Mother is working 2011	0.766	0.759	0.809	0.7689
Father is employed 2011	0.823	0.809	0.886	0.8408
Mother is employed 2011	0.775	0.767	0.820	0.7812
Father is employed 2014	0.732	0.709	0.815	0.7707
Mother is employed 2014	0.709	0.696	0.768	0.7215
Mother's salary 2011	37389	30812	44103	57667
Δ Mother's salary	224	161	650	226
Father's salary 2011	22251	19676	24706	30281
Δ Father's salary	-761	-724	-137	-1230
Δ Retirement income_wo	665	877	104	196
Δ Retirement income_me	1411	1780	303	663
Δ sel-employed income_wo	13	199	140	-97
Δ sel-employed income_me	-1	-15	-3	-533
Father independant worker 2011	0.054	0.040	0.064	0.0973
Mother independant worker 2011	0.084	0.068	0.086	0.1439
Mother is retired 2011	0.042	0.056	0.008	0.0111
Mother retired	0.029	0.039	0.005	0.0084
Father is retired 2011	0.049	0.067	0.006	0.0082
Father retired	0.044	0.056	0.012	0.0190
Father start working	0.020	0.022	0.016	0.0143
Mother start working	0.009	0.011	0.004	0.0050
Mother stop working (¬retired)	0.064	0.062	0.067	0.0689
Father stop working (¬retired)	0.064	0.063	0.068	0.0666
Centile 2011 (std of living)	81.10	76.746	86.801	93.86
Centile 2014 (std of living)	81.37	78.222	83.612	91.63
Income tax 2014 (administrative)	6797	4700	6402	14624
Income tax 2011 (administrative)	4996	3492	3776	11114
Income tax 2014 (author's computation)	8486	5896	8378	17952
Income tax 2011 (author's computation)	6769	4768	5701	14608
Computed MTR from administrativeIncome tax	0.206	0.171	0.270	0.299
Computed MTR 2011	0.192	0.167	0.140	0.311
Computed MTR 2014	0.231	0.204	0.271	0.308
Share 0 child	0.227	0.323	0.000	0.000
Share 1 child	0.160	0.118	0.165	0.310
Share 2 children	0.417	0.365	0.553	0.534
Share 3 children	0.164	0.161	0.235	0.135
Share 4 children	0.025	0.026	0.038	0.017
Share 5 children	0.003	0.004	0.005	0.001
Age Father	45.717	46.102	43.747	45.37
Age Mother	43.870	44.360	41.792	43.20
Age Eldest Child	8.846	7.847	11.803	10.88
Age Youngest child	6.755	5.825	9.030	8.91

brackets created by the decote mechanism, [20] I see that the main change in the repartition of households in the income tax scheme is a change from the 14% tax bracket (from 60% to 41% of the sample) to the 30% tax bracket (from 31% to 51% of the sample).

The fact that households shifted from the 14% MTR to the 30% MTR can be due to two distinct causes. The first one is due to the fact that income has increased over the period. The other one is due to the lowering of the family ratio scheme. To disentangle those the two, I can look at the 2014 counterfactual income tax, which is the income tax a household would have paid if the 2011 income tax schedule would have been applied to its 2014 income. I see that the 19% decrease in households being on the first tax bracket, 5% can be attributed to the general increase in income in the population, and thus 14% is due to the lowering of the family ratio scheme.

3.4 Identification Strategy

A difference-in-difference is based on the estimates of the dependent variable based on the interaction of two binary variables: the after reform one and the treated group one. An after reform binary is also included in the regression to account for the mean evolution of the dependent variable between, before and after the reform. The treated binary is also included to account for the possible difference between the treated and the control group prior to the policy change.

$$y_{it} = \beta_0 + \beta_1 \text{Post} + \beta_2 \text{Treated} + \delta \text{Treated} \times \text{Post} + c_i + \epsilon_{it} \tag{3.1}$$

When using individual-level panel data c_i, the individual fixed effect is included to control for individual unobserved effect.

The OLS estimate of $\hat{\delta}$ implies : $\hat{\delta} = \Delta \bar{y}_{\text{treated}} - \Delta \bar{y}_{\text{untreated}}$,

which represent the dependent mean evolution of the treated group minus the one of the untreated group, which is stated as the effect of the treatment.

This equation can be evaluated through a first difference setting which leads to :

$$\Delta y_i = \beta_1^{'} + \delta_1^{'} \text{Treated} + \epsilon_i^{'} \tag{3.2}$$

And I have $\delta_1^{'} = \delta_1$, and $\beta_1^{'} = \beta_1$.

20. which multiplied the statutory rate for households concerned by the mechanism by 1.5 in 2011 and 2 in 2014. That creates the 8.25 and 21% implicit marginal tax rate for 2011 and the 28% implicit MTR for 2014 (e.g for the 5.5% tax bracket 5.5% × 1.5 = 8.25)

Back to our case, I have a change in the tax scheme happening between 2012 and 2013. This change in tax scheme gives three groups: the control group, the group facing the first treatment (i.e. being between the 2011 and 2013 thresholds), and the one facing the second treatment (i.e. being over the 2011 threshold). I can thus run a difference in difference regression with two treatments.

$$\Delta y_i = \beta_0 + \delta_1 \text{Treatment}_1 + \delta_1 \text{Treatment}_2 + \epsilon_i \tag{3.3}$$

δ_1 account for being between the two brackets, a negative sign would imply that the substitution effect due to the increase of the leisure price dominates the income effect, a positive sign would imply that the income effect dominates. δ_2 represent the effect of being above the 2013 bracket since it implies a reduction in disposable income without a change in the marginal tax rate, I would expect a positive sign.
Some assumptions are conditional for δ_1 and δ_2 to capture the refom.
One key assumption is that the counterfactual without the reform would imply that the taxpayers would still have its income in the treatment span.
Such a regression doesn't take into account the position in the income distribution. It is possible that being on a specific position of the income distribution the variation of income will have a different trend and that this trend concerns more specifically the treated. It is also possible that the variation of income depends on the number of children in the household and that the parameters capture mainly a big part of the difference between the mean evolution of households with children against households without children. I thus run the regression by including control variables for the number of children, and a binary is added for the effect of being over the 2011 thresholds (from 1 to 6 children).
This leads to a Difference-in-Differences-in-Differences estimation that allows to control for potentially confounding trends: change in income due to the position in the distribution, the number of children in the household, and possible interactions between the two. Such a property of the French family ratio scheme is quite remarkable and has indeed been emphasized by Piketty (1999).
This regression also considers Treatment 1 and Treatment 2 as different treatments for each number of children in the household, which allows to see the specific impact of the reform for a given number of children. The result is the following estimator, which is formally a triple-difference estimator with 12 treatments.

$$
\begin{aligned}
\Delta y_i = \beta_0 &+ \sum_{i=1}^{6} \beta_i \text{Children}_i + \sum_{j=1}^{6} {}_b\delta_j \text{Between}_j + \sum_{j=1}^{6} {}_o\delta_j \text{Over}_j \\
&+ \sum_{i=1}^{6} {}_b\gamma_i \text{Children}_i \times \text{Between}_i \\
&+ \sum_{i=1}^{6} {}_o\gamma_i \text{Children}_i \times \text{Over}_i \\
&+ \epsilon_i
\end{aligned} \tag{3.4}
$$

Δy_i represent the change in taxable income between 2011 (before the reform) and 2014 (after the reform).

The intersect β_0 captures the time trend, i.e., the mean change in wage between 2011 and 2014. Children$_i$ is a dummy indicating for the number of children (the reference being 0 children), β_i thus captures the variation in income for i children in the household.

δ capture the effect of being on a specific part of the distribution: ${}_b\delta_i$ captures the effect of being on the position in the distribution where the treatment 1 applies to households having 1 child. ${}_o\delta_i$ captures the effect of being above the 2011 threshold for a given number of children i.

The parameters of interest are γ_i, i.e., the triple difference estimators. Those are the parameters that capture the interaction between being on the specific location of the income distribution, where for a given number of children in the household the treatment took place, interacted with that given number of children. The left subscripts b, and o, account for respectively the first treatment (between thresholds), and the second treatment (over 2011 threshold).

The first parameters of interest ${}_b\gamma_i$, captures the effect of the change in marginal tax rate (MTR). The sign of the parameter determines whether the income effect dominates, or the substitution effect dominates. If the sign is positive, the income effect dominates (the loss in income due to the reform implied an increase in the effort to compensate for the loss in income). It the sign is negative, the substitution effect dominates: the increase in MTR leads to favor leisure over income.

Such estimation makes it hard to determine what is the control group. The control groups is constituted first of households without children. Then it is also constituted by households with children that are below the 2013 ceiling. More surprisingly treated households also constitute a control group, but deflated of the mean estimated effect of the reform. This is because the estimate of interest (all the γ) capture the mean effect of being in the treatment group. [21]

For example the OLS estimate ${}_b\hat{\gamma}_3$, accounts for the effect of the 2012/2013 reform on the household with three children for which income was between 79 166 euros and 101 426 euros can be expressed as follow :

$$\begin{aligned} {}_b\hat{\gamma}_3 = & \left(\bar{y}_{T^1_{3,3C,2014}} - \bar{y}_{T^1_{3,3C,2011}}\right) \\ & - \left(\bar{y}_{T^1_{3,\{0,1,2,4,5,6\}C,2014}} - \bar{y}_{T^1_{3,\{0,1,2,4,5,6\}C,2011}}\right) \\ & - \left(\bar{y}_{\neg T^1_{3,3C,2014}} - \bar{y}_{\neg T^1_{3,3C,2011}}\right) \end{aligned} \tag{3.5}$$

The first line of the left-hand side represents the mean change in income for the households of three children being between the 2014 and 2011 thresholds.

The second line represents the mean change in income for the households for which the number of children is not 3, but being between the 2014 and 2011 thresholds.

The third line represents the mean change in income for the households for which the number of children is 3, but not being between the 2014 and 2011 thresholds. I have thus controlled for two kinds of potentially confounding trends.

Flatten Thresholds: The series of thresholds $\sum_{i=1}^{6} {}_b\gamma_i \text{Children}_i \times \text{Between}_i$, and $\sum_{i=1}^{6} {}_o\gamma_i \text{Children}_i \times \text{Over}_i$ are overlapping. For instance, as shown in Table 22, a household with a taxable income of 95 000 euros, dummies will be true for Over_1 and Over_2 since the taxable income is greater than the 2011 threshold for 1 and 2 children. For that same exemple, the dummies Between_3 and Between_4 will also be true. One consequence is that it is difficult to interpret the parameters linked with the dummies $Over_i$ and $Between_i$. However, each possible configuration of these dummies variables is a linear combination of all thresholds intervals once they have been ordered. The result is (for 6 children), 11 income span plus a twelve one for households over the highest threshold.

x

By substituting $\sum_{i=1}^{6} {}_b\gamma_i \text{Children}_i \times \text{Between}_i + \sum_{i=1}^{6} {}_o\gamma_i \text{Children}_i \times \text{Over}_i$ in Equation 3.4 with

$\sum_{i=1}^{12} \text{Income\_Span}_i$ the regression is strictly equivalent for all other parameters while

21. This fact has been checked with numerical simulations.

allowing to have a clearly interpretable effect of being on a specific position in the income distribution. This is the way the results will be reported.

4 Results:

In order that tables keep a reasonable size, standard errors or parameters may be taken out when they are not crucial for the analysis. Although all the results in that section are available at `https://github.com/adrienpacifico/fq_lowering/` with all parameters and standart errors, and with the exact code used to produce the results.

Triple Diff: I run the triple-diff estimation in three different manners. First, I run a classical ordinary least square (OLS) estimation that captures the average change in taxable income between 2011 and 2014. However, because I can expect that richer households would be more prone to –in absolute values– larger income variations compare to poorer households, the estimation is likely to be subject to heteroscedasticity.
The literature on tax elasticity of entire population has focused on young working-age population and considers that older population de-facto less elastic (Alpert and Powell, 2013; Messacar et al., 2017), younger workers were more prone to changes and has broader prospects to make their income vary.

I propose two estimates: an OLS on all the population, an OLS with the age of the oldest parent as control.
Before looking at the parameters of interest let's first focus on the variables that capture general trends. The $Child_n$ rows of Table 41 show that the family composition has a strong influence on the evolution of income. Effect of the reform taken out, families of one child will have an increase in income between 2011 and 2014 of 1829 € on average. As the number of children increases, the greater the mean evolution of income (free of the reform effect).
The economic conjuncture was not good between 2011-2014 and high earners were negatively impacted, this is translated by those negatives parameters. However the constant is positive with an average trend in income (without the trend due to an income location variables) increasing by 6381 euros on average, which implies that over the period, income tends to converge between middle-income households and high-income households.
The fact that those income location parameters are significant implies that evaluation in a classical diff-in-diff estimate would have lead to biased estimates if control variables for

Table 41 – Triple-diff estimate

	Triple	Triple age controls
$Over_1 \times Child_1$	2292^{***}	2446^{***}
	(232)	(231)
$Over_2 \times Child_2$	4314^{***}	4363^{***}
	(237)	(236)
$Over_3 \times Child_3$	3996^{***}	3925^{***}
	(399)	(398)
$Over_4 \times Child_4$	3120^{***}	3032^{***}
	(1054)	(1052)
$Over_5 \times Child_5$	5174	4846
	(3955)	(3961)
$Over_6 \times Child_6$	-198	-727
	(13784)	(13843)
$Between1 \times Child_1$	621^{**}	$622**$
	(255)	(254)
$Between2 \times Child_2$	2487^{***}	2496^{***}
	(197)	(197)
$Between3 \times Child_3$	4234^{***}	4224^{***}
	(316)	(315)
$Between4 \times Child_4$	2780^{***}	2706^{***}
	(754)	(752)
$Between5 \times Child_5$	-4147^{*}	$-4254*$
	(2194)	(2190)
$Between6 \times Child_6$	-9431^{**}	-9655^{**}
	(4765)	(4834)
$Child_1$	1829^{***}	372^{***}
$Child_2$	2662^{***}	507^{***}
$Child_3$	4388^{***}	2327^{***}
$Child_4$	6234^{***}	4269^{***}
$Child_5$	7406^{***}	5585^{***}
$Child_6$	8987^{***}	7066^{***}
Taxable income $\in [58291, 63233]$	-5399^{***}	-5186^{***}
Taxable income $\in [63233, 63530]$	-5806^{***}	-5600^{***}
Taxable income $\in [63530, 73516]$	-6564^{***}	-6305^{***}
Taxable income $\in [73516, 73806]$	-7736^{***}	-7443^{***}
Taxable income $\in [73806, 84103]$	-7683^{***}	-7363^{***}
Taxable income $\in [84103, 94368]$	-8164^{***}	-7783^{***}
Taxable income $\in [94368, 94451]$	-8325^{***}	-7989^{***}
Taxable income $\in [94451, 104633]$	-7289^{***}	-6854^{***}
Taxable income $\in [104633, 115185]$	-7523^{***}	-7017^{***}
Taxable income $\in [115185, 135941]$	-7466^{***}	-6896^{***}
Taxable income $\in [135941, 150684]$	-6456^{***}	-5844^{***}
Taxable income over 150684 euros	-8524^{***}	-7897^{***}
Age oldest parent		-206.13^{***}
(Age oldest parent)^2		0.31
Intercept	6381^{***}	16642^{***}
Adjusted R-square in %	4.52	5.20
Number of observations	193555	193555

children were not introduced. Income splines usually introduced to mitigate the change in the distribution effect captures a part of the reform effect and leads to under-estimate the potential effects of a reform. By using the triple-diff estimate I am not facing those issues and thus justify the benefits of such an estimation.

The effect of being over the 2011 threshold: The interaction $Over \times Child$ gives the effect of the change in disposable income and thus account for a pure income effect. The effect is significant from one to four children. The impact of facing a loss of 836 euros for a family of one child implies an average increase of 2292 euros. Which suggest that the income effect had a strong impact on households taxable income.

The effect of being between the two thresholds: The interaction $Between \times Child$ gives the effect of the change in the marginal tax rate for each child rank. The effect is not significant for families with one child, while the effect is significant and positive for families from 1 to 4 children. Indeed the average effect of the reform is of 621 euros, 2847 euros, 4234 euros, and 2780 euros for families of respectively 1 to 4 children. Following our framework, since the average change in taxable income is positive, I can conclude that the income effect dominates the substitution effect, which is contrasting with the established literature. However, I see that for 5 children, households earn less on average (-4147 €), which means that the substitution effect dominates. One explanation could be that as the utility function is concave, as the income effect should become negligible as households become richer, and the higher the number of children the higher the income at which the treatment takes place. This can be confirmed by the fact that the effect is increasing from one to three children, and is decreasing afterward. The behavioral reactions are large compared to the change in income tax. The fact that for households of 3 children in treatment 2, that face a loss of 1672 euros in disposable income, leads to an average increase of 3996 euros in taxable income is quite puzzling and seems too large.

The introduction of the age controls leaves nearly unchanged the effect of the treatments, the trend due to position in the income distribution are 4% smaller, but it changes the variables that captures the trends associated with the number of children, , the constant is increasing from 6381 euros to 16642 euros. [22]

22. To make the argumentation clearer, only the age of the oldest parent is taken intoo account, but the effect of introducing the age of both parents in the regression has very similar effect as there is a strong correlation between the age of spouses.

The effect in the position of the income distribution moves only slightly with the parameters being 4% lower on average suggesting that the variation in income due to a specific position of the income distribution is more linked with a skill level than age characteristics and reinforce my feeling that the triple-diffrence specification captures correctly the change in the distribution bias. The rest of the variation can be explained by a simple composition effect. Older workers earn more but have their income increasing at a slower rate. The reference group earning less than 58291 euros being younger, the age variable is capturing the heterogeneous composition.

As the parents get older the change in income over the 2011-2014 period decreases, one additional year implies a negative growth of 206 euros. The effect of the number of children is smaller, families with two children has an average increase of 2662 euros when the effect of age is not take into account. It decreases down to 567 euros when taking the age into account, which represent a decrease of 79%. Not surprisingly it reveals a link between the age and the family composition.

The fact that the effects of the treatments are very stable while other variables changes across specification are reassuring about the fact that the trend captured is specific the group treated. The treatments are very stable across many other specifications shown in section 3.A including dummies for localities (communes), houses characteristics such as living floor space, age of the house, and so on.

Two things can temperate such a large effect. First, the change in income is the before-tax income, and since these households face a MTR of 30%, the variation in disposable income is thus 70% of the income variation reported in Table 41.[23] Such an average behavioral reaction is still too big to be believable. Indeed the fact that a lump sum decrease in disposable income implies an increase in disposable income greater than the loss due to the tax would implies that the cost of effort is concave, which deviate from classical assumptions made in the literature but also empirical evidences.

Another fact that can explain so big behavioral reaction could be that households react on the extensive margin since I observe top decile households and that assortative matching is strong, the reaction of a potential secondary earner starting to work full time could explain such big behavioral reactions.

Controlling for the age of the oldest parent, while it reduces considerably the impact of having children on the change of taxable income between 2011 and 2014, it does not seem

23. Applying a the 30% marginal tax rate implies a lump sum loss of 1672 euros in tax leads to an increase of $3996 \times 0.7 = 2797$ euros on average.

to have a significant impact on the behavioral assessment of the reaction to the reform. Curiously enough, I see that this effect is much smaller for young households than for old ones. Older households thus mainly drive the behavioral reaction. This is surprising as the literature usually claim that prime age males are the most elastic taxpayers, and thus the one that should react the most.

By sex and type of income The empirical literature has concluded that as independent have more flexible income than wage owner, and that women have a bigger behavioral reaction than men. To test that result for France, I run the same OLS triple-difference estimator, by taking as the change in wage income or sel-employed income as the dependent variable. I run this estimation for men and women separately. The population used for the estimation is the population that has a non-null income of interest in 2011 or in 2014. For a matter of concision, I only report the parameters of interest. Complete tables can be found in the appendix.

Table 42 – Triple-dff by income and sex

	Wage income father	Wage income mother	sel-employed income father (BNCI)	sel-employed income mother (BNCI)
$Over_1 \times Child_1$	2713^{***}	1425^{***}	149	-86
$Over_2 \times Child_2$	5576^{***}	1599^{***}	563^{**}	313^{*}
$Over_3 \times Child_3$	4725^{***}	150	805	848^{*}
$Over_4 \times Child_4$	2289	3997^{**}	464	1739^{*}
$Over_5 \times Child_5$	-10499	-2363	5321	3921^{*}
$Between1 \times Child_1$	1563^{***}	803.12^{**}	-91	-85
$Between2 \times Child_2$	2439^{***}	1282^{***}	107	-247^{*}
$Between3 \times Child_3$	4783^{***}	1888^{***}	626	152
$Between4 \times Child_4$	-2525	552.13	687	69
$Between5 \times Child_5$	24230^{**}	523.83	3909	-2126
Age oldest parent	-12262.07^{***}	-3541.92^{***}	1375^{***}	115
Age oldest parent squared	100.98^{***}	27.91^{***}	-12^{***}	-1
adjusted-R2	5.39	3.74	1.06	0.47
N	60283	60283	60283	60283

The first column of Table 42 represent the change in wage income for women that had a wage income either in 2011 or in 2014. Surprisingly I see that women have smaller reactions than man (second column of the table). This can be due to the fact that their wage is smaller, but it is quite unexpected for one that would expect that women react on the extensive margin. Treated households that are between the two ceiling, the income effect still dominates for both men and women, even if it is not significant for men at 4, and 5 children.

When looking at income derived by sel-employement, the behavioral reaction is small and less significant (but the sample size is smaller). I do not observe a consistent effect for households between the two thresholds and parameters are mostly positive. This seems to indicate that self-employed workers that are supposed to be the ablest to do income shifting do not do so as I would have expected negative parameters for all treated households.

This shows two interesting things, first, that man reacts more than women, second that wage earner reacted in larger magnitude than sel-employed.

To that point the analysis is puzzling, I observe too large to be true aggregated reactions due to variation in mean wage, one explanation for such large behavioral reaction would be a large behavioral reaction by entering the labor market.

4.1 Behavioral reactions on the extensive margin:

Table 43 – Extensive margins

	Father start working	Mother start working	Father stop working	Mother stop working
$Over_1 \times Child_1$	0.0032**	0.0058***	-0.0256***	0.0001
$Over_2 \times Child_2$	0.0086***	0.0010	-0.0480***	0.0007
$Over_3 \times Child_3$	0.0064***	-0.0147***	-0.0519***	0.0057
$Over_4 \times Child_4$	0.0017	-0.0206**	-0.0602***	0.0140
$Between_1 \times Child_1$	0.0013	0.0085***	-0.0093	0.0011
$Between_2 \times Child_2$	0.0065***	0.0040**	-0.0113**	0.0047
$Between_3 \times Child_3$	0.0047***	-0.0054*	-0.0286***	-0.0032
$Between_4 \times Child_4$	0.0017	-0.0168**	-0.0382***	-0.0017
$Child_1$	-0.0019	-0.0011	0.0808***	-0.0052*
$Child_2$	-0.0053***	0.0064***	0.0629***	-0.0189***
$Child_3$	-0.0020	0.0250***	0.0529***	-0.0257***
$Child_4$	0.0030	0.0462***	0.0388***	-0.0264***
Taxable income $\in [58291, 63233]$	-0.0090***	-0.0140***	0.0209***	0.0085***
Taxable income $\in [63233, 63530]$	-0.0067**	-0.0137***	0.0312***	0.0165**
Taxable income $\in [63530, 73516]$	-0.0120***	-0.0153***	0.0374***	0.0071***
Taxable income $\in [73516, 73806]$	-0.0147***	-0.0166***	0.0604***	0.0071
Taxable income $\in [73806, 84103]$	-0.0128***	-0.0126***	0.0684***	0.0092***
Taxable income $\in [84103, 94368]$	-0.0118***	-0.0101***	0.0838***	0.0108***
Taxable income $\in [94368, 94451]$	-0.0182***	-0.0248***	0.0869**	-0.0314
Taxable income $\in [94451, 104633]$	-0.0135***	-0.0044**	0.0947***	0.0012
Taxable income $\in [104633, 115185]$	-0.0151***	-0.0065***	0.1084***	0.0064
Taxable income $\in [115185, 135941]$	-0.0144***	-0.0074***	0.1185***	0.0091**
Taxable income $\in [135941, 150684]$	-0.0147***	-0.0057**	0.1406***	0.0067
Taxable income over 150684 euros	-0.0170***	-0.0052**	0.1605***	0.0125**
Intercept	0.0877***	0.1316***	-1.1587***	-0.0323**
Age_wo	0.0012***	-0.0058***	0.0063***	0.0070***
Age_me	-0.0046***	0.0012**	0.0959***	0.0002
I(Age_wo_squared / 10 ** 4)	-0.1025***	0.5614***	-1.1955***	-0.9674***
I(Age_me_squared / 10 ** 4)	0.5090***	-0.1009**	-11.8298***	-0.0203
I(Age_Elder_child / 10 ** 4)	0.9410**	-1.4765**	-0.9211	-13.8524***
adjusted-R2	0.54%	0.94%	26.85%	0.44%
N	192640	192640	192640	192640

Table 43 shows for a linear probability model, that being treated increases the probability for men to start working, while the effect is mixed for women depending on the child rank. Although the probability that men stop working (without getting retired) while treated by the reform is negative. A father of three children in the treatment 2 is 5.19% less likely to stop to work if impacted by the reform. Surprisingly and contrasting with the rest of the literature, being impacted by the tax reform has no impact on the probability that a mother stop to work.

It shows that men reacting to the reform by keeping their job more often. While I could have expected that women concerned by treatment 1 reacted on the extensive margin by stopping to work, it is not what I observe.

Building on the fact that older households react more than younger household, I test another extensive margin: the retirement margin.

Table 44 – Change in Retirement Income and probability to get retired

	OLS men	OLS women	LPM men	LPM women
$Over_1 \times Child_1$	-1787^{***}	-414.33^{***}	-0.0196^{***}	-0.0092^{***}
$Over_2 \times Child_2$	-3165^{***}	-550.43^{***}	-0.0290^{***}	-0.0090^{***}
$Over_3 \times Child_3$	-2734^{***}	-283.27	-0.0256^{***}	-0.0065^{**}
$Over_4 \times Child_4$	-2230^{**}	-347.90	-0.0239^{***}	-0.0019
$Between1 \times Child_1$	-492^{*}	118.89	-0.0016	-0.0012
$Between2 \times Child_2$	-1773^{***}	-316.72^{**}	-0.0214^{***}	-0.0067^{***}
$Between3 \times Child_3$	-2176^{***}	-390.09^{**}	-0.0258^{***}	-0.0096^{***}
$Between4 \times Child_4$	-1720^{**}	-404.94	-0.0256^{***}	-0.0067^{*}
Age controls	x	x	x	x
Adjusted R^2 in %	4.9	7.9	11.72	9.43

Table 44 gives the variation of retirement income for women and men, I see that a large part of the total effect of the reform is due to changes in retirement income which decreases. Moreover, the linear probability model shows that the probability to get retired either for men of women is lower for households treated by the reform. The effect is stronger as the magnitude of the fiscal loss increases.

I can conclude that the reform had a positive impact on income mainly because men nearing retirement chose to stay on the labor market to cope with the effect of the reform. The difference between men and women in behavioral reaction could be because men are 3 years older on average, they are more likely to be able to choose to delay their retirement decision.

5 Conclusion

I analyzed a fiscal reform that happened between 2011 and 2014 for which I were able to measure the pure income effect of the top decile, and to which extent the income effect or the substitution effect dominates.

As the literature usually consider only uncompensated elasticity assuming that there is no income effect, several articles show that income effect does exist and may be quite substantial. Research that looks at lottery winners shows consistently the existence of income effect in multiple countries, Imbens et al. (2001) shows that the effect is stronger for individuals close to the standard retirement age, which is consistent with the income effect I find. Kindermann et al. (2018) calibrate an increase in inheritance taxation based on the lottery literature results and they show that an increase in inheritance taxation would increase tax revenues by more than the mechanical effect due to heir working more to compensate for the loss in expected income. This is similar to the effect that I observe; by increasing the tax on households they increase their labor supply either because the increase is a change in MTR or when it is a lump sum increase. What is interesting here is that it concerns households in the last decile of the income distribution which could be expected to be less subject to the income effect than the bottom of the distribution. Moreover, as the tax is progressive, households of the last decile pay most of the French income tax. It is likely that the government could increase its tax revenue as in Kindermann et al. (2018) by increasing the income tax through a mechanical effect, but also through a behavioral effect. With that regards, the equity-efficiency tradeoff might not be a tradeoff anymore.

I also show that women react less than men to the tax reform. [24] This is quite unexpected as the taxation and labor economic literature usually shows that only women react, and they react on the extensive margin. Several facts could explain why it is no so here. First, Blau and Kahn (2007) and Heim (2007) show there is a trend for elasticities of women to decrease in the US and converges to the ones of men (which is usually close to zero). It is possible that France has the same trend that happened and that it is stronger for the top of the income distribution. Second, a large part of the effect is driven by households reacting on the retirement extensive margin. Pedrant (2018) study French couples joint retirement decisions of couples with a collective model framework and shows that men are taking the burden of unexpected change in income. If it is so that men are absorbing

24. An estimation ran on couples that are under 40 years old show no behavioral reaction of women, while men react very little

more income shocks than women it would make sense to see men react more than women. Moreover, Sicsic (2018) also finds smaller elasticities for women than for men in France over the period 2006-2015.

An original contribution to this article is also to try to evaluate the precision of the assessment of the reform.

These effects would thus not be useful to determine an optimal tax policy in the long run and would correspond to short-run behavioral reactions. A way to test such a fact would be to do an analysis in cross-section instead of using the panel dimension of the dataset. However, this gives pieces of information on a relatively unexplored field of the tax literature of older workers tax responsiveness. Indeed, Alpert and Powell (2013) find large elasticities for older workers on the extensive margin with a positive income effect. Such findings have not been followed by many studies on a subject and could have broader implications on evaluating changes in the retirement pension scheme if there exist interactions with the income tax scheme.

Appendix

3.A Alternative specifications

	Only treatment	Treatmt_var_w_child_var	Treatment_var_w_income_thrsh_var	Triple_diff	Triple_diff_w_child_only	Tripl_age_parents	Triple_age	Triple_control_local	Triple_countrol_housing	Triple_control_local_dep	Triple_no_othr_income	Triple $\Delta y > 0$	Triple $\Delta y < 0$
Over_1_X_1_child[T.True]	-3389.23***	-4952.11***	2953.23***	2292.83***	-772.31***	2422.92***	2429.31***	2460.59***	2416.68***	2372.25***	2377.17***	595.97**	1272.42***
	(163.90)	(186.10)	(203.04)	(232.70)	(290.44)	(232.00)	(232.01)	(231.88)	(232.27)	(232.04)	(310.12)	(262.88)	(383.16)
Over_2_X_2_child[T.True]	-986.05***	-2423.35***	6260.48***	4314.50***	962.87***	4317.02***	4300.71***	4322.09***	4272.98***	4133.43***	4442.20***	1886.52***	624.73
	(139.33)	(143.62)	(222.86)	(237.59)	(356.05)	(236.45)	(236.44)	(236.41)	(236.60)	(236.35)	(355.99)	(298.39)	(394.83)
Over_3_X_3_child[T.True]	599.51*	-1438.33***	7766.49***	3996.62***	949.88**	3904.08***	3866.70***	3838.07***	3748.40***	3559.68***	3467.60***	935.30*	-1178.63*
	(314.88)	(324.34)	(388.57)	(399.75)	(481.87)	(398.79)	(398.94)	(398.95)	(398.99)	(398.53)	(647.36)	(529.75)	(698.34)
Over_4_X_4_child[T.True]	1464.34	-1637.15	8738.61***	3120.05***	532.95	3029.54***	3028.25***	3004.94***	2891.17***	2705.92***	416.68	-1789.80	-3485.37*
	(987.46)	(1016.26)	(1028.33)	(1054.45)	(1086.45)	(1052.39)	(1053.31)	(1051.53)	(1050.30)	(1050.22)	(1807.96)	(1507.56)	(1927.17)
Over_5_X_5_child[T.True]	4430.19	729.05	11961.57***	5174.49	3063.37	4835.13	4865.81	4764.39	5100.01	5033.21	-4217.48	-7831.69	-2304.41
	(3888.23)	(3947.93)	(3896.92)	(3955.09)	(3961.72)	(3955.97)	(3953.59)	(3913.77)	(3953.83)	(3923.64)	(7195.10)	(5802.81)	(4310.23)
Over_6_X_6_child[T.True]	-1.30	-4677.39	8173.92	-198.49	-1700.65	-727.41	-604.79	-847.64	-1118.43	-1068.10	-9909.33	12244.27***	-25752.38***
	(13707.07)	(13777.08)	(13716.11)	(13784.48)	(13787.77)	(13765.45)	(13731.98)	(13806.69)	(13651.01)	(13568.30)	(24459.81)	(3672.75)	(875.21)
Between_1_X_1_child[T.True]	-3214.53***	-4777.40***	144.02	621.81**	-271.70	626.09**	627.49**	636.42**	614.27**	599.53**	238.44	126.78	695.31*
	(215.98)	(233.28)	(233.74)	(255.94)	(262.36)	(255.28)	(255.05)	(254.73)	(255.68)	(255.41)	(298.43)	(272.08)	(403.25)
Between_2_X_2_child[T.True]	-1680.61***	-3117.92***	3288.60***	2487.83***	225.91	2473.23***	2471.83***	2472.00***	2478.17***	2441.96***	2927.02***	1457.34***	396.17
	(130.58)	(135.14)	(183.35)	(197.85)	(246.29)	(197.20)	(197.15)	(197.10)	(197.48)	(197.08)	(255.74)	(227.19)	(329.38)
Between_3_X_3_child[T.True]	477.89**	-1559.94***	7845.43***	4234.29***	1453.84***	4193.74***	4165.46***	4122.14***	4030.32***	3908.92***	3996.09***	1747.00***	-591.33
	(239.89)	(252.18)	(302.12)	(316.23)	(403.21)	(315.51)	(315.47)	(315.18)	(315.40)	(315.03)	(445.07)	(380.75)	(541.95)
Between_4_X_4_child[T.True]	1041.09	-2060.40***	8361.99***	2780.14***	28.38	2688.63***	2631.27***	2588.11***	2572.11***	2465.29***	171.14	-1306.13	-1160.62
	(688.15)	(728.87)	(718.36)	(754.96)	(790.90)	(752.94)	(754.21)	(753.47)	(754.33)	(754.52)	(1146.58)	(959.02)	(1373.10)
Between_5_X_5_child[T.True]	-4420.06**	-8121.20***	2641.40	-4147.12*	-6685.45***	-4265.55*	-4207.59*	-4543.61**	-4517.74**	-4642.18**	-11294.10**	-6203.39*	-4429.10
	(2075.34)	(2185.06)	(2088.49)	(2194.87)	(2206.40)	(2193.33)	(2193.46)	(2184.36)	(2172.62)	(2181.67)	(4442.52)	(3347.44)	(4500.83)
Between_6_X_6_child[T.True]	-7911.55*	-12587.63***	-1058.74	-9431.32**	-11624.12**	-9718.80**	-9733.74**	-9786.13**	-10093.97**	-9914.62**	-7623.90	9116.62**	-28295.77***
	(4565.00)	(4770.54)	(4564.87)	(4765.82)	(4769.40)	(4846.61)	(4818.36)	(4756.52)	(4874.64)	(4887.58)	(13973.82)	(4173.10)	(7774.08)
Flatten_thresholds_104633_115185[T.True]			-9157.98***	-7523.49***	-3777.70***	-6934.17***	-6937.51***	-7260.27***	-7513.43***	-8088.93***	-5980.52***	6188.80***	-11821.68***
			(363.44)	(367.74)	(479.56)	(366.84)	(366.77)	(367.23)	(367.76)	(368.99)	(621.11)	(497.63)	(644.87)
Flatten_thresholds_115185_135941[T.True]			-9099.23***	-7466.62***	-3731.01***	-6817.63***	-6832.77***	-7260.44***	-7544.35***	-8227.40***	-5815.00***	7816.68***	-11827.81***
			(357.50)	(361.85)	(476.94)	(360.66)	(360.58)	(361.72)	(362.40)	(364.09)	(623.15)	(526.11)	(608.34)
Flatten_thresholds_135941_150684[T.True]			-8072.70***	-6456.94***	-2557.07***	-5770.78***	-5785.53***	-6241.93***	-6573.56***	-7283.45***	-5407.50***	9502.48***	-12968.81***
			(534.97)	(537.63)	(641.13)	(536.24)	(536.14)	(536.78)	(537.10)	(537.54)	(997.28)	(844.74)	(958.51)
Flatten_thresholds_58291_63233[T.True]			-5336.14***	-5399.22***	-4505.71***	-5158.23***	-5161.95***	-5202.98***	-5258.79***	-5405.99***	-3377.73***	-1119.59***	-1686.44***
			(105.02)	(105.28)	(120.05)	(105.29)	(105.29)	(105.36)	(105.85)	(106.02)	(122.15)	(107.22)	(174.99)
Flatten_thresholds_63233_63530[T.True]			-5833.21***	-5806.61***	-4671.18***	-5560.79***	-5577.65***	-5608.47***	-5672.23***	-5871.44***	-4110.38***	-1432.28***	-1237.54***
			(389.07)	(382.53)	(435.82)	(381.72)	(381.53)	(381.33)	(381.76)	(380.91)	(420.57)	(377.84)	(475.98)
Flatten_thresholds_63530_73516[T.True]			-6946.81***	-6564.94***	-4142.69***	-6257.34***	-6266.15***	-6356.29***	-6464.73***	-6706.92***	-4877.19***	-405.74**	-3662.39***
			(140.03)	(146.22)	(207.37)	(145.85)	(145.80)	(145.96)	(146.44)	(146.71)	(201.91)	(179.95)	(242.88)
Flatten_thresholds_73516_73806[T.True]			-8521.52***	-7736.87***	-4816.01***	-7371.03***	-7388.66***	-7504.45***	-7561.64***	-7853.27***	-6012.01***	-36.51	-4314.68***
			(641.66)	(634.84)	(722.48)	(630.52)	(630.00)	(629.62)	(624.76)	(623.57)	(791.66)	(718.20)	(939.57)
Flatten_thresholds_73806_84103[T.True]			-9096.58***	-7683.04***	-4439.60***	-7295.47***	-7295.84***	-7450.51***	-7577.15***	-7908.41***	-6093.05***	784.59***	-5976.63***
			(203.26)	(210.34)	(338.57)	(209.44)	(209.38)	(209.70)	(209.95)	(210.43)	(316.12)	(269.67)	(344.73)
Flatten_thresholds_84103_94368[T.True]			-9709.69***	-8164.76***	-4546.02***	-7704.38***	-7704.79***	-7924.87***	-8118.67***	-8564.36***	-6131.71***	2383.38***	-8252.37***
			(245.30)	(251.56)	(376.67)	(250.47)	(250.38)	(250.91)	(251.44)	(252.36)	(382.30)	(315.72)	(433.31)
Flatten_thresholds_94368_94451[T.True]			-9851.21***	-8325.28***	-5803.28***	-7912.76***	-7940.60***	-8151.58***	-8387.66***	-8755.70***	-5387.70*	2921.66	-6228.21**
			(1865.07)	(1868.30)	(2093.32)	(1847.77)	(1847.85)	(1844.47)	(1828.72)	(1845.95)	(2863.76)	(2049.30)	(2970.13)
Flatten_thresholds_94451_104633[T.True]			-8902.85***	-7289.21***	-3469.19***	-6778.84***	-6779.43***	-7045.56***	-7302.51***	-7837.31***	-5998.52***	3750.55***	-9688.88***
			(299.62)	(304.50)	(422.90)	(303.05)	(302.99)	(303.67)	(304.25)	(305.50)	(480.97)	(397.99)	(524.51)
Flatten_thresholds_more_then_150684			-10152.82***	-8524.53***	-5431.11***	-7827.61***	-7832.30***	-8471.54***	-8845.14***	-9654.07***	-6135.83***	12358.62***	-15187.22***
			(489.25)	(492.74)	(605.76)	(492.52)	(492.58)	(494.69)	(495.25)	(496.36)	(981.99)	(808.91)	(844.94)
Intercept	6647.34***	3114.95***	8624.94***	6381.12***	8210.22***	16514.36***	15681.85***	15071.09***	14581.91***	12635.56***	14645.73***	33507.36***	-28649.44***
	(37.81)	(79.28)	(40.15)	(83.26)	(95.92)	(927.29)	(962.70)	(971.66)	(1100.92)	(1157.97)	(1222.73)	(1066.93)	(2079.96)
child_1		5095.27***		1829.10***		261.82*	506.64***	448.89***	435.52***	332.97**	-63.65	-1083.99***	1311.42***
		(124.43)		(127.01)		(144.68)	(154.47)	(154.42)	(154.86)	(155.04)	(178.23)	(158.66)	(267.82)
child_2		4969.70***		2662.71***	673.29***	480.99***	1085.98***	917.31***	871.55***	751.01***	-112.33	-1867.36***	3083.11***
		(94.48)		(95.21)	(110.38)	(128.78)	(151.13)	(152.23)	(152.68)	(152.73)	(181.96)	(158.84)	(269.85)
child_3		5570.23***		4388.28***	1947.29***	2308.96***	3220.32***	2869.99***	2819.11***	2664.22***	2213.87***	-763.10***	4950.92***
		(117.31)		(114.56)	(134.55)	(144.77)	(180.45)	(182.50)	(182.99)	(183.31)	(224.04)	(196.33)	(327.84)
child_4		6633.89***		6234.57***	3441.44***	4235.92***	5331.24***	4771.26***	4650.07***	4348.42***	6853.97***	2173.96***	6549.69***
		(255.73)		(251.00)	(264.81)	(266.06)	(296.70)	(298.47)	(299.03)	(299.00)	(504.99)	(484.16)	(651.77)
child_5		7233.54***		7406.48***	4345.47***	5520.99***	6782.30***	6039.10***	5762.08***	5336.85***	13111.00***	7164.88***	5995.69**
		(689.22)		(683.37)	(687.41)	(686.31)	(703.53)	(703.56)	(707.43)	(707.95)	(2250.60)	(2021.37)	(2786.50)
child_6		8208.48***		8987.94***	5567.58***	7040.73***	8438.46***	7518.04***	7322.09***	6899.55***	7843.50***	-1631.06	13892.20***
		(1387.78)		(1373.81)	(1372.81)	(1385.20)	(1396.30)	(1401.27)	(1412.75)	(1408.99)	(2634.93)	(3601.30)	(622.14)
Age_Elder_child							-121.70***	-120.43***	-118.72***	-115.68***	-61.54***	29.37	-26.88
							(17.52)	(17.50)	(17.51)	(17.44)	(23.06)	(19.68)	(32.99)
Age_Youngest_child							81.40***	77.38***	76.42***	75.25***	37.03	-64.11***	18.87
							(18.03)	(18.00)	(18.01)	(17.95)	(23.49)	(20.02)	(34.62)
Age_me						-103.75**	-78.43*	-72.65	-59.94	-42.90	-118.65**	-607.48***	601.36***
						(46.34)	(46.72)	(46.73)	(46.90)	(47.05)	(57.40)	(50.51)	(94.58)
Age_me_squared						0.06	-0.21	-0.32	-0.44	-0.61	0.33	6.28***	-6.32***
						(0.51)	(0.51)	(0.51)	(0.51)	(0.52)	(0.63)	(0.56)	(1.00)
Age_wo						-101.11**	-84.16**	-76.41*	-75.46*	-64.30	-13.17	-333.23***	319.71***
						(41.69)	(42.02)	(41.98)	(42.15)	(42.10)	(52.21)	(42.97)	(81.87)
Age_wo_squared						0.14	-0.07	-0.21	-0.23	-0.37	-1.02*	3.02***	-3.47***
						(0.48)	(0.48)	(0.48)	(0.48)	(0.48)	(0.60)	(0.50)	(0.89)
House_age								3.68***	3.02***	2.79***			
								(0.94)	(0.95)	(0.97)			
Living floor space								14.33***	16.84***	23.41***			
								(1.02)	(1.05)	(1.11)			
Social_housing[T.True]								109.58	-124.05	-655.50**			
								(260.39)	(263.16)	(266.66)			
Proprietaire[T.True]								-1223.55***	-1038.77***	-702.81***			
								(149.85)	(150.97)	(152.46)			
Code_departement										X			
Code_commune									X	X			
adjusted-R2	0.43%	2.30%	3.66%	4.52%	2.34%	5.21%	5.25%	5.43%	5.55%	5.85%	4.38%	7.26%	18.12%
N	193555	193555	193555	193555	149604	193555	193555	193480	193480	193480	87773	69144	18629

3.B Common trend assumption and income dynamic

The results of any difference-in-differences is conditional to having the same trend in the treated group and the control group. Sadly this is not the case as shown in Table 3.B1 it is not the case and the common trend assumption is not respected at all. Table 3.B1 endogenous variable is the variation in taxable income between 2010 and 2011 for the group that were between or over the before and after reform thresholds in 2011. As the Table 41 is ran over 3 years (between 2011 to 2014) the coefficients of Table 3.B1 must be multiplied by 3 in order to be compared to Table 41.

Table 3.B1 – Placebo: Change in taxable income between 2010 and 2011

	Coef.	Std.Err.	z	P>|z|	[0.025	0.975]
child_1:Over_threshold_1_child[T.True]	1013.7136	291.3228	3.4797	0.0005	442.7313	1584.6959
child_2:Over_threshold_2_child[T.True]	2003.7273	346.2298	5.7873	0.0000	1325.1295	2682.3252
child_3:Over_threshold_3_child[T.True]	1074.8791	510.1980	2.1068	0.0351	74.9093	2074.8488
child_4:Over_threshold_4_child[T.True]	1312.4529	1378.3050	0.9522	0.3410	-1388.9752	4013.8810
child_5:Over_threshold_5_child[T.True]	4303.2466	5118.3928	0.8407	0.4005	-5728.6190	14335.1122
child_6:Over_threshold_6_child[T.True]	-15548.6533	2368.2153	-6.5656	0.0000	-20190.2699	-10907.0366
child_1:Between_threshold_1_child[T.True]	-418.8438	264.3425	-1.5845	0.1131	-936.9455	99.2580
child_2:Between_threshold_2_child[T.True]	576.4065	198.9304	2.8975	0.0038	186.5101	966.3030
child_3:Between_threshold_3_child[T.True]	1308.1298	372.5270	3.5115	0.0004	577.9903	2038.2693
child_4:Between_threshold_4_child[T.True]	2033.9523	1032.1475	1.9706	0.0488	10.9803	4056.9244
child_5:Between_threshold_5_child[T.True]	582.5841	2211.6896	0.2634	0.7922	-3752.2479	4917.4160
child_6:Between_threshold_6_child[T.True]	10807.8874	6803.4378	1.5886	0.1122	-2526.6056	24142.3804
child_1	-761.4231	164.7657	-4.6212	0.0000	-1084.3579	-438.4883
child_2	-885.6099	177.5007	-4.9893	0.0000	-1233.5048	-537.7150
child_4	-853.3973	495.7822	-1.7213	0.0852	-1825.1126	118.3180
child_3	-603.9164	195.7742	-3.0848	0.0020	-987.6267	-220.2060
child_5	326.5476	486.3644	0.6714	0.5020	-626.7090	1279.8042
child_6	355.2790	2212.2645	0.1606	0.8724	-3980.6798	4691.2378
Flatten_thresholds_58291_63233[T.True]	1805.9904	101.9668	17.7116	0.0000	1606.1391	2005.8416
Flatten_thresholds_63233_63530[T.True]	1768.9434	372.3513	4.7507	0.0000	1039.1482	2498.7386
Flatten_thresholds_63530_73516[T.True]	1821.6234	162.5337	11.2077	0.0000	1503.0632	2140.1835
Flatten_thresholds_73516_73806[T.True]	967.4151	543.6417	1.7795	0.0752	-98.1031	2032.9332
Flatten_thresholds_73806_84103[T.True]	1877.6617	309.7642	6.0616	0.0000	1270.5350	2484.7884
Flatten_thresholds_84103_94368[T.True]	2664.5254	354.4948	7.5164	0.0000	1969.7283	3359.3225
Flatten_thresholds_94368_94451[T.True]	3890.5815	1375.0332	2.8294	0.0047	1195.5660	6585.5970
Flatten_thresholds_94451_104633[T.True]	3887.9329	381.3415	10.1954	0.0000	3140.5172	4635.3485
Flatten_thresholds_104633_115185[T.True]	5406.4239	429.0085	12.6021	0.0000	4565.5827	6247.2651
Flatten_thresholds_115185_135941[T.True]	6567.8691	610.7410	10.7539	0.0000	5370.8387	7764.8994
Flatten_thresholds_135941_150684[T.True]	8134.5162	781.1546	10.4135	0.0000	6603.4813	9665.5511
Flatten_thresholds_more_then_150684	10870.8475	822.5024	13.2168	0.0000	9258.7725	12482.9225
Age_wo	-141.5416	47.8843	-2.9559	0.0031	-235.3932	-47.6900
Age_me	12.8352	50.2110	0.2556	0.7982	-85.5766	111.2470
Age_wo_squared	0.3549	0.5572	0.6369	0.5242	-0.7371	1.4469
Age_me_squared	-1.2148	0.5578	-2.1777	0.0294	-2.3082	-0.1215
Age_Elder_child	-8.4385	19.2949	-0.4373	0.6619	-46.2559	29.3789
Age_Youngest_child	23.8394	19.8137	1.2032	0.2289	-14.9948	62.6737
Intercept	8885.6160	1204.9986	7.3740	0.0000	6523.8622	11247.3699

As I am not able to see why there is a common trend due to the interaction of a specific position in the income distribution and a specific number of children, I conclude that the effects on the placebo seems too big to draw any hindsight of the impact of the reform of the lowering of the maximum tax child break ceiling.

It might be possible to see if I can extract hindsight from the income dynamic of the treated group.

Table 3.B2 – Triple-diff income dynamic

	Δ2010_2011	Δ2011_2012	Δ2012_2013	Δ2013_2014	sum_delta_rbg_2011_2014	Δ2011_2014	Delta - common trend
child_1:Between_threshold_1_child[T.True]	-345.73	336.22	487.45	-0.71	822.96	822.96	1860.13
child_2:Between_threshold_2_child[T.True]	596.24	524.34	855.02	948.67	2328.03	2328.03	539.30
child_3:Between_threshold_3_child[T.True]	1406.99	1201.89	1125.62	1872.06	4199.57	4199.57	-21.39
child_4:Between_threshold_4_child[T.True]	2450.07	1404.61	1384.90	180.41	2969.92	2969.92	-4380.29
child_5:Between_threshold_5_child[T.True]	3102.30	-2213.25	-226.89	-1151.09	-3591.23	-3591.23	-12898.12
child_6:Between_threshold_6_child[T.True]	11309.54	-9056.82	-2063.65	2340.45	-8780.02	-8780.02	-42708.66
child_1:Over_threshold_1_child[T.True]	700.16	610.08	741.05	1056.78	2407.91	2407.91	307.43
child_2:Over_threshold_2_child[T.True]	2247.33	1343.61	862.20	2074.99	4280.80	4280.80	-2461.18
child_3:Over_threshold_3_child[T.True]	1408.91	2137.46	742.77	1268.34	4148.57	4148.57	-78.15
child_4:Over_threshold_4_child[T.True]	1952.02	1991.49	-305.29	1446.08	3132.28	3132.28	-2723.78
child_5:Over_threshold_5_child[T.True]	3380.27	3458.37	5491.63	-4752.35	4197.65	4197.65	-5943.15
child_6:Over_threshold_6_child[T.True]	13285.67	-23328.78	23431.79	-23106.26	-23003.26	-23003.26	-62860.26
Flatten_thresholds_58291_63233[T.True]	1568.13	-1889.56	-1390.36	-1987.60	-5267.52	-5267.52	-9971.90
Flatten_thresholds_63233_63530[T.True]	1752.43	-2400.85	-1620.98	-1855.76	-5877.60	-5877.60	-11134.89
Flatten_thresholds_63530_73516[T.True]	1558.36	-2309.65	-1667.61	-2347.87	-6325.13	-6325.13	-11000.22
Flatten_thresholds_73516_73806[T.True]	724.91	-2990.47	-1846.51	-2949.05	-7786.03	-7786.03	-9960.77
Flatten_thresholds_73806_84103[T.True]	1518.25	-2929.14	-1673.85	-2907.07	-7510.06	-7510.06	-12064.81
Flatten_thresholds_84103_94368[T.True]	2131.44	-3105.64	-1811.44	-3134.73	-8051.82	-8051.82	-14446.15
Flatten_thresholds_94368_94451[T.True]	3821.03	-1629.95	-1720.68	-4277.41	-7628.04	-7628.04	-19091.12
Flatten_thresholds_94451_104633[T.True]	3404.73	-3219.80	-1640.32	-2362.77	-7222.89	-7222.89	-17437.07
Flatten_thresholds_104633_115185[T.True]	5039.77	-3301.09	-1573.51	-2549.85	-7424.45	-7424.45	-22543.76
Flatten_thresholds_115185_135941[T.True]	5537.94	-3860.17	-1346.77	-2328.80	-7535.74	-7535.74	-24149.57
Flatten_thresholds_135941_150684[T.True]	7669.91	-3262.88	-2143.53	-875.76	-6282.18	-6282.18	-29291.92
Flatten_thresholds_more_then_150684	9939.53	-4932.77	-1426.38	-1817.95	-8177.11	-8177.11	-37995.70
child_1	1443.93	562.68	605.43	740.68	1908.79	1908.79	-2422.99
child_2	1962.69	961.19	979.84	895.19	2836.22	2836.22	-3051.85
child_3	2178.43	1401.89	1592.11	1619.58	4613.58	4613.58	-1921.71
child_4	1776.74	1866.71	1861.48	2597.42	6325.60	6325.60	995.39
child_5	2270.77	2359.50	1240.16	4153.05	7752.72	7752.72	940.41
child_6	3111.88	3529.84	2559.65	2537.93	8627.42	8627.42	-708.21
Intercept	-632.30	2072.31	1958.87	2013.81	6 677.29	6 677.29	-8573

3.C Retirement pension reform

The legal retirement age has been progressively increased from 60 to 62 years old by one quarter every year in 2011. It implies a shift from 40 to 42 contributive years to the pension system to be entitled to a full retirement pension. Thus individuals being born after 1951 up to 1959 (aged between 60 to 52 years old in 2011) face an increase in their legal retirement age of one quarter every year, and individuals born after 1959 face increase of two year of their retirement age. The reform has been implemented progressively base on the date of birth. As I cannot observe the numbers of years of work over a citizen career, I use the date of birth as a proxy in order to control a potential polution of the retirement pension system in the estimation. Do do so I use each birth date as a dummy to capture the effect of being born a particular year.

Table 3.C1 – Triple-diff with age as binary control

	Coef.	Std.Err.	z	P>|z|	[0.025	0.975]
child_1:Over_threshold_1_child[T.True]	2243.1657	231.6777	9.6823	0.0000	1789.0858	2697.2456
child_2:Over_threshold_2_child[T.True]	3973.8246	236.4942	16.8031	0.0000	3510.3045	4437.3447
child_3:Over_threshold_3_child[T.True]	3473.0517	399.0729	8.7028	0.0000	2690.8832	4255.2202
child_4:Over_threshold_4_child[T.True]	2640.2053	1052.0227	2.5096	0.0121	578.2786	4702.1320
child_5:Over_threshold_5_child[T.True]	4547.3686	3921.6337	1.1596	0.2462	-3138.8922	12233.6295
child_6:Over_threshold_6_child[T.True]	-766.0383	13918.7543	-0.0550	0.9561	-28046.2955	26514.2190
child_1:Between_threshold_1_child[T.True]	618.9482	254.3004	2.4339	0.0149	120.5286	1117.3677
child_2:Between_threshold_2_child[T.True]	2297.4942	197.0133	11.6616	0.0000	1911.3552	2683.6333
child_3:Between_threshold_3_child[T.True]	3809.5045	315.2478	12.0842	0.0000	3191.6301	4427.3789
child_4:Between_threshold_4_child[T.True]	2314.2887	753.3694	3.0719	0.0021	837.7117	3790.8657
child_5:Between_threshold_5_child[T.True]	-4903.4519	2190.3352	-2.2387	0.0252	-9196.4299	-610.4738
child_6:Between_threshold_6_child[T.True]	-9942.1393	4724.4496	-2.1044	0.0353	-19201.8904	-682.3881
Flatten_thresholds_58291_63233[T.True]	-5190.7402	105.2154	-49.3344	0.0000	-5396.9586	-4984.5217
Flatten_thresholds_63233_63530[T.True]	-5571.4843	381.5813	-14.6010	0.0000	-6319.3700	-4823.5987
Flatten_thresholds_63530_73516[T.True]	-6241.5960	145.5886	-42.8715	0.0000	-6526.9443	-5956.2477
Flatten_thresholds_73516_73806[T.True]	-7407.0879	627.8722	-11.7971	0.0000	-8637.6947	-6176.4810
Flatten_thresholds_73806_84103[T.True]	-7225.4272	209.2301	-34.5334	0.0000	-7635.5107	-6815.3438
Flatten_thresholds_84103_94368[T.True]	-7696.6296	250.4800	-30.7275	0.0000	-8187.5614	-7205.6978
Flatten_thresholds_94368_94451[T.True]	-7887.1417	1850.3264	-4.2626	0.0000	-11513.7149	-4260.5685
Flatten_thresholds_94451_104633[T.True]	-6815.9814	303.0218	-22.4934	0.0000	-7409.8932	-6222.0695
Flatten_thresholds_104633_115185[T.True]	-7011.4571	366.8651	-19.1118	0.0000	-7730.4995	-6292.4146
Flatten_thresholds_115185_135941[T.True]	-7046.4945	361.4348	-19.4959	0.0000	-7754.8936	-6338.0954
Flatten_thresholds_135941_150684[T.True]	-6065.0892	536.6178	-11.3024	0.0000	-7116.8408	-5013.3377
Flatten_thresholds_more_then_150684	-8251.9731	494.6747	-16.6816	0.0000	-9221.5178	-7282.4285
child_1	464.6482	156.3648	2.9716	0.0030	158.1789	771.1175
child_2	1098.7501	155.5636	7.0630	0.0000	793.8510	1403.6492
child_3	2866.5910	185.3396	15.4667	0.0000	2503.3320	3229.8501
child_4	4601.1786	300.6287	15.3052	0.0000	4011.9571	5190.4000
child_5	5733.1544	705.6158	8.1250	0.0000	4350.1728	7116.1360
child_6	7006.8130	1391.9004	5.0340	0.0000	4278.7384	9734.8876
C(Age_wo)[T.50.0]	542.6539	236.8836	2.2908	0.0220	78.3707	1006.9371
C(Age_wo)[T.51.0]	1133.1939	251.8190	4.5000	0.0000	639.6376	1626.7501
C(Age_wo)[T.52.0]	1020.2100	260.6817	3.9136	0.0001	509.2833	1531.1367
C(Age_wo)[T.53.0]	1469.8300	291.2241	5.0471	0.0000	899.0412	2040.6189
C(Age_wo)[T.54.0]	695.5606	333.5230	2.0855	0.0370	41.8675	1349.2536
C(Age_wo)[T.55.0]	1100.0672	379.2515	2.9006	0.0037	356.7479	1843.3864
C(Age_wo)[T.56.0]	1067.4572	430.2747	2.4809	0.0131	224.1343	1910.7802
C(Age_wo)[T.57.0]	1815.4634	480.7970	3.7759	0.0002	873.1186	2757.8082
C(Age_wo)[T.58.0]	1987.2349	540.2914	3.6781	0.0002	928.2832	3046.1866
C(Age_wo)[T.59.0]	1321.9794	602.8238	2.1930	0.0283	140.4663	2503.4924
C(Age_wo)[T.60.0]	-695.5008	656.3893	-1.0596	0.2893	-1982.0003	590.9986
C(Age_wo)[T.61.0]	1373.5815	717.5480	1.9143	0.0556	-32.7867	2779.9497
C(Age_wo)[T.62.0]	2514.0143	777.7267	3.2325	0.0012	989.6981	4038.3306
C(Age_wo)[T.63.0]	2984.8348	850.5679	3.5092	0.0004	1317.7524	4651.9172
C(Age_wo)[T.64.0]	3469.6938	927.2696	3.7418	0.0002	1652.2789	5287.1088
C(Age_me)[T.50.0]	-160.5817	208.2169	-0.7712	0.4406	-568.6794	247.5159
C(Age_me)[T.51.0]	66.7941	222.2471	0.3005	0.7638	-368.8023	502.3904
C(Age_me)[T.52.0]	378.9331	266.1091	1.4240	0.1545	-142.6311	900.4972
C(Age_me)[T.53.0]	185.6191	337.7049	0.5496	0.5826	-476.2703	847.5086
C(Age_me)[T.54.0]	-113.3918	414.8424	-0.2733	0.7846	-926.4680	699.6844
C(Age_me)[T.55.0]	440.5090	504.2093	0.8737	0.3823	-547.7230	1428.7411
C(Age_me)[T.56.0]	159.2252	596.7438	0.2668	0.7896	-1010.3713	1328.8216
C(Age_me)[T.57.0]	1119.3161	693.0513	1.6151	0.1063	-239.0394	2477.6716
C(Age_me)[T.58.0]	127.0113	799.1201	0.1589	0.8737	-1439.2353	1693.2578
C(Age_me)[T.59.0]	-34.4622	904.5000	-0.0381	0.9696	-1807.2497	1738.3253
C(Age_me)[T.60.0]	-1573.0397	1010.7747	-1.5563	0.1196	-3554.1217	408.0422
C(Age_me)[T.61.0]	-711.6908	1114.2865	-0.6387	0.5230	-2895.6522	1472.2706
C(Age_me)[T.62.0]	1073.4737	1226.6859	0.8751	0.3815	-1330.7864	3477.7338
C(Age_me)[T.63.0]	1617.3854	1338.6283	1.2082	0.2270	-1006.2778	4241.0487
C(Age_me)[T.64.0]	2274.1967	1452.6444	1.5656	0.1175	-572.9340	5121.3273
Age_Elder_child	-53.3198	18.0070	-2.9611	0.0031	-88.6128	-18.0268
Age_Youngest_child	3.0025	18.5842	0.1616	0.8717	-33.4218	39.4268
Intercept	19257.4313	2684.2274	7.1743	0.0000	13996.4423	24518.4203

Number of observations: 77669
Adj. R-squared: 0.013

Table 3.C1 shows that controlling for age with dummies (which is equivalent to controlling for date of birth) gives estimates that are extremely close to the one provided in the main analysis. I see that to have a particular age for men does not have a significant impact on the change in the household taxable income, while women having a woman that has the age to be impacted by the retirement pension reform shows a positive impact on taxable income which suggest that women reacted on the extensive margin to the reform by delaying their retirement.
But it still leaves the possibility that there exists a trend specific to households touched by both the lowering of the ceilings and the retirement pension reform. To control for that hypothesis I ran a quadruple difference on those most hardly impacted by the reform : those born between 1951 and 1959.

$$\begin{aligned}\Delta y_i = \beta_0 &+ \sum_{i=1}^{6} \beta_i \text{Children}_i + \sum_{j=1}^{6} {}_b\delta_j \text{Between}_j + \sum_{j=1}^{6} {}_o\delta_j \text{Over}_j \\ &+ \alpha \text{ Born between 1951 and 1959} \\ &+ \sum_{i=1}^{6} {}_b\zeta_i \text{Children}_i \times \text{Between}_i \times \text{Born between 1951 and 1959} \\ &+ \sum_{i=1}^{6} {}_o\zeta_i \text{Children}_i \times \text{Over}_i \times \text{Born between 1951 and 1959} \\ &+ \sum_{i=1}^{6} {}_b\gamma_i \text{Children}_i \times \text{Between}_i \\ &+ \sum_{i=1}^{6} {}_o\gamma_i \text{Children}_i \times \text{Over}_i \\ &+ \epsilon_i\end{aligned} \tag{3.6}$$

The estimates ${}_b\gamma_i$ and ${}_o\gamma_i$ does not vary much. The ζ terms are not significant which suggest that there is not a behavioral reaction due to the interaction between the lowering of the child tax break ceiling and the retirement pension reform. These results are displayed in Table 3.C2.

Table 3.C2 – Retirement pension reform: quadruple-diff

Dep. Variable:	I(Delta_Rbg)	**R-squared:**	0.058		
Model:	OLS	**Adj. R-squared:**	0.058		
No. Observations:	193480	**AIC:**	4.262e+06		
	coef	**std err**	**z**	**P>|z|**	**[95.0% Conf. Int.]**
Intercept	1.918e+04	2685.034	7.145	0.000	1.39e+04 2.44e+04
Flatten_thresholds_58291_63233[T.True]	-5195.2242	105.238	-49.367	0.000	-5401.487 -4988.962
Flatten_thresholds_63233_63530[T.True]	-5571.9069	381.656	-14.599	0.000	-6319.940 -4823.874
Flatten_thresholds_63530_73516[T.True]	-6256.9645	145.693	-42.946	0.000	-6542.519 -5971.411
Flatten_thresholds_73516_73806[T.True]	-7411.1487	628.116	-11.799	0.000	-8642.233 -6180.065
Flatten_thresholds_73806_84103[T.True]	-7233.3875	209.290	-34.562	0.000	-7643.589 -6823.186
Flatten_thresholds_84103_94368[T.True]	-7698.3736	250.510	-30.731	0.000	-8189.363 -7207.384
Flatten_thresholds_94368_94451[T.True]	-7877.9748	1839.507	-4.283	0.000	-1.15e+04 -4272.608
Flatten_thresholds_94451_104633[T.True]	-6820.2907	303.087	-22.503	0.000	-7414.330 -6226.251
Flatten_thresholds_104633_115185[T.True]	-7003.5038	366.972	-19.085	0.000	-7722.756 -6284.252
Flatten_thresholds_115185_135941[T.True]	-7040.1740	361.532	-19.473	0.000	-7748.764 -6331.584
Flatten_thresholds_135941_150684[T.True]	-6067.0035	536.696	-11.304	0.000	-7118.908 -5015.099
Proprietaire[T.True]	-1094.8990	150.096	-7.295	0.000	-1389.081 -800.717
Social_housing[T.True]	81.0104	259.455	0.312	0.755	-427.513 589.534
C(Age_wo)[T.28.0]	-3095.0191	930.924	-3.325	0.001	-4919.597 -1270.441
C(Age_wo)[T.30.0]	-3388.5877	762.935	-4.442	0.000	-4883.912 -1893.263
C(Age_wo)[T.32.0]	-3353.1771	648.901	-5.167	0.000	-4624.999 -2081.355
C(Age_wo)[T.34.0]	-2421.6452	537.413	-4.506	0.000	-3474.956 -1368.334
C(Age_wo)[T.36.0]	-2441.5936	432.903	-5.640	0.000	-3290.068 -1593.119
C(Age_wo)[T.38.0]	-1986.1170	325.175	-6.108	0.000	-2623.449 -1348.785
C(Age_wo)[T.40.0]	-1377.5214	230.679	-5.972	0.000	-1829.644 -925.399
C(Age_wo)[T.42.0]	-942.1042	172.760	-5.453	0.000	-1280.707 -603.501
C(Age_wo)[T.44.0]	-426.8560	208.683	-2.045	0.041	-835.868 -17.845
C(Age_wo)[T.46.0]	830.0316	305.434	2.718	0.007	231.393 1428.670
C(Age_wo)[T.48.0]	1549.1167	434.017	3.569	0.000	698.459 2399.774
C(Age_wo)[T.50.0]	2393.6266	578.806	4.135	0.000	1259.188 3528.065
C(Age_wo)[T.52.0]	-440.2328	429.579	-1.025	0.305	-1282.192 401.726
C(Age_wo)[T.54.0]	-625.5129	313.622	-1.994	0.046	-1240.201 -10.825
C(Age_wo)[T.56.0]	-112.0020	262.862	-0.426	0.670	-627.201 403.197
C(Age_wo)[T.58.0]	964.4658	315.532	3.057	0.002	346.035 1582.897
C(Age_wo)[T.59.0]	387.3132	379.650	1.020	0.308	-356.787 1131.413
C(Age_wo)[T.60.0]	-1529.8067	440.593	-3.472	0.001	-2393.353 -666.261
C(Age_wo)[T.61.0]	-110.2620	361.775	-0.305	0.761	-819.328 598.804
C(Age_wo)[T.62.0]	1129.5295	424.382	2.662	0.008	297.756 1961.303
C(Age_wo)[T.63.0]	1696.1551	511.740	3.314	0.001	693.163 2699.147
C(Age_wo)[T.64.0]	2279.2369	608.283	3.747	0.000	1087.024 3471.450
C(Age_me)[T.28.0]	182.5982	1519.881	0.120	0.904	-2796.313 3161.510
C(Age_me)[T.30.0]	-448.8811	1251.270	-0.359	0.720	-2901.325 2003.562
C(Age_me)[T.32.0]	-395.0803	1060.553	-0.373	0.710	-2473.726 1683.565
C(Age_me)[T.34.0]	-644.9589	880.134	-0.733	0.464	-2369.990 1080.072
C(Age_me)[T.36.0]	-939.2401	698.610	-1.344	0.179	-2308.491 430.011
C(Age_me)[T.38.0]	-688.8764	509.704	-1.352	0.177	-1687.878 310.126
C(Age_me)[T.40.0]	-833.6864	324.939	-2.566	0.010	-1470.555 -196.818
C(Age_me)[T.42.0]	-745.6632	185.137	-4.028	0.000	-1108.525 -382.801
C(Age_me)[T.44.0]	-342.4626	232.900	-1.470	0.141	-798.938 114.013
C(Age_me)[T.46.0]	-481.4794	424.626	-1.134	0.257	-1313.732 350.773
C(Age_me)[T.48.0]	-11.3472	655.325	-0.017	0.986	-1295.761 1273.066
C(Age_me)[T.50.0]	305.5294	900.458	0.339	0.734	-1459.336 2070.395
C(Age_me)[T.52.0]	219.3007	637.953	0.344	0.731	-1031.065 1469.666
C(Age_me)[T.54.0]	-274.0987	397.711	-0.689	0.491	-1053.598 505.401
C(Age_me)[T.56.0]	4.7511	236.781	0.020	0.984	-459.331 468.833
C(Age_me)[T.58.0]	27.9159	355.052	0.079	0.937	-667.973 723.805
C(Age_me)[T.59.0]	-132.3173	479.018	-0.276	0.782	-1071.176 806.541
C(Age_me)[T.60.0]	-1659.5520	615.221	-2.697	0.007	-2865.363 -453.741
C(Age_me)[T.61.0]	-1321.9923	440.189	-3.003	0.003	-2184.747 -459.237
C(Age_me)[T.62.0]	486.7746	581.034	0.838	0.402	-652.032 1625.581
C(Age_me)[T.63.0]	1055.8604	728.761	1.449	0.147	-372.485 2484.206
C(Age_me)[T.64.0]	1738.6381	883.840	1.967	0.049	6.343 3470.933
child_1	581.3500	159.742	3.639	0.000	268.262 894.438
child_1:Between_threshold_1_child[T.True]	684.6788	278.555	2.458	0.014	138.721 1230.636
child_1:Over_threshold_1_child[T.True]	2514.1206	257.315	9.771	0.000	2009.792 3018.449
child_2	1280.3575	161.393	7.933	0.000	964.033 1596.681
child_2:Between_threshold_2_child[T.True]	2432.1534	201.273	12.084	0.000	2037.666 2826.641
child_2:Over_threshold_2_child[T.True]	4013.1381	241.702	16.604	0.000	3539.411 4486.865
child_3	3067.6752	190.818	16.076	0.000	2693.679 3441.671
child_3:Between_threshold_3_child[T.True]	3911.3400	323.049	12.108	0.000	3278.177 4544.503
child_3:Over_threshold_3_child[T.True]	3482.8343	413.497	8.423	0.000	2672.394 4293.274
child_4	4807.8859	304.028	15.814	0.000	4212.003 5403.769
child_4:Between_threshold_4_child[T.True]	2892.6340	781.860	3.700	0.000	1360.216 4425.052
child_4:Over_threshold_4_child[T.True]	3469.8558	1127.892	3.076	0.002	1259.228 5680.483
child_5	5939.8517	707.224	8.399	0.000	4553.717 7325.986
child_5:Between_threshold_5_child[T.True]	-4919.8210	2190.165	-2.246	0.025	-9212.465 -627.177
child_5:Over_threshold_5_child[T.True]	4553.6192	3923.120	1.161	0.246	-3135.554 1.22e+04
child_6	7219.5915	1392.326	5.185	0.000	4490.683 9948.500
child_6:Between_threshold_6_child[T.True]	-9956.4846	4720.997	-2.109	0.035	-1.92e+04 -703.501
child_6:Over_threshold_6_child[T.True]	-741.4971	1.39e+04	-0.053	0.958	-2.8e+04 2.65e+04
Flatten_thresholds_more_then_150684	-8244.6163	494.729	-16.665	0.000	-9214.268 -7274.964
Interaction_age_me_between_52_60_between_thresholds_child_1	379.8976	617.481	0.615	0.538	-830.342 1590.138
Interaction_age_me_between_52_60_between_thresholds_child_2	-1722.1613	513.282	-3.355	0.001	-2728.176 -716.146
Interaction_age_me_between_52_60_between_thresholds_child_3	-966.0391	951.628	-1.015	0.310	-2831.196 899.117
Interaction_age_me_between_52_60_between_thresholds_child_4	-8768.5906	2495.190	-3.514	0.000	-1.37e+04 -3878.108
Interaction_age_wo_between_52_60_between_thresholds_child_1	-985.5419	690.140	-1.428	0.153	-2338.191 367.107
Interaction_age_wo_between_52_60_between_thresholds_child_2	288.4235	729.258	0.396	0.692	-1140.896 1717.743
Interaction_age_wo_between_52_60_between_thresholds_child_3	-1414.4021	1532.192	-0.923	0.356	-4417.444 1588.640
Interaction_age_wo_between_52_60_between_thresholds_child_4	3808.8395	5114.922	0.745	0.456	-6216.223 1.38e+04
Interaction_age_me_between_52_60_over_thresholds_child_1	-587.2162	422.374	-1.390	0.164	-1415.053 240.621
Interaction_age_me_between_52_60_over_thresholds_child_2	-540.2512	487.587	-1.108	0.268	-1495.904 415.402
Interaction_age_me_between_52_60_over_thresholds_child_3	-542.2953	1117.416	-0.485	0.627	-2732.390 1647.800
Interaction_age_me_between_52_60_over_thresholds_child_4	-4156.0083	2647.488	-1.570	0.116	-9344.990 1032.974
Interaction_age_wo_between_52_60_over_thresholds_child_1	-540.4017	461.034	-1.172	0.241	-1444.012 363.209
Interaction_age_wo_between_52_60_over_thresholds_child_2	136.8539	689.895	0.198	0.843	-1215.315 1489.023
Interaction_age_wo_between_52_60_over_thresholds_child_3	579.9411	1722.896	0.337	0.736	-2796.873 3956.755
Interaction_age_wo_between_52_60_over_thresholds_child_4	-1.121e+04	6026.645	-1.860	0.063	-2.3e+04 600.319
Age_wo_squared	-3.9072	0.755	-5.173	0.000	-5.387 -2.427
Age_me_squared	-2.0734	1.277	-1.624	0.104	-4.576 0.430
Age_Elder_child	-57.5695	18.042	-3.191	0.001	-92.931 -22.208
Age_Youngest_child	7.4519	18.622	0.400	0.689	-29.046 43.950
SURFTOT	14.7075	1.022	14.385	0.000	12.704 16.711
House_age	3.3911	0.941	3.604	0.000	1.547 5.235
Age_over_60_me	1466.3674	2084.764	0.703	0.482	-2619.695 5552.430
Age_over_60_wo	4276.5642	1254.087	3.410	0.001	1818.599 6734.529
Age_between_52_60_me	-492.9134	363.301	-1.357	0.175	-1204.969 219.143
Age_between_52_60_wo	-718.0953	245.873	-2.921	0.003	-1199.997 -236.193

3.D Both parents working

Table 3.D1 – Results: Triple-diff with both parents working

Model:	OLS	Adj. R-squared:	0.013
Dependent Variable:	I(Delta_Rbg)	AIC:	1671774.1863
Date:	2019-05-21 16:05	BIC:	1672107.5706
No. Observations:	77705	Log-Likelihood:	-8.3585e+05
Df Model:	35	F-statistic:	1288.
Df Residuals:	77669	Prob (F-statistic):	0.00
R-squared:	0.014	Scale:	1.2909e+08

	Coef.	Std.Err.	z	P>|z|	[0.025	0.975]
child_1:Over_threshold_1_child[T.True]	246.8448	271.4298	0.9094	0.3631	-285.1478	778.8374
child_2:Over_threshold_2_child[T.True]	1387.2756	297.4113	4.6645	0.0000	804.3601	1970.1911
child_3:Over_threshold_3_child[T.True]	2081.1183	503.2011	4.1358	0.0000	1094.8622	3067.3743
child_4:Over_threshold_4_child[T.True]	3903.0588	1433.8105	2.7222	0.0065	1092.8418	6713.2758
child_5:Over_threshold_5_child[T.True]	5047.2409	3528.6668	1.4304	0.1526	-1868.8189	11963.3006
child_6:Over_threshold_6_child[T.True]	-0.0000	0.0000	-0.0601	0.9521	-0.0000	0.0000
child_1:Between_threshold_1_child[T.True]	-330.4153	248.6065	-1.3291	0.1838	-817.6751	156.8446
child_2:Between_threshold_2_child[T.True]	349.6620	217.7322	1.6059	0.1083	-77.0853	776.4093
child_3:Between_threshold_3_child[T.True]	1997.9937	365.9863	5.4592	0.0000	1280.6737	2715.3137
child_4:Between_threshold_4_child[T.True]	1680.2392	945.4314	1.7772	0.0755	-172.7722	3533.2506
child_5:Between_threshold_5_child[T.True]	-1832.2186	3491.6331	-0.5247	0.5998	-8675.6938	5011.2566
child_6:Between_threshold_6_child[T.True]	-562.1307	6828.9470	-0.0823	0.9344	-13946.6210	12822.3595
Flatten_thresholds_58291_63233[T.True]	-639.1458	106.0119	-6.0290	0.0000	-846.9252	-431.3663
Flatten_thresholds_63233_63530[T.True]	-1152.8044	380.4688	-3.0300	0.0024	-1898.5094	-407.0993
Flatten_thresholds_63530_73516[T.True]	-299.1475	175.1890	-1.7076	0.0877	-642.5117	44.2167
Flatten_thresholds_73516_73806[T.True]	-893.5035	729.9807	-1.2240	0.2209	-2324.2395	537.2325
Flatten_thresholds_73806_84103[T.True]	-325.1272	266.0109	-1.2222	0.2216	-846.4990	196.2445
Flatten_thresholds_84103_94368[T.True]	253.3638	309.4332	0.8188	0.4129	-353.1142	859.8418
Flatten_thresholds_94368_94451[T.True]	1963.0885	1594.1770	1.2314	0.2182	-1161.4409	5087.6180
Flatten_thresholds_94451_104633[T.True]	773.0929	374.5901	2.0638	0.0390	38.9099	1507.2760
Flatten_thresholds_104633_115185[T.True]	874.2987	455.3999	1.9198	0.0549	-18.2686	1766.8660
Flatten_thresholds_115185_135941[T.True]	538.1627	465.7563	1.1555	0.2479	-374.7028	1451.0282
Flatten_thresholds_135941_150684[T.True]	357.7510	699.1873	0.5117	0.6089	-1012.6309	1728.1329
Flatten_thresholds_more_then_150684	-892.1601	667.7760	-1.3360	0.1815	-2200.9770	416.6568
child_1	244.2386	172.1133	1.4191	0.1559	-93.0972	581.5744
child_2	301.4730	174.0273	1.7323	0.0832	-39.6142	642.5602
child_3	1061.4543	211.1551	5.0269	0.0000	647.5980	1475.3106
child_4	1416.1906	358.4432	3.9509	0.0001	713.6548	2118.7264
child_5	3869.5820	1356.6704	2.8523	0.0043	1210.5569	6528.6071
child_6	3596.6017	2655.2763	1.3545	0.1756	-1607.6442	8800.8477
Age_wo	4.9460	77.8095	0.0636	0.9493	-147.5578	157.4499
Age_me	-800.2358	85.8936	-9.3166	0.0000	-968.5842	-631.8874
Intercept	26575.9724	1646.3590	16.1423	0.0000	23349.1680	29802.7768
Age_Elder_child	-41.2613	21.1743	-1.9487	0.0513	-82.7622	0.2396
Age_Youngest_child	10.6676	21.5395	0.4953	0.6204	-31.5491	52.8842

Omnibus:	12060.035	Durbin-Watson:	2.004
Prob(Omnibus):	0.000	Jarque-Bera (JB):	99305.082
Skew:	0.508	Prob(JB):	0.000
Kurtosis:	8.444	Condition No.:	10463403898658132

As shown in Table 43 and Table 44 a part of the effect is due to reaction on the extensive margin, Table 3.D1 contains only couples where both member of the couple are working before and after the reform. I identify working couples as couples for which both individuals have a labor income greater than 20 000 euros in 2011 and in 2014. I take such a

large threshold to rule out part time to full time extensive behavioral reactions.
The estimates of the triple-difference shows that the effect is not sollely due to reactions on the extensive margin. The effects are still positive and significant. Although the effects are smaller a significant share of the effect is due to reactions at the intensive margin.

Double Differences: As the reform embodies a triple diff in its inner nature, it might not be obvious what a double diff could be. It could be for each child rank to compare what happened above or below thresholds. It could be to run a regression on a specific treated group with households without children in the same position of the income distribution as the reference group.
Another solution would be to implement a simple DD with two treatments as in Equation 3.3. This is what is done in the first (1) regression of Table 3.D2 where I regress the tax reform would have impacted the change in taxable income between 2011 and 2014 based on whether or not a household if its income did not change. This shows that the reform had a negative impact on both households that face a change in MTR and a lump sum decrease. The interpretation would be that the substitution effect dominates for households that face an increase in their MTR (Treatment 1). Households that face a lump sum decrease in their disposable income would have reacted by decreasing their taxable income. This last interpretation would not be consistent with microeconomic theory as it would imply that households utility is decreasing either in income or in leisure. [25]
However, that regression is biased since it does not take into account trends that could be specific to change a specific location in the income distribution.
I can look at column (2) once I controlled for the income location.

25. Marginal rate of substitution supposes that taxpayers are willing to trade one unit of leisure for n of disposable income. If households increase their leisure when their disposable income decreases, it implies that the sign of n is negative and thus that either leisure or disposable income is (at least locally) a bad

Table 3.D2 – Double Differences with different types of controls

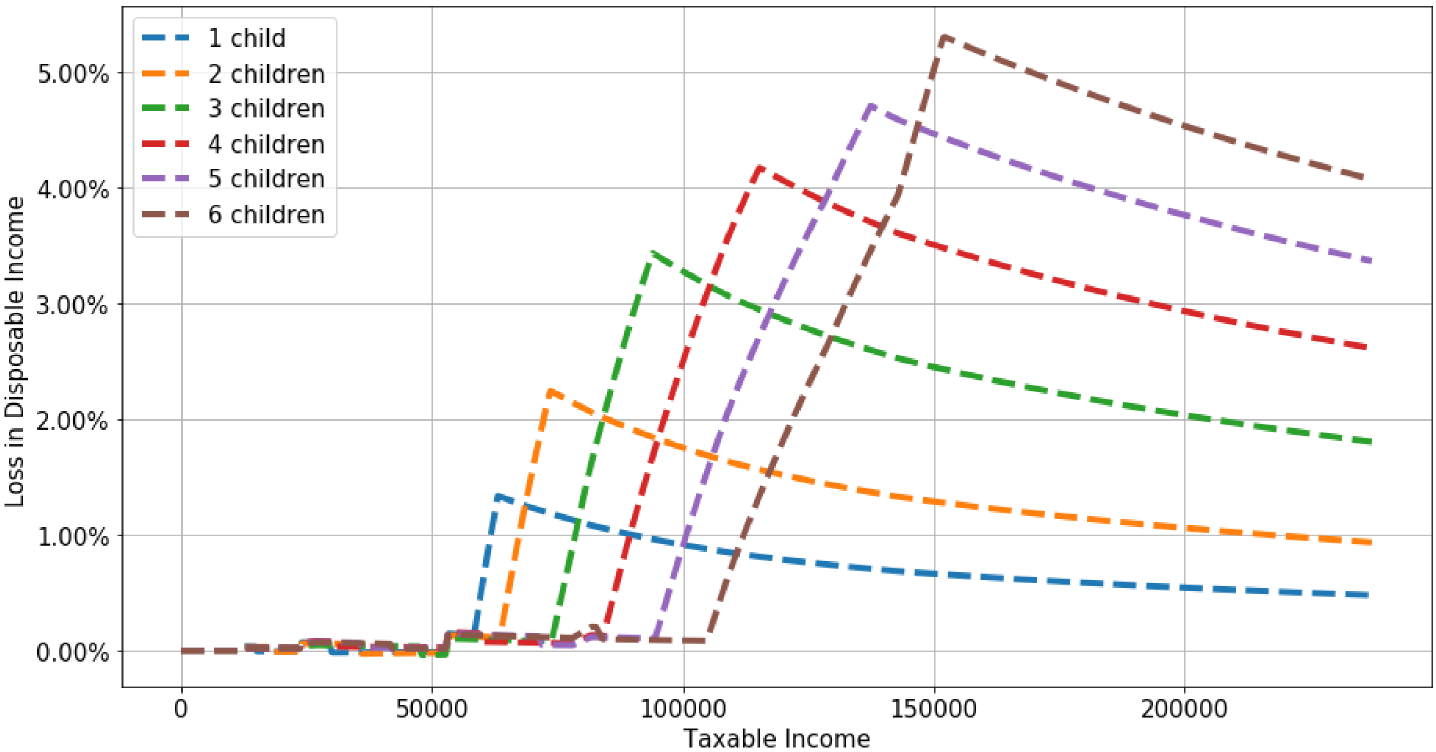
	(1)	(2)	(3)	(4)
Treatment 1	-1342***	3990***	-3033***	2490***
	(107)	(139)	(107)	(147)
Treatment 2	-1472***	4148***	-2883***	3313***
	(105)	(169)	(108)	(192)
Intercept	6647***	8625 ***	3113***	6335***
	(37)	(40)	(79)	(83)
Taxable income $\in [58291, 63233]$		-5973***		-5707***
		(100)		(99)
Taxable income $\in [63233, 63530]$		-6020***		-5977***
		(390)		(382)
Taxable income $\in [63530, 73516]$		-7439***		-6738***
		(125)		(129)
Taxable income $\in [73516, 73806]$		-7815***		-7480***
		(637)		(632)
Taxable income $\in [73806, 84103]$		-7717***		-7129***
		(178)		(189)
Taxable income $\in [84103, 94368]$		-8120***		-7574***
		(221)		(231)
Taxable income $\in [94368, 94451]$		-8230***		-7723***
		(1848)		(1856)
Taxable income $\in [94451, 104633]$		-7300***		-6942***
		(282)		(292)
Taxable income $\in [104633, 115185]$		-7530***		-7187***
		(347)		(355)
Taxable income $\in [115185, 135941]$		-7380***		-7170***
		(338)		(348)
Taxable income $\in [135941, 150684]$		-6290***		-6110***
		(524)		(529)
Taxable income over 150684 euros		-8273***		-8167***
		(473)		(481)
1 child1			4135***	1244***
			(117)	(124)
2 child2			5073***	2898***
			(94)	(94)
3 child3			6021***	4715***
			(116)	(112)
4 child4			6948***	6189***
			(253)	(249)
5 child5			6658***	6432***
			(674)	(672)
6 child6			7216***	7626***
			(1364)	(1362)
Number of observations	193555	193555	193555	193555

As the mean increase in the population is of 8625 euros, I see that being on a specific

location of the income distribution has a negative effect. As an example, the marginal impact of earning between 84103 and 94368 euros in 2011 is a decrease in declared taxable income of 8230 euros in 2014 compared to households earning less than 58291 euros. Treatments have both a positive impact on the change in the tax base, households when controlling only for the position in the income distribution. Wich would mean that the income effect strongly dominates the substitution effect. However, when controlling just for the number of children (3), the effect is strongly negative with a decrease in taxable income of about 3000 euros for both treated group.
When controlling for both income position and the number of children (4), both difference in trends for the number of children, the impact of each treatment is positive. Meaning that I indeed observe a pure positive income effect (Treatment 2), and a substitution effect that the dominates the income effect (Treatment 1). However, I can note that regression (4) is just a pooled triple-diff, namely the weighted average of the triple diff.

3.E Loss in precentage of disposable income.

Figure 3.E1 – Loss in relative disposable income due to the reform.



3.F Extensive margins, probability linear models:

	Me_start_working	Wo_start_working	Me_stop_working_not_retired	Wo_stop_working_not_retired	Me_get_retired	Wo_get_retired
$Over_1 \times Child_1$	0.0032**	0.0058***	-0.0256***	0.0001	-0.0196***	-0.0092***
	(0.0015)	(0.0017)	(0.0057)	(0.0038)	(0.0034)	(0.0027)
$Over_1 \times Child_2$	0.0086***	0.0010	-0.0480***	0.0007	-0.0290***	-0.0090***
	(0.0012)	(0.0016)	(0.0050)	(0.0033)	(0.0034)	(0.0029)
$Over_1 \times Child_3$	0.0064***	-0.0147***	-0.0519***	0.0057	-0.0256***	-0.0065**
	(0.0015)	(0.0026)	(0.0067)	(0.0046)	(0.0036)	(0.0031)
$Over_1 \times Child_4$	0.0017	-0.0206**	-0.0602***	0.0140	-0.0239***	-0.0019
	(0.0034)	(0.0082)	(0.0149)	(0.0110)	(0.0042)	(0.0047)
$Between1 \times Child_1$	0.0013	0.0085***	-0.0093	0.0011	-0.0016	-0.0012
	(0.0018)	(0.0023)	(0.0078)	(0.0056)	(0.0037)	(0.0027)
$Between1 \times Child_2$	0.0065***	0.0040**	-0.0113**	0.0047	-0.0214***	-0.0067***
	(0.0012)	(0.0017)	(0.0051)	(0.0036)	(0.0028)	(0.0023)
$Between1 \times Child_3$	0.0047***	-0.0054*	-0.0286***	-0.0032	-0.0258***	-0.0096***
	(0.0016)	(0.0028)	(0.0067)	(0.0045)	(0.0035)	(0.0029)
$Between1 \times Child_4$	0.0017	-0.0168**	-0.0382***	-0.0017	-0.0256***	-0.0067*
	(0.0036)	(0.0079)	(0.0138)	(0.0091)	(0.0043)	(0.0039)
$Child_1$	-0.0019	-0.0011	0.0808***	-0.0052*	-0.0338***	-0.0260***
$Child_2$	-0.0053***	0.0064***	0.0629***	-0.0189***	-0.0301***	-0.0184***
$Child_3$	-0.0020	0.0250***	0.0529***	-0.0257***	-0.0344***	-0.0180***
$Child_4$	0.0030	0.0462***	0.0388***	-0.0264***	-0.0377***	-0.0186***
Taxable income $\in [58291, 63233]$	-0.0090***	-0.0140***	0.0209***	0.0085***	-0.0005	-0.0018
Taxable income $\in [63233, 63530]$	-0.0067**	-0.0137***	0.0312***	0.0165**	-0.0040	-0.0059
Taxable income $\in [63530, 73516]$	-0.0120***	-0.0153***	0.0374***	0.0071***	0.0149***	0.0021
Taxable income $\in [73516, 73806]$	-0.0147***	-0.0166***	0.0604***	0.0071	0.0165**	-0.0012
Taxable income $\in [73806, 84103]$	-0.0128***	-0.0126***	0.0684***	0.0092***	0.0210***	0.0040
Taxable income $\in [84103, 94368]$	-0.0118***	-0.0101***	0.0838***	0.0108***	0.0196***	0.0026
Taxable income $\in [94368, 94451]$	-0.0182***	-0.0248***	0.0869**	-0.0314	0.0033	-0.0145***
Taxable income $\in [94451, 104633]$	-0.0135***	-0.0044**	0.0947***	0.0012	0.0214***	0.0031
Taxable income $\in [104633, 115185]$	-0.0151***	-0.0065***	0.1084***	0.0064	0.0179***	0.0018
Taxable income $\in [115185, 135941]$	-0.0144***	-0.0074***	0.1185***	0.0091**	0.0136***	-0.0034
Taxable income $\in [135941, 150684]$	-0.0147***	-0.0057**	0.1406***	0.0067	0.0104**	-0.0026
Taxable income over 150684 euros	-0.0170***	-0.0052**	0.1605***	0.0125**	0.0067	-0.0020
Intercept	0.0877***	0.1316***	-1.1587***	-0.0323**	0.3897***	0.3532***
Age_wo	0.0012***	-0.0058***	0.0063***	0.0070***	-0.0017***	-0.0118***
	(0.0003)	(0.0007)	(0.0012)	(0.0004)	(0.0006)	(0.0005)
Age_me	-0.0046***	0.0012**	0.0959***	0.0002	-0.0186***	-0.0066***
	(0.0006)	(0.0005)	(0.0018)	(0.0007)	(0.0008)	(0.0006)
I(Age_wo_squared / 10 ** 4)	-0.1025***	0.5614***	-1.1955***	-0.9674***	0.2693***	1.7518***
	(0.0348)	(0.0721)	(0.1369)	(0.0527)	(0.0713)	(0.0650)
I(Age_me_squared / 10 ** 4)	0.5090***	-0.1009**	-11.8298***	-0.0203	2.5521***	0.7521***
	(0.0653)	(0.0477)	(0.1955)	(0.0747)	(0.0865)	(0.0708)
I(Age_Elder_child / 10 ** 4)	0.9410**	-1.4765**	-0.9211	-13.8524***	-2.3328***	-0.8657
	(0.4754)	(0.6009)	(1.8390)	(1.2051)	(0.8539)	(0.6875)
adjusted-R2	0.54%	0.94%	26.85%	0.44%	11.72%	9.43%
N	192640	192640	192640	192640	192640	192640

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Conclusion

Cette thèse a visée à ouvrir des pistes d'amélioration des politiques publiques. Le premier en explorant un détail technique, la temporalité de l'impôt, relativement inexploré par la littérature. Le second en documentant des comportements de non-optimisation de la part des ménages documente de nouveaux comportements vis à vis d'un système fiscal lié a des choix d'optimisation lors de la déclaration fiscale. Le troisième en essayant d'identifier via une nouvelle méthodologie le comportement des ménages aisés vis à vis des modifications de l'impôt, tout en identifiant séparément les effets revenus des effets de substitution.

7 Softwares:

git (Hamano and Torvalds, 2005), Jupyter (Kluyver et al., 2016), LaTeX(Lamport, 1994), Matplotlib (Hunter, 2007), Numpy (Van Der Walt et al., 2011) , Openfisca (Ben Jelloul and Schaff, 2012), Pandas (McKinney, 2011), Python (Rossum, 1995), Statsmodels (Seabold and Perktold, 2010).

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