

Taxation and the digital economy: A survey of theoretical models

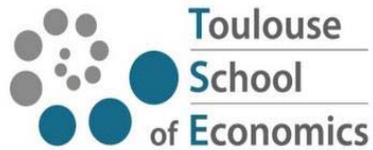
Final report

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With contributions from:

Maya Bacache
Francis Bloch
Marc Bourreau
Bernard Caillaud
Helmuth Cremer
Jacques Crémer
Gabrielle Demange
Romain de Nijs
Stéphane Gauthier
Jean-Marie Lozachmeur





La fiscalité du numérique : quels enseignements tirer des modèles théoriques ?

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- Taxing Networks Externalities

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- Digital Platforms, Advertising, and Taxation

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- Taxation and Privacy Protection on Internet Platforms

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- Tax Competition, Tax Coordination and E-Commerce

Maya Bacache

- Optimal Discrimination Ban

Stéphane Gauthier

La fiscalité du numérique : quels enseignements tirer des modèles théoriques ?

Résumé - Recommandations

✓ Résumé

L'économie numérique crée de nouveaux défis en matière de fiscalité. L'émergence de plates-formes Internet puissantes, capables de transformer des industries entières comme le commerce ou la publicité, affecte la capacité des autorités nationales à taxer les transactions et les bénéfices. Les principaux acteurs de l'économie numérique, localisés hors de la juridiction des autorités fiscales nationales, utilisent les prix de transfert pour réduire leurs impôts sur les bénéfices, conduisant à une perte nette de recettes fiscales. Les nouvelles formes de commerce affectent la capacité des autorités fiscales à percevoir des taxes indirectes sur les ventes ou les transactions financières, résultant à nouveau en une perte de recettes fiscales. La base d'imposition des grandes plateformes Internet est ainsi limitée à la fois par la difficulté à assigner leurs activités économiques à des juridictions géographiques précises et parce que les principaux éléments de la chaîne de valeur comme l'utilisation de données personnelles ne sont pas soumis à des transactions financières. Face à cette situation, les autorités fiscales doivent réformer et adapter leurs instruments pour tenir compte des nouvelles conditions créées par l'économie numérique.

L'économie numérique est caractérisée par quatre éléments principaux : (i) un brouillage des frontières géographiques qui rend plus complexe l'attribution d'activités à des juridictions précises, (ii) des externalités de réseau importantes qui donnent un pouvoir de monopole aux plates-formes en raison de problèmes de coordination des utilisateurs, (iii) ses marchés multi-face, car les plates-formes sont utilisées pour connecter différents acteurs, et les stratégies de fixation des prix sur les différentes faces de la plate-forme sont interdépendantes, (iv) la collecte et l'exploitation de données personnelles téléchargées, comme intrants dans la chaîne de valeur de la plate-forme. Toute discussion sur la fiscalité appliquée à l'économie numérique doit tenir compte de ces caractéristiques spécifiques.

Dans cette étude, nous développons cinq modèles théoriques originaux pour analyser les effets de la fiscalité sur l'économie numérique. Ces cinq modèles se concentrent sur des aspects spécifiques de l'économie numérique et reflètent les quatre caractéristiques importantes décrites ci-dessus.

- *Le premier modèle*, inspiré par les plates-formes de réseaux sociaux, traite des externalités de réseau, de la coordination des utilisateurs et de la concurrence en présence de fiscalité spécifique.
- *Le deuxième modèle*, axé sur les marchés bi-faces, analyse les effets de la fiscalité sur une plate-forme mettant en relation utilisateurs et annonceurs publicitaires,

et propose une étude comparative de la fiscalité de chaque côté du marché.

- *Le troisième modèle* traite de la collecte et de l'exploitation de données personnelles et étudie l'effet de différentes taxes sur le niveau d'exploitation de données.
- *Les deux derniers modèles* traitent des répercussions de la disparition des frontières géographiques sur le commerce et analysent comment l'émergence du commerce électronique affecte la concurrence fiscale entre pays qui fixent les taxes à la consommation. Un modèle met l'accent sur l'absence de discrimination par marché géographique avec des plates-formes d'échange comme eBay. L'autre modèle met en lumière les effets de substitution entre commerce électronique et achats transfrontaliers.

Résumons brièvement les enseignements des cinq modèles théoriques et les effets et arbitrages qu'ils mettent en lumière.

Imposition de la rente liée aux effets de réseau

Les plates-formes Internet recueillent une rente en raison de leur position comme intermédiaires entre les utilisateurs. Les difficultés de coordination des utilisateurs confèrent un pouvoir de monopole à ces plates-formes. Un impôt sur les bénéfiques (ou de façon équivalente car les coûts sont négligeables, un impôt sur les revenus) permet de ponctionner cette rente en la transférant aux autorités publiques sans effets de distorsion sur l'efficacité productive et allocative. En présence de coûts fixes, la fiscalité peut générer des effets négatifs sur les incitations de la plate-forme pour développer de nouveaux services ou améliorer la qualité des services existants.

Imposition sur les marchés bi-faces

Sur les marchés bi-faces, l'imposition de taxes d'un côté du marché peut conduire la plate-forme à déplacer les revenus de l'autre côté du marché. Ce phénomène explique pourquoi, contrairement aux marchés classiques, la taxation *ad valorem* peut être pire que la taxation unitaire. L'imposition d'une taxe sur les recettes publicitaires peut conduire la plate-forme à demander un prix de souscription au service aux utilisateurs, avec un effet d'exclusion envers les utilisateurs qui ont les valeurs les plus basses. Une taxe sur les flux de données peut également amener la plate-forme à facturer l'accès au service afin de limiter la quantité de données téléchargées par les utilisateurs. Une taxe unitaire par utilisateur, qu'elle soit à la charge de la plate-forme ou payée directement à l'utilisateur, se traduit également par l'exclusion des utilisateurs avec les valeurs de service les plus basses.

Fiscalité et protection des données personnelles

Les revenus des plates-formes internet peuvent être décomposés en revenus liés à l'accès immédiat et revenus générés par la collecte de données. La collecte de données par les plates-formes est excessive du point de vue des utilisateurs. Les taxes basées sur les revenus de la plate-forme n'ont aucun effet sur le niveau de collecte des données, et les taxes basées sur le nombre d'utilisateurs ou le nombre de clics résultent en une

augmentation plutôt qu'une diminution de la collecte de données. Une taxe différenciant entre les origines de revenus de la plate-forme, et imposant à un niveau plus élevé les revenus générés par la collecte de données, pourrait abaisser le niveau de collecte de données. Permettre à l'utilisateur de choisir un service sans recueil de données personnelles peut nuire en moyenne aux utilisateurs, car cette option incite la plate-forme à accroître le niveau de collecte de données sur les autres utilisateurs. Une politique de prix permettant de rémunérer les utilisateurs pour la collecte de données améliore le bien-être des utilisateurs et de la plate-forme, alors qu'une politique de prix conduisant à faire payer les utilisateurs pour un service sans collecte de données augmente le profit de la plate-forme au détriment des utilisateurs.

Imposition des plates-formes et interactions entre instruments fiscaux

L'imposition des données ou de la publicité en ligne peut entraîner un changement dans les modèles d'affaires des plates-formes. Cette fiscalité spécifique réduit le volume d'activité sur la plate-forme et par là, les recettes de TVA. Toutefois, pour de faibles niveaux de taxation des données ou de la publicité en ligne, l'effet direct de la taxe domine l'effet indirect sur la TVA et les recettes fiscales augmentent. Les taxes sur les données et sur la publicité ne sont pas des substituts parfaits, et une taxe sur la publicité en ligne affecte le comportement des annonceurs et crée plus de distorsions qu'une taxe sur les données. Si la plate-forme rémunère les utilisateurs pour le téléchargement de données personnelles, une partie des bénéfices de la plate-forme peut être imposée sous forme de revenus supplémentaires reçus par les utilisateurs.

Fiscalité et concurrence entre plates-formes

La fiscalité affecte la structure des marchés et la concurrence entre plates-formes Internet. Si les plates-formes investissent pour attirer les utilisateurs, le niveau d'investissement sera excessif. La fiscalité sur les profits peut alors avoir un effet positif sur le profit des plates-formes en réduisant les investissements improductifs, au prix d'une détérioration de la qualité pour les utilisateurs. Sur les marchés bi-faces, lorsque deux plates-formes sont en concurrence pour attirer les utilisateurs sur un côté du marché, la fiscalité n'a aucun effet sur la structure du marché si les plates-formes sont symétriques, mais peut biaiser la taille des plates-formes quand les plates-formes sont initialement asymétriques.

Concurrence fiscale et commerce électronique

Le développement du commerce électronique a changé les conditions de la concurrence fiscale entre les pays fixant leurs taux de TVA. Le commerce électronique fait baisser les coûts de transactions transfrontalières et permet aux plates-formes de se soustraire à l'impôt, ce qui renforce la concurrence entre pays quand le principe d'origine est appliqué, entraînant une diminution des taux de TVA. Quand le principe de destination est appliqué, comme le commerce électronique sert de substitut pour les achats transfrontaliers, il réduit la concurrence entre pays, permettant une augmentation des taux de TVA. Les plates-formes de commerce électronique comme eBay ne permettent pas la discrimination entre acheteurs en fonction de leur pays de résidence. Lorsque la discrimination de prix est impossible, et les acheteurs ont un biais en faveur des produits nationaux, la concurrence

fiscale entre les deux pays est atténuée et les taux d'imposition plus élevés que lorsque les vendeurs peuvent ajuster leurs prix en fonction des origines géographiques des acheteurs. Les conclusions des modèles théoriques conduisent à formuler les recommandations suivantes.

✓ **Recommandations**

1. Mettre en place un appareil statistique pour mesurer l'activité de plates-formes Internet.

Toute taxe spécifique sur l'activité des plates-formes Internet nécessite une mesure précise de leur activité. Pour mesurer cette activité, les autorités fiscales et réglementaires doivent avoir accès à des données sur le nombre d'utilisateurs, de clics, l'identité des annonceurs et la revente et l'exploitation de données. Il est extrêmement important de construire un appareil statistique pour mesurer l'activité de plates-formes Internet.

2. Déterminer une règle de partage des bénéfices des sociétés reflétant le nombre d'utilisateurs dans la juridiction de l'administration fiscale.

Les règles actuelles de partage de l'impôt sur les sociétés multinationales sont fondées sur des prix de transfert et des définitions territoriales qui sont obsolètes. Dans le cadre des négociations internationales, de nouvelles règles doivent être mises en place pour adapter ces définitions à l'économie numérique. Ces règles de partage devraient refléter le nombre d'utilisateurs dans la juridiction d'une administration fiscale, car la présence de ces utilisateurs est une condition nécessaire pour la plate-forme pour faire des profits. De plus, les impôts sur les bénéfices ne créent pas de distorsions et permettent aux autorités fiscales de capturer une partie de la rente générée par les externalités de réseau.

3. En l'absence d'une règle de partage équitable sur les bénéfices des sociétés, préconiser un impôt sur la base de revenus (ventes ou revenus publicitaires) générés dans la juridiction de l'administration fiscale.

En l'absence d'une règle de partage transparente et équitable, l'autorité fiscale nationale peut mettre en œuvre une taxation *ad valorem* sur la base des profits générés sur son territoire. Étant donné que les coûts variables sont négligeables, les bénéfices peuvent être identifiés aux revenus des plates-formes. Le chiffre d'affaires lié aux ventes peut facilement être observé ; les revenus générés par la publicité sont plus difficiles à évaluer si les contrats entre les annonceurs et les plates-formes sont localisés à l'extérieur du pays. Des règles spécifiques peuvent être mises en place pour évaluer les recettes publicitaires sur la base des informations statistiques recueillies sur l'activité des plates-formes Internet dans le pays.

4. En l'absence d'une règle de partage équitable sur les bénéfices des sociétés et si les taxes sur les revenus générés dans le pays ne peuvent pas être mises en œuvre, préconiser une taxe sur la base de l'activité de plate-forme (nombre d'utilisateurs, flux de données ou nombre d'annonceurs). Cette taxe doit être calibrée à des taux très faibles et de préférence être liée à la collecte de données.

Une taxe unitaire basée sur le nombre d'utilisateurs (*adwords*), ou le nombre de clics reflétant les flux de données, crée des distorsions et modifie le comportement de la plate-forme, des annonceurs et des utilisateurs. Elle a des effets négatifs sur la participation des utilisateurs à la plate-forme, peut conduire la plate-forme à facturer ses services aux utilisateurs, excluant ainsi les utilisateurs aux valeurs les plus faibles. En outre, cette fiscalité entraînera probablement une augmentation de l'exploitation des données personnelles. Les instruments fiscaux fondés sur des mesures directes de l'activité Internet ne devraient donc être utilisés qu'en dernier recours, s'il s'avère impossible de baser une taxe sur les profits ou les revenus.

5. Différencier le taux d'imposition en fonction de l'origine des revenus : ceux générés par un accès immédiat devraient être imposés à des taux inférieurs à ceux générés par l'exploitation des données.

Les revenus issus de la plate-forme sont de deux sortes : un revenu de base généré par un accès immédiat (vente, recettes publicitaires liées à un mot-clé de recherche) et les recettes liées à l'exploitation de données (revente de données sur les recherches à des tiers, stockage de données de ventes pour une tarification ou une publicité ciblée). Étant donné que les plates-formes choisissent des niveaux excessifs d'exploitation de données, des taxes différenciées ont un effet positif sur le bien-être des consommateurs car elles réduisent l'incitation de la plate-forme à exploiter les données

6. Encourager les plates-formes à offrir des menus d'options avec différents degrés d'exploitation des données et à rémunérer les utilisateurs pour le téléchargement de données personnelles.

En offrant différentes options pour les niveaux d'exploitation des données (une généralisation des procédures existantes sur l'acceptation des cookies ou de la géo-localisation), les plates-formes pourront discriminer entre utilisateurs en fonction de leur attachement à la confidentialité des données. À travers différents niveaux de rémunération (sous forme de compensation monétaire ou d'accès à des services de qualité supérieure), la plate-forme pourra augmenter le bien-être des utilisateurs. Cette rémunération implicite des données existe déjà dans la grande distribution quand les chaînes de supermarché offrent des rabais aux consommateurs qui utilisent leurs cartes de fidélité enregistrant tous leurs achats. De plus, si les plates-formes utilisent des compensations monétaires, cette monétisation des données personnelles servira de base à une imposition comme revenu supplémentaire des utilisateurs résidents.

7. Renforcer la veille technologique pour anticiper les changements futurs dans les services, la qualité et la structure du marché. Prévoir des réductions d'impôt et des subventions pour encourager l'innovation.

L'imposition des profits ou revenus de plates-formes Internet a un effet sur les investissements de long terme des plates-formes et peut conduire à un sous-investissement limitant les innovations et dégradant à terme la qualité des services. Il est impératif de demander aux autorités réglementaires d'assurer une veille renforcée sur l'évolution des plates-formes Internet, des services, des produits et structure concurrentielle. Afin

d'encourager l'innovation et l'augmentation de la qualité du service, des réductions d'impôts ciblées et des subventions devraient être mises en place.

8. Généraliser le principe de destination et harmoniser le niveau de taxation des ventes.

Quand le principe d'origine est appliqué, le commerce électronique renforce la concurrence fiscale et il en résulte une baisse généralisée des taux de TVA. Quand le principe de destination est appliqué, le commerce électronique réduit la concurrence fiscale ce qui permet une augmentation du niveau d'imposition indirecte.

✓ En conclusion

Les modèles présentés dans cette étude sont une première analyse des effets de la fiscalité sur l'économie numérique mais laissent des questions sans réponse. Ils mettent en évidence des arbitrages qualitatifs mais ne permettent pas de quantifier exactement l'incidence de différents instruments fiscaux. De plus, l'analyse suppose que les modèles d'affaires des plates-formes restent fixes, alors que l'économie numérique est caractérisée par des changements technologiques rapides et une évolution continue des modèles d'affaires et des stratégies de prix. La mise en œuvre de recommandations formulées ici nécessite une compréhension plus détaillée des effets quantitatifs de la fiscalité et de la réactivité des plates-formes Internet.

Afin d'approfondir la discussion et d'affiner ces recommandations, l'analyse doit être enrichie dans les directions suivantes.

- Nous devons essayer de quantifier le taux d'imposition optimal sur les profits, revenus ou données. Cet exercice de quantification nécessite un calibrage des modèles et d'exécuter des simulations pour analyser l'impact sur le bien-être de différents taux d'imposition.
- Nous devons analyser les réactions probables des acteurs de l'économie numérique à des changements dans les régimes d'imposition et prévoir les changements dans les modèles d'affaires.
- Nous devons valider, par des données empiriques, l'analyse du rôle du commerce électronique sur la concurrence fiscale. Nous souhaitons développer des études empiriques sur l'effet de plates-formes sans discrimination géographique, et sur l'effet du passage au principe de destination pour les services électroniques au 1^{er} janvier 2015.
- Nous devons enrichir les modèles théoriques pour tenir compte de la concurrence entre plates-formes soumises à différentes juridictions et la dynamique de la structure du marché et de la concurrence.
- Nous devons développer des modèles théoriques des chaînes de valeur pour déterminer la règle de partage optimale des bénéfices entre administrations fiscales

sur la base de différentes activités.

Taxation and the digital economy: A survey of theoretical models

Summary - Recommendations

✓ Summary

The digital economy creates new challenges for taxation. The emergence of powerful internet platforms, transforming entire industries like commerce or advertising, has affected the ability of national authorities to tax transactions and corporate profits. The main actors of the digital economy localized outside the jurisdiction of national tax authorities, use transfer prices to reduce their tax bills inducing thus a net loss in tax revenues from corporate taxation. In addition, the shift away from traditional forms of commerce affects the tax authorities' ability to collect taxes based on sales and financial transactions, leading again to a loss in fiscal revenue. Overall, the tax base of major internet platforms is reduced both because of difficulties in locating activities to specific geographical jurisdictions and because major elements of the revenue-generating chain, like the use of personal data uploaded by users, do not result in financial transactions.

Faced with this situation, tax authorities should reform and adapt their instruments to take into account the new conditions created by the emergence of the digital economy. The digital economy is characterized by four important features : (i) a blurring of geographical frontiers which makes the assignment of activities to jurisdictions more complex, (ii) large network externalities which give monopoly power to platforms because of coordination issues, (iii) multi-sided markets, where platforms are used to connect different actors, and pricing strategies on different sides of the platform are interdependent, (iv) the collection of data uploaded by users and used as inputs to generate profits for the platform. Any discussion of taxation in the digital economy must take into account these specific features.

In this report, we have developed five original theoretical models to analyze the effects of taxation in the digital economy. The five models focus on specific aspects of the digital economy and reflect the four important features described above.

- *The first model*, inspired by platforms for social networking, deals with network externalities, coordination and competition in the presence of taxation.
- *The second model*, focused on two-sided markets, considers a platform mediating between users and advertisers, and allows for a comparative study of taxation on either side of the market.
- *The third model* centers on the amount of data collection and exploitation and studies how different taxes affect the level of data exploitation.
- *The last two models* deal with the blurring of geographical frontiers and analyze how the emergence of electronic commerce affects fiscal competition between

countries fixing sales taxes. One model centers around exchange platforms which cannot discriminate among consumers according to their geographical origin, like eBay. The other model considers substitution effects between electronic commerce and cross-border shopping.

We briefly summarize how the five models shed light on the different trade-offs and on effects of taxation in the digital economy.

Taxation of network rents

Internet platforms collect network rents because of their positions as intermediaries between users or between the two sides of the market. Taxation of profits (or revenues) of internet platforms is just a transfer from the platforms to the government, with no distortive effects on productive and allocative efficiency. In the presence of fixed costs, taxation may generate negative effects on the platform's incentives to develop new services or improve the quality of existing services.

Taxation on two-sided markets

On two-sided markets, taxation on one side may lead the platform to shift revenues to the other side. This explains why, contrary to classical markets, *ad valorem* commodity taxation may be worse than unit taxation. Charging a tax on advertising revenues may induce the platform to charge a subscription price to users, resulting in exclusion of users with the lowest values. A tax on data flows may lead the platform to start charging a subscription price in order to limit the amount of data voluntarily uploaded by users. Taxes per user, whether charged to the platform or directly to the user, also result in exclusion of users with the lowest values.

Taxation and privacy protection

The revenues of internet platforms can be decomposed into revenues linked to one-time access and revenues generated by data collection. Data collection by platforms is excessive from the point of view of users. Taxes based on the platform's revenues are ineffective, and taxes based on the number of users or accesses result in an increase rather than a decrease in data collection. A tax differentiating between the sources of the revenues of the platform, and imposing a higher tax level on revenues generated by data collection, could lower the level of data collection. Giving the user the possibility to « opt out » may actually harm the average user by inducing the platform to increase data collection on all other users. A pricing policy by which users are paid for data collection improves the welfare of users and of the platform, whereas a pricing policy by which users pay to opt out increases the profit of the platform at the expense of users.

Taxation of platforms and fiscal interactions

Taxation of data or online advertising or new privacy regulation may result in a shift in the business models of the platforms. Taxation reduces the volume of activity on the platform, lowering revenues from VAT. However, for small levels of taxation on data or online advertising, the direct effect of the tax dominates the indirect effect on VAT, and fiscal revenues are increased. Taxes on data and advertising are not perfect substitutes, and a tax

on advertising results in more distortions than a tax on data. If the platform pays users for uploading personal data, part of the platform's profits can be taxed as additional income received by resident users.

Taxation and competition

Taxation affects the market structure and competition among internet platforms. If platforms invest in quality to attract users, taxation may increase the joint profit of the platforms by preventing unproductive investments, but will result in lower quality for users. On two-sided markets, when two platforms compete to attract users on one side of the market, taxation has no effect on the market structure when the platforms are symmetric, but may distort the sizes of the platforms when the platforms are initially asymmetric.

E-commerce and fiscal competition

The development of e-commerce has changed the conditions for fiscal competition between countries setting their rate of VAT. E-commerce leads to a decrease in cross-border transaction costs and a possibility of evading taxation, which strengthens competition between countries under the origin principle, resulting in a decrease in VAT rates. On the other hand, under the destination principle, e-commerce substitutes for cross-border shopping, and reduces competition between countries, leading to higher VAT rates. Typical e-commerce platforms prevent sellers from price discriminating among buyers according to their country of residence. When price discrimination is banned, and buyers have a bias in favor of domestic goods, tax competition between the two countries is mitigated and tax rates are higher than when sellers can adjust their prices to buyers according to their geographical location.

Based on these findings, we would like to issue the following recommendations.

✓ Recommendations

1. Develop a statistical apparatus to measure the activity of internet platforms.

Any specific tax on internet activity requires a precise measure of the activity of internet platforms. To measure this activity, tax and regulatory authorities must have access to data on users, numbers of clicks, advertisers. It is thus extremely important to construct a statistical apparatus to measure the activity of internet platforms.

2. Determine a sharing rule for corporate profits reflecting the number of users in the jurisdiction of the tax authority

Current rules for the corporate taxation of multinationals are based on transfer pricing and territorial definitions which are obsolete. In the context of international negotiations, new rules must be put in place to adapt definitions to the digital economy. These sharing rules should reflect the number of users in the jurisdiction of a tax authority, as the presence of these users is a necessary condition for the platform to make profits. Taxes based on profits are not distortive and enable tax authorities to capture some of the network rent generated by network externalities.

3. In the absence of a fair sharing rule on corporate profits, consider using a specific tax based on revenues (sales or advertising) generated in the jurisdiction of the tax authority

In the absence of a transparent and fair sharing rule, the national tax authority may implement an *ad valorem* taxation based on the profits generated in the jurisdiction. Given that variable costs are negligible, profits can be identified with revenues. Sales revenues can easily be observed; revenues generated by advertising are more difficult to assess if contracts between advertisers and platforms are located outside the country. Specific rules can be put in place to assess advertising revenues based on statistical information on the activity of internet platforms in the country.

4. In the absence of a fair sharing rule on corporate profits and if taxes on revenues generated in the country cannot be implemented, consider using a specific tax based on activity (number of users, flow of data or number of advertisers). This tax should be calibrated at very low rates, and preferably be based on the collection of data.

A unit tax, based on number of users or adwords, or number of clicks reflecting data flows, is distortive and will change the behavior of the platform, advertisers and users. It has negative effects on participation on the platform, and can lead the platform to change its pricing behavior, excluding some users from the platform. In addition, it will likely result in an increase in data exploitation. Hence tax instruments based on direct measures of internet activity should only be used as a last resort, if it is impossible to base a tax on revenues or profits.

5. Differentiate tax rates according to the origin of revenues: revenues generated by one-time access should be taxed at lower rates than revenues generated by data exploitation.

There are two sorts of revenues of the platform: a basic revenue generated by one-time access (sale of an item, advertising revenue linked to a keyword) and revenue linked to data exploitation (sale of data on searches to third parties, storage of sales data for future targeting). Given that platforms choose excessive levels of data exploitation, differentiated taxes on revenues reduce a platform's incentive to collect and exploit data, and results in an increase in the welfare of consumers.

6. Encourage platforms to offer menus of options with different degrees of data exploitation and to compensate users for uploading personal data.

By offering different options to consumers with different levels of data exploitation, generalizing procedures like the choice to accept cookies or to be geo-localized, platforms will sort consumers according to their privacy costs. Offering different levels of compensation (monetary or through higher quality services) will increase the welfare of users. This compensation for data already exists in some industries. For example, supermarket chains offer discounts to consumers using loyalty cards which store their history of purchases. In addition, if platforms use monetary compensations, this creates a monetary value for the data which can be taxed as additional income from resident users.

7. Strengthen the technology watch to anticipate future changes in services, quality and market structure. Provide targeted tax breaks and subsidies to encourage innovation.

Taxation of profits or revenues of internet platforms distort a platform's long-term decision to invest. Hence, in order to prevent taxation from hampering innovation, it is imperative to ask regulatory authorities to keep a careful watch on the evolution of internet platforms, services, products and competitive structure. In order to encourage innovation and an increase in service quality, targeted tax breaks and subsidies should be put in place.

8. Generalize the principle of destination and harmonize the level of sales taxation

Under the principle of origin, electronic commerce reinforces tax competition, resulting in a race to the bottom. Under the principle of destination, electronic commerce instead reduces tax competition, allowing for an increase in the level of taxation.

✓ **Concluding remarks**

The models presented in this report set the stage for the analysis of the effects of taxation in the digital economy, but leave a number of questions unanswered. They highlight qualitative trade-offs, but fall short of quantifying exactly the effects of different policies. In addition, the analysis supposes that business models remain fixed, whereas the digital economy is characterized by fast technological changes and a continuous evolution of business models and pricing strategies. The implementation of our recommendations requires a more detailed understanding of the quantitative effects of taxation and the reactivity of internet platforms. In order to advance the discussion, and refine our recommendations, we need to enrich the analysis in the following directions.

- The exact quantification of the optimal tax rate on data requires a calibration of the models and to run simulations to analyze the welfare impact of different tax rates.
- The analysis of likely reactions of actors of the digital economy to changes in taxation régimes.
- The analysis of fiscal competition and electronic commerce needs to be validated by empirical data. Empirical studies on the effect of exchange platforms on geographical discrimination, and on the effect of the passage to the destination principle for electronic services on January 1, 2015, should be developed.
- Theoretical models should be enriched to take into account competition between platforms subject to different jurisdictions, and the dynamics of market structure and competition.
- Theoretical models should be developed to help determine the optimal sharing rule for profits across jurisdictions based on different activities.

La fiscalité du numérique : quels enseignements tirer des modèles théoriques ?

Biographies

Maya Bacache est ancienne élève de l'École normale supérieure (rue d'Ulm). Agrégée de sciences économiques et sociales, elle a soutenu sa thèse à l'Université Paris 1 en 2002 puis son Habilitation à Diriger les Recherches en 2010. Elle est professeur en sciences économiques à Telecom ParisTech, co-responsable de la Chaire 'Markets for technologies' avec l'École des Mines, et co-directrice du programme Économie publique au Cepremap. Ses recherches portent sur la régulation à l'ère du numérique et, en économie publique, sur le rôle de l'État et l'emploi public. Elle est éditrice associée de la revue *Politique et Management Public*.

Maya Bacache graduated from The École normale supérieure (Ulm). French aggregation in economics, holds a Ph.D. in economic sciences from the Paris 1 University (2002) and qualified as research director in 2010 (Habilitation à Diriger les Recherches). Professor in economics at Telecom ParisTech, co-director of the research Chair 'Markets for technologies' with the École des Mines, and director of the program Public Economics at the Cepremap. She specializes in regulation and the digital economy, as well as in public economics (State and the public sector labor market).

Francis Bloch est Professeur à l'Université Paris 1 et membre associé de l'École d'Économie de Paris. Ancien élève d'HEC, titulaire d'un Ph.D. de l'Université de Pennsylvanie, il a enseigné à Brown University (États-Unis), l'Université Catholique de Louvain (Belgique), l'Université d'Aix-Marseille et Polytechnique. Il est membre du conseil de la *Game Theory Society*. Ses travaux portent sur l'économie des réseaux et la formation des coalitions. Il est éditeur associé de *Games and Economic Behavior*, *Journal of Public Economic Theory* et *Economics Letters*.

Francis Bloch is Professor at Paris 1 University and associate member at Paris School of Economics. Graduated from HEC Business school, Ph.D. from Pennsylvania University, he lectured at Brown University (USA), Université Catholique de Louvain (Belgium), Aix-Marseille University and at Polytechnique School. Council member of the Game Theory Society. His research focuses on network economics and coalition-building. Associate editor for *Games and Economic Behavior*, *Journal of Public Economic Theory* and *Economics Letters*.

Marc Bourreau est Professeur d'économie à Telecom ParisTech. Il est directeur de la chaire Innovation et Régulation à Telecom ParisTech (depuis 2011), chercheur associé au CREST(LEI), au Cepremap et membre du Comité scientifique, Florence School of Regulation, Media et Communications Area, European University Institute (depuis 2009). Il a soutenu son Habilitation à Diriger les Recherches à l'Université Paris I Panthéon-Sorbonne (2003) et sa thèse en économie à l'Université Paris II Panthéon-Assas (1999). Il est Ingénieur civil de l'École Nationale Supérieure des Télécommunications (1992). Éditeur de la

revue *Information Economics & Policy* (depuis 2011). Ses travaux portent sur l'économie des télécommunications, la régulation et l'économie industrielle.

Marc Bourreau is Professor of economics at Telecom ParisTech. Director of the Chair Innovation and Regulation at Telecom ParisTech (since 2011); Associate researcher at CREST-LEI and at Cepremap; Scientific committee member, Florence School of Regulation, Media and Communications Area, European University Institute (since 2009). Qualified as research director in 2003 (Habilitation à Diriger les Recherches) at Paris I Panthéon-Sorbonne University (2003), holds a Ph.D. in economics (Paris II Panthéon-Assas University, 1999). Civil engineer, graduated from École Nationale Supérieure des Télécommunications (1992). Editor of *Information Economics & Policy* (since 2011). His research focuses on the economics of telecommunications, regulation and industrial economics.

Bernard Caillaud est Ingénieur Général des Ponts, Eaux et Forêts et titulaire de la chaire associée à l'École d'Économie de Paris. Ancien élève de l'École Polytechnique, il a obtenu un Ph.D. au Massachusetts Institute of Technology. Il a dirigé le CERAS et l'UMR Jourdan, et a été Éditeur en Chef de *International Journal of Industrial Organization*. Il a reçu la médaille de bronze du CNRS et il est membre du CEPR depuis 1994. Ses travaux portent sur l'économie des contrats, l'économie des marchés biface et l'économie politique.

Bernard Caillaud is General Engineer of the École des Ponts, Eaux et Forêts in charge of the Associated Chair at Paris School of Economics. Graduated from École Polytechnique, he holds a Ph.D. from the Massachusetts Institute of Technology. Former director of the CERAS and the 'Jourdan' research unit; former editor of *International Journal of Industrial Organization*. Awarded the CNRS bronze medal; member of the CEPR since 1994. His research focuses on economics of contracts, on two-sided markets and economic policy.

Helmuth Cremer est Professeur à l'Université de Toulouse 1 et membre de l'École d'Économie de Toulouse. Il est titulaire d'un doctorat de l'Université catholique de Louvain et a enseigné à Virginia Tech (États-Unis). Il a été membre junior de l'Institut Universitaire de France (IUF) et occupe actuellement la chaire Économie publique comme membre senior de l'IUF. Ses travaux portent sur l'économie de la taxation, du vieillissement et des prestations sociales. Il a été éditeur associé du *Journal of Public Economics* et il est éditeur en chef de la *German Economic Review*.

Helmuth Cremer is Professor at Toulouse 1 University, and Researcher at Toulouse School of Economics. He holds a Ph.D. from Université catholique de Louvain and lectured at Virginia Tech (USA). Junior Member at Institut Universitaire de France, now in charge of its Chair in public economics as a Senior Member. His research focuses on taxation, ageing-population and social allowances. Former associate editor of *Journal of Public Economics* and editor of *German Economic Review*.

Jacques Crémer est Directeur de Recherche de classe exceptionnelle au CNRS (à la retraite) et membre associé de l'École d'Économie de Toulouse. Ancien élève de l'École Polytechnique, il a obtenu un Ph.D. au Massachusetts Institute of Technology. Il a enseigné à l'Université de Pennsylvanie et à Virginia Tech (États-Unis). Il est membre du CEPR depuis 1993, *Fellow* de l'Econometric Society depuis 1992, membre de l'Econometric Society depuis 2009. Il a été directeur de l'Institut d'économie industrielle (IDEI), et membre

du conseil scientifique Sciences de l'homme et de la société (SHS) au CNRS. Ses travaux portent sur l'économie des contrats, des enchères et l'économie industrielle des marchés biface. Il a été éditeur associé de l'*International Journal of Industrial Organization* et du *Rand Journal of Economics*.

Jacques Crémer is Senior Researcher at the CNRS (retired) and Associate Member of the Toulouse school of Economics. Graduated from École Polytechnique, he holds a Ph.D. from the Massachusetts Institute of Technology. He lectured at the Pennsylvania University and at Virginia Tech (USA). CEPR member since 1993; *Fellow* (1992), then member of the *Econometric Society* (2009). Former director of the Toulouse Industrial Economic Institute (IDEI); member of the Human and Social Sciences scientific council of the CNRS. His research focuses on the economics of contracts, auctions and the industrial economics of two-sided markets. Former Associate Editor of *International Journal of Industrial Organization* and of *Rand Journal of Economics*.

Gabrielle Demange est directrice d'études à l'EHESS et chaire associée à l'École d'Économie de Paris. Ancienne élève de l'École normale supérieure et de l'ENSAE, agrégée de mathématiques, elle est titulaire d'une thèse d'État à l'Université Paris IX. Membre du CEPR depuis 1997, *Fellow* de l'Econometric Society depuis 1992 et *Economic Theory Fellow* de la Society for the Advancement of Economics Theory depuis 2011. Elle a été membre du conseil de la Game Theory Society et de la Society for Social Choice and Welfare. Ses travaux portent sur la finance, les modèles d'appariement et la théorie des réseaux sociaux. Elle a été co-éditeur de la revue *Economic Theory* et est actuellement éditeur associée de la *Review of Economic Design*.

Gabrielle Demange is EHESS's Directeur d'études, Associate Chair Paris School of Economics. Graduated from École normale supérieure and the ENSAE, French aggregation in mathematics, holds a PhD from the Paris IX University. CEPR Member since 1997, Fellow of the Econometric Society since 1992 and Economic Theory Fellow of The Society for the Advancement of Economics Theory (since 2011). Former member of the Council of the Game Theory Society and of the Society for Social Choice and Welfare. Her research focuses on finance, matching models and social networks theory. Former co-editor of *Economic Theory* and associate editor of *The Review of Economic Design*.

Romain de Nijs est chercheur à l'École des Ponts ParisTech et membre associé de l'École d'Économie de Paris. Ancien élève de l'École Polytechnique, il est titulaire d'un doctorat de l'École des Ponts. Ses travaux portent sur l'économie de la concurrence et l'économie du numérique.

Romain de Nijs is a Research Fellow at École des Ponts ParisTech and an Associate member at Paris School of Economics. Graduated from the École Polytechnique, he also holds a Ph.D. in Economics from the École des Ponts ParisTech. His research focuses on competition policy and the digital economy.

Stéphane Gauthier est professeur à l'Université Paris 1 et membre associé de l'École d'Économie de Paris. Ses recherches portent sur l'économie de la fiscalité, en particulier sur l'interaction entre la fiscalité directe et la fiscalité indirecte. Il appartient à l'Advanced Investigator Grant European Research Council (ERC): "The Welfare State in a Complex

World: Taxes and Benefits in a Diverse Society", coordonné par Guy Laroque. Il est éditeur associé de la revue *Annales d'Économie et de Statistique*.

Stéphane Gauthier is Professor at Paris 1 University and Associate Member at Paris School of Economics. His research focuses on optimal taxation, specially interactions between direct and indirect taxes. Member of the Advanced Investigator Grant ERC: "The Welfare State in a Complex World: Taxes and Benefits in a Diverse Society", coordinated by Guy Laroque. Associate editor of *Annales d'Économie et de Statistique*.

Jean-Marie Lozachmeur est chargé de recherches de première classe au CNRS et membre de l'École d'Économie de Toulouse. Il a obtenu sa thèse à l'Université de Liège et le prix CESifo du meilleur jeune économiste en économie publique en 2004. Ses travaux portent sur l'économie publique, l'économie politique, l'économie du travail et de la santé. Il est éditeur associé de la *German Economic Review*.

Jean-Marie Lozachmeur is CNRS Researcher (CR1), GREMAQ, Toulouse University and Member of Toulouse School of Economics. Ph.D. in Economics, University of Liège, Belgium; awarded in 2004 CESifo Prize of the Best Young Scholar in Public Economics. His research focuses on public economics, political economy, labor economics and health economics. Associate editor of the *German Economic Review*.

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➤ Comité de pilotage

Dominique AUVERLOT, Chef du département Développement durable (DDD), France Stratégie

Antton ACHIARY, mission Très haut débit, ministère du Redressement productif

Guillaume APPÉRÉ, Sous-directeur Fiscalité des transactions, DGFIP, ministère des Finances et des Comptes publics

Mahdi BEN JELLOUL, Chargé de mission, département Économie Finance, France Stratégie

Pierre-Jean BENGHOZI, Professeur d'économie à l'École Polytechnique, Membre du collège de l'ARCEP

Pierre BOLLINGER, Chef du service Débats, partenariat et affaires internationales, France Stratégie

Yann BONNET, Rapporteur général, Conseil national du numérique

Mathilde BRAS, Rapporteur, Conseil national du numérique

Julia CHARRIÉ, Chargée de mission, DDD, France Stratégie

François CHOLLEY, Président de la Section de la régulation et des ressources, CGEIET

Laurent GILLE, Professeur d'économie à Télécom ParisTech

Joël HAMELIN, Conseiller scientifique, DDD, France Stratégie

Lionel JANIN, Chargé de mission, DDD, France Stratégie

Édouard MARCUS, Sous-directeur Prospective et relations internationales, DGFIP, ministère des Finances et des Comptes publics

Mehdi NEMRI, Chargé de mission, DDD, France Stratégie

Taxation and the digital economy: A survey of theoretical models

Introduction

In their 1998 book, which became the reference manual about the new economy, Varian & Shapiro questioned whether the digital revolution was also to be considered as an epistemological revolution, meaning that economic science should reconsider its concepts, its paradigm, and its methods to be able to explain the changes of the world. With the outbreak and widespread of free commodities and services, information economics seemed to disrupt the economic paradigm. This new economy, characterized by the existence of important fixed costs but zero marginal costs, by network effects (production and consumption alike), by non-rival consumption goods, seemed to announce the possible era of a free and cooperative economy.

Twenty years later, it is obvious that the “all-free” has not survived and that digital firms have invented new business models. Actually, in 2014, the firms with the highest profit rate are definitely digital firms. Yet, they seem to be those who clearly escape from taxes. Far from being void, the economic theory has reinvented itself to explain and understand the new strategies at work. Paradoxically, the new query in the 2000's is to know how – and define whether it should be necessary – to capture part of this value creation and reallocate it *via* citizens' taxes and charges. Since 2008, the crisis of public budgets has highlighted the state's need to think over its tax system. The issue is to sort out whether digital economy transformations call for a new tax, for the adaptation of former tax systems, or for the set-up of international cooperation to fight tax optimization strategies developed by digital firms, like other MNEs. If the matter is of real importance, it is nonetheless quite a new issue for economic science (Mirrlees, 2010).

The present study is the result of a work on digital taxation carried out by economists, researchers at Paris School of Economics, Toulouse School of Economics and Telecom ParisTech. Their intent is not to outline a specific public policy but, through economical mechanisms and theoretical arguments, to feed the work for policy decision makers.

This final report is organized as follow. Section one is a brief review of current institutional debates and academic literature related to the economics of the digital economy. Section 2 presents an overview of five academic papers. Section 3, and main part of the report, publishes these five research papers among which three address the link between personal data and taxation and two papers the link between e-commerce and taxation.

I. Context from an economic perspective

1. Institutions concerned by digital taxation¹

1.1. The rise of a new digital economy

1.1.1. New technologies, growth and impact

Information and communication technologies (ICTs) have triggered a new industrial revolution. The growth of the digital sector has been much quicker than former ground-breaking technologies. Internet has reached most of the French households three times faster than telephone landlines. Yet, the most spectacular feature of the development of digital technologies is the deep changes induced in other sectors: from the travel industry to banking and education, through ever changing technologies like cloud computing, participative platforms, digital payment systems or connected devices. The core digital economy may only account for 5.2% of the French GDP in 2009, but the sectors that significantly gained in productivity thanks to ICTs represent 80% of GDP.

1.1.2. Digital giants have created a new type of MNEs

Digital multinational enterprises (MNEs) heavily rely on intangible assets, typically Intellectual Property (algorithms, technologies, etc.). Due to the immaterial nature of digital technologies, those intangibles and the business and financial functions of major digital MNEs are extremely mobile, allowing those firms to grow in tax optimal structures. They also have the ability to carry out high volumes of sales far from a specific tax jurisdiction.

For cultural and tax reasons, but also to increase and boost R&D, digital MNEs rarely pay royalties to their shareholders. Would they, investors could fear that these firms would lose the technological competition. Indeed, R&D is vital to digital MNEs: they rely on network effects to achieve global and rapid growth. Therefore their products need the best performance, design and user-friendliness. This is why those markets are highly volatile: a single innovation may entirely disrupt the market. Yet, they tend toward monopoly or oligopoly because leader firms heavily invest in R&D to stay on top, and because the best product quickly wins over the whole market thanks to network effects.

1.1.3. Digital economy does not fit traditional market models

Digital MNEs have specific business models. They benefit from B2B, B2C but also C2C transactions (e.g. Amazon Marketplace). Yet the dominant and most original feature of their services is that they are mostly free to use. In a word, customers enjoy a free service in exchange for personal data used by the MNE to sell targeted advertisement to businesses. This could be seen as a kind of barter transaction. In fact, digital MNEs operate in multi-sided markets where one group, the users, affects the outcome for another group, the advertisers,

¹ The authors are grateful to E. Mifsud (Telecom ParisTech) and his remarks and comments for this sub-section.

across a platform (the digital MNE) through positive or negative externalities. When the users spend time on a page or click on links, this creates a positive externality for the advertiser displaying a banner there. The digital MNE doesn't collect revenue from the user side but from the advertiser one, thanks to the sale of online advertisement.

In those new models, the user becomes part of the global value chain. The value of the MNE lies in the data provided by the user, let it be through a passive tracking of his e-mails, location, web history, or through an active collaboration to a social network, peer review site or development platform. The Boston Consulting Group estimated that personal data collected in Europe was worth 315 billion euros in 2011. However, the free nature of the services provided in exchange for this data makes it difficult to get a consistent figure.

1.2. Tax revenues don't benefit from digital MNEs growth

In 2009, Greenwich Consulting estimated that the shortfall in French VAT revenues from digital MNEs would amount to 600 million euros in 2014. The Conseil National du Numérique concluded that the shortfall in corporate tax gain for Apple, Google, Amazon and Facebook was worth approximately 500 million euros in 2012. Digital MNEs use several of their singular features for tax avoidance purposes, through base erosion and profit shifting.

1.2.1. Digital MNEs are built in a tax-efficient structure

Digital giants are young firms. Therefore, they have organized their structure in a tax efficient manner from the very beginning of their growth. Because of the mobile nature of their intangibles and functions, they do not need costly and complex organization as traditional firms do. The large majority of those firms are American: while they set up their international sales to avoid taxation, their home sales are still subject to US taxes. This creates an asymmetry between the US and the EU and contributes to the unfavorable position of the EU in the digital race. Throughout their international growth, digital MNEs will use "treaty shopping" to locate their subsidiaries in the most profitable tax jurisdictions.

1.2.2. Avoiding the Permanent Establishment status

Both direct and indirect taxes rely on the presence of a Permanent Establishment – meaning physical and continuous presence– of the firm in the country. Relevant criteria are the attendance of staff, real estate, or the completion of full business cycles in the country. The ability to generate substantial sales at a distance far from tax jurisdictions enables the digital MNEs to avoid the Permanent Establishment status which is fundamental to prevent direct and indirect taxation.

i. Profits shifts to low-tax entities

Major digital firms manage to escape corporate taxes by shifting their profits to entities in countries with low corporate tax rates, very often tax-havens. In their structure, a service entity –with substantial staff and offices– sells digital services to customers in the EU (for instance located in Ireland). This entity pays royalties on a sub-license for the use of the Intellectual Property right (or any other intangible asset) to an intermediate entity, still in the EU. Therefore, there is no withholding tax for this transaction. The interest of the

intermediate entity is that it is located in a EU country with no withholding tax for profits tunneled to tax-havens (for instance Netherlands). This allows the MNE to shift its revenues to a low tax country through transfer fees and to escape corporate tax. It won't pay royalties to US shareholders because revenues brought back to the US would be subject to corporate tax.

ii. Taking advantage of the lack of harmonization and fiscal competition

VAT on the sale of goods through e-commerce follows the destination principle: the tax is levied by the country where the consumer is located. This removes the incentive for a MNE to avoid the Permanent Establishment status. However, the VAT rate for the sale of e-services was, until January 2015, the rate of the country of the provider's permanent establishment. In this former situation, tax competition between states would lead to market distortions and push firms to set their permanent establishment in a low-tax member state. However, the shift from the origin principle to the destination principle is progressive.

Besides, some digital MNEs benefit from special tax arrangements from states eager to attract foreign investment at the expense of international tax cooperation.

1.2.3. Free contribution of users escapes taxation

In the multi-sided market model, the service provided to users is free. Therefore, no taxation is possible at the consumer level, which makes the destination principle irrelevant. The only transaction generating value is between the digital company and the advertiser, and this can easily take place in a low-tax state. The exchange of personal data for services is a barter transaction and it cannot be taxed under existing tax regulations.

1.3. How to tax digital MNEs?

Tax evasion of digital MNEs has become a growing concern for most of the European governments, including the European Commission. Attracting foreign investment is less and less seen as a relevant reason to implement tax cuts. Aside from the fiscal revenue shortfall, this issue has taken a political turn in recent years since people and politicians feel that, in a time of financial crisis, these highly profitable firms do not contribute to the national effort.

Besides, due to the quick rise of tension related to personal data exploitation legislators question digital MNEs data collection methods. The growing concern about personal data protection reinforces the feeling that large digital firms make huge profits in EU states through tracking without making a fair contribution in return.

The OECD and governments have recently addressed this issue through studies and reports aimed at tackling the taxation of the digital economy.

1.3.1. The OECD and the European Commission focus on tax evasion

The OECD committee on fiscal affairs (2014) explores solutions targeting tax evasion in general. Digital MNEs use the same tax avoidance schemes as other MNEs, but their high

reliance on intangibles, the mobility of those intangibles and of their business functions, and their ability to conduct sales at distance make those schemes much more efficient and easy for them to implement. *The Base Evasion and Profit Shifting* plan aims at preventing the transfer of profits to low-tax entities. The actions include setting better guidelines for transfer pricing and profit splitting inside a company. It also aims at preventing the avoidance of permanent establishment status for tax purposes and at improving the permanent establishment status to include permanent digital presence as criteria. It also puts forward actions to limit treaty abuse, “treaty shopping” and harmful tax practices. The conclusion of the OECD report is to align taxation with economic activity and value production.

At the same time the European Commission has taken steps to make the European VATs more efficient. Progressively from January 2015, VAT on e-service sales will follow the destination principle. This will remove the incentive for digital MNEs to locate their subsidiary in low-tax member state. The EU will also try to harmonize VAT rates and policies to set a fairer taxation of goods and services from non-members states.

However, those measures do not tackle the multi-sided characteristics of the digital economy. Major MNEs often do not sell services to European users, but exchange them against personal data. Profits are generated on the other side of the platform, between advertisers and the MNE at a distance far from the consumption country. The creation of value by the users remains untaxed by the state it originates from.

1.3.2. Governments aiming to target digital tax

In the latter years, several European countries have tried to set out new actions of their own, though each projects underlines the difficulties not only to define the grounds of digital taxation, but also the limits of taking action separately.

Italy has put forward a draft for a ‘Google Tax’ in 2013. It was specifically designed to bring the profits of online advertising back in the country. Under this law, a firm could only advertise in Italy through a company with a tax presence –a Permanent Establishment– in Italy. This project was dropped in 2014 until further progress is made at the international level.

In 2013, a French expert mission on digital economy taxation (also known as the Collin-Colin report) has drawn a tax project on data tracking. It aimed at taking the ‘free labour’ of French users into account in tax bases. The principle of the tax relies on a ‘fee per user’ regularly and systematically tracked *via* an online platform. This fee could be reduced if the digital company respects ethical data usage policies. Such data collection in a country would *de facto* create a Permanent Establishment of the firm in that country.

This proposal has been widely criticized by –among others– the European Commission on the ground that “*there is no convincing argument why the collection of data via electronic means in a country should in itself create a taxable presence in that country*”. However, the Collin-Colin report raises the question of finding how to efficiently tax the creation of value in a multi-sided market.

At the end of 2014, the United Kingdom government has announced a “Google Tax” – the Diverted Profit Tax– to be launched in 2015. It specifically targets foreign multinational making profits but shifting them to low-tax states like Luxembourg or Ireland. HM Treasury estimates that Google made profits of 3.4 billion GBP in 2014 in the UK but only paid 20.4 million GBP in UK taxes. The law will raise the corporate rate tax from 21 to 25 percent and will target intra company fees allowing the shifting of profits to Ireland. However, the Treasury expects numerous legal challenges before the law can come into effect.

1.3.3. International negotiations timetable

International negotiations on tax cooperation have progressed at the OECD and are due to be completed in September 2015. They include prevention of the avoidance of the Permanent Establishment, limiting base erosion by interest deductions, countering harmful tax practices and assuring that transfer pricing is in line with the creation of value chain.

The European Commission focuses mainly on tax harmonization in the Union, through the creation of a one-stop shop for sales of goods and services in the EU, regardless of the citizenship of the provider. They also aim at putting an end to tax competition within the EU, through a Code of Conduct for Business Taxation. Improvements are likely in the control of hybrid mismatch arrangements, a better application of the Control of Foreign Corporation provisions, and the prevention of ‘treaty shopping’ structures.

A specific round of negotiation is taking place in order to tackle digital specificities such as data collection, network effects and multisided markets.

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2. Digital taxation: A survey of economic literature

To sum up economic literature about digital taxation is not an easy task since different issues are embedded in this topic. First, industrial economics addresses firms strategies and change in the value chain; then digital economics analyzes the specificities of the sector; public economics studies optimum taxation; marketing, advertising, tax law are all fields that have to be encompassed in the study of digital taxation.

If taking into account these various fields is useful and necessary, the literature reviewed is not exhaustive and cannot involve all the topics linked to ours. We have therefore tightened our selection to the most recent and most relevant articles released in economics.

2.1. Tax competition literature

Public economics and tax system literature address tax competition between countries as both mobility factors and firms multinationalization lead the way to fiscal optimization profitable to the lowest tax bidder. The issue at stake is to go further the different tax systems prevalent in a context of globalization and see to what extent digitalized economy presents specific criteria calling for particular adaptation of these tax competition models.

Tax systems are designed and implemented by governments on a national scale. Their history is to be understood in a quite closed economy where mobilities –labor, capital, goods and services– between countries were limited or traceable. Various elements disrupt these historic tax systems: international trade, the multinational activity of companies, the development of intangible assets, digitalization of goods and services, etc. These transformations require thinking over and modifying tax systems along with the need for international cooperation. Governments are engaged in a game with one another since tax systems have become inter-independent. Indeed, governments face MNE fiscal optimization from companies locating their activity in the countries where tax is the lowest, while, on the other hand, companies can undergo double taxation for the same activity or be confronted to legal and tax vagueness.

Due to increasing policy issues affected by international tax competition, there has been a drastic rise of public economics literature. While theoretical literature on tax competition develops the models of Zodrow and Mieszkowski (1986) and Wilson (1986) (ZMW model), literature on tax competition and digitization is really scarce and has no referring models.

Tax system shortened to its simplest form enables to differentiate indirect taxes on consumption (VAT being the best known) from direct taxes on the income of economic agents (labor or capital) and corporate taxes. Economic literature agrees on the idea that because of capital mobility, capital income tax turns out to create competition between countries making it most profitable to the lowest tax bidder. With the increase of capital mobility and the growth of multinationals, the tax impact of capital income tax is even more reduced and, *de facto*, the capital income tax rates converge downwards (Auerbach and Feldstein, 2002). Besides this classic theme of tax competition when tax base is mobile, internationalization of activities is also at the origin of several difficulties. For instance tax authorities have to define the tax base corresponding to value creation in their jurisdiction.

2.1.1. Indirect tax literature

Tax on consumption (*sales tax* in the US, VAT in Europe) was introduced when most of international trade relied on tangible goods consumed locally. Growing e-commerce and then, to a greater extent, of e-services, has seen the development, across frontiers, not only of tangible goods but also of digital services, making it difficult to trace trades and locate the consumer. Analyzing these consumption taxes requires to differentiate destination-based taxation from origin-based taxation. According to the principle of destination, the tax rate of the consumer's country applies, while according to the principle of origin, the tax rate of the producer's country applies. It is necessary to set apart whether the consumer is the final consumer (BtoC) or a company (BtoB) (Ligthart, 2004).

Though from January 2015, the destination principle will gradually be applied in the EU, VAT in Europe has been going back and forth between the origin principle and the destination principle. Since both principles carry advantages and disadvantages, European policies have implemented different solutions. The main advantage of the destination principle is that no matter the place of origin of the good (locally produced or imported), the same VAT rate applies and thus the consumer prices of imported and locally produced goods are equalized. The destination principle is effective (Diamond and Mirrlees, 1971) since, regardless of the production place, companies receive the same pre-tax price and balance their marginal costs at this price. The main drawback, especially if custom borders are removed, is the difficulty in locating exchanges and defining the consumption place. The cross-border transit is difficult to embody –thus to define– while the location of the company is not determined. This last point advocates for the origin-based principle. However, the origin-based principle triggers tax competition between countries: if a country has a low VAT rate, it gives its companies a competitive advantage for export. The origin-based principle therefore encourages the company to locate in the country with the lowest consumption tax rate which leads to tax competition between countries to the benefit of the lowest bidder. All countries therefore share the same interest in applying a lower tax rate than their neighbors.

E-commerce may seem close to the pre-digital economy and often seems affiliated to distance-selling. Goods traded *via* online platforms are not specific goods: the first two categories of top selling items on eBay are antiques and clothes. E-platforms business model is neither based on the use of personal data nor on an advertising model. The market is not two-sided but is closer to a model of supplier / distributor / consumer. If traded goods are not specific, traditional taxation and VAT can theoretically apply. True reality covers other difficulties (e.g. identifying trade, particularly the sale of services). Economic literature has also addressed the e-commerce consumer tax, considering the administrative cost of collecting such taxes: Keen (2002), for example, suggests to exempt all consumption taxes that would amount below a certain administrative cost threshold where collecting and controlling taxes exceed the amount of income tax. In practice, the use of Internet raises the question of how to detect the exchange and its traceability. Digitalization confronts to trade/exchange traceability which is compulsory to implement an efficient VAT.

The very principle of taxing internet consumption has been the subject of vigorous debates in the 90's (Varian, 2000). Indeed competition has risen between e-sellers and traditional trade, the latter bearing taxes for real whereas the former escape from it, though not in theory but in practice. This tax distortion makes consumption tax rather inefficient

(Goolsbee, 2000). On the other side, some authors have argued in favor of an exemption of internet taxation arguing that internet was a young starting industry with positive external effects. But Zoodrow (2003) shows that these positive external effects of Internet trading, on exports for example, are actually quite small. Some authors suggest consumption tax should be collected not by the selling company but by intermediaries who have access to the information and that governments recognize: for example McLure (2000) claims that banks should collect this VAT, whereas Seote and Kamp (1996) suggest that it should be done by access providers. These two solutions, despite their easy implementation, raise important questions about data access and internet neutrality.

Tax competition which exists between countries in case of indirect taxation, is a well-known process, summarized in the simple Kanbur and Keen (1993) model (standardized by Nielsen, 2001). The very rich economic literature on the variations of these first models has been summed up by Keen and Konrad (2012). The main issue is the pressure exerted by consumers who cross the border to buy in the nearby countries at a lower tax rate than that applied by the government. From this point of view, e-commerce resembles cross-boarder shopping. To our knowledge, the only study about the links between tax competition and e-commerce is Agrawal's (2013) who quantifies the impact of internet penetration on tax rates.

Academic economic literature on e-commerce and its tax system remains relatively scarce. It is mainly empirical and focuses on the estimation of demand elasticity on the web (Einav et al., 2013; Goolsbee, Lovenheim and Slemrod, 2010; Goolsbee, 2000).

2.1.2. Corporate tax literature

Corporate tax, if quite easy to design in a given economy, does indeed bring up difficulties in the case of multinationals operating in various countries (Devereux and Griffith, 1998). Basically, it relies on the notion of fixed establishment: if a firm possesses a fixed establishment in a country, the country's corporate tax rate will apply and international agreements allow to avoid double taxation of the company by two countries, the first one (where the company is established) and the second (where for example parent company or shareholders are based).

Indeed, for a MNE with several subsidiaries in different countries –that are trading goods and services, intermediate consumptions or patents– it can be difficult to decide in which subsidiary, thus in which country, to locate the generated profit. For example when a MNE belonging to American agents, produces *via* a subsidiary in China, products that are consumed in France, it is not easy to decide in which of the three countries, and *via* which tax, it would be efficient to tax its activity (Mirrlees et al., 2010). It is specially the case when the various stages of the production process are complementary thus essential to production: for a wine produced in Algerian vineyards, stored in Australian cellars but only drunk in France, it is impossible to say which country is the source of the firm profit, thus which country can tax the firm profit. Such impediment is even greater concerning digital services for which the network effect may drive all countries concerned to be considered as essentials in the activity process.

These exchanges between one company's subsidiaries especially allow the MNE to arbitrate between the profits of each of the various subsidiaries: for example if an *A* subsidiary of a country *A* buys intermediate goods to the subsidiary *B* of a country *B*, the

MNE chooses to display profits in the subsidiary *A* by fixing the exchanges prices quite low, or, to display losses by pricing these internal exchanges at a high price. These exchange prices between subsidiaries don't impact at all the overall profit of the MNE but the displayed profit of each subsidiary, thus corporate taxes levied in each of the two countries *A* and *B*.

"Transfer prices" are the prices of goods and services exchanged between subsidiaries of various countries, used to estimate the taxable profit in each country. Governments estimate these transfer prices following the principle of full competition, also known as "arm's-length principle": it consists of estimating these transfer prices following the market price revealed through a similar exchange between separate companies. Not to mention the difficulty of such an estimate as the arm's-length price for market-exchanged traditional goods, there is just no equivalent to these transfers on markets for specific goods such as brands or patents; thus the concept of arm's-length price can become meaningless. The limits of such a concept may even be greater if considering that when companies grow into MNEs, it is definitely for achieving productivity gains from external trade, therefore transfer price estimates, according to arm's-length principle, actually overestimate the transfer prices.

MNEs make use of the different tax regimes of the countries in which they are located in order to reduce the total amount of taxes they shall pay. They take advantage of (1) the tax rate differences between countries, and of (2) the differences of (tax) base between countries.

(1) The first strategy is made possible because a MNE can partially control the location of the taxable base. In theory, taxable base in a country should coincide with value creation made in this country. In reality, a MNE can partially choose the distribution of its total base, involving all its activities, between different countries. Value creation in one country is not easily detected: location of business activities is not well established, meaning that production in a country *A*, of an entity belonging to a MNE whose head office is in a country *B*, is not necessarily submitted to the tax regime of country *A*. On the one hand, the tax base itself, to a certain extent, is movable location wise; on the other hand, the tax base can be relocated, in the accounting sense of the term, *via* the system of transfer pricing.

These two dimensions appear clearly in the case of intangible assets. Dischinger and Riedel (2011) observe that these assets are often taxed at low rates. First, the location of these assets in countries with low taxation is easier: the entities of the MNEs located in these countries sell patents and licenses to the entities in countries with stronger taxation and, in return, receive "royalties". The corporate tax base is reduced in countries with strong taxation (*via* costs increase) and moved to countries with low taxation (*via* the increase of value production). Furthermore, transfer pricings are more difficult to establish for these assets, as they have no exact equivalent on the market.

The same argument applies when assets are located, but with the possibility to move the profits that are assigned to the various entities (« profit shifting »): a multinational can decide on the allocation of the profits between its various entities by charging the transfers of the intermediate goods at shadow prices. The entities located in countries with strong taxation find themselves in deficit, and the others are in surplus. Countries try to limit these reallocations by imposing that they be made at the price of similar operations on the market (principle of « arm's length »).

Bauer and Langenmayr (2013) show that since MNEs choose their location, transfer pricing system leaves a surplus to the companies that decide to become integrated. An increase of transfer pricing implies that a larger part of the multinational's profit is taxed at a low rate: this gives great advantage to multinationals compared to non-integrated companies.

(2) Another development of the second strategy leans on the differences of tax base: a MNE can reduce the tax it settles even if the apparent rates are identical. These operations are labelled "hybrids". A class of hybrid operations concerns the method of financing capital increase. In theory, this financing can be made by debt or increase in capital (Egger et al., 2010). As soon as the tax rates between countries are different, the MNE has a strict preference for one of the two financing solutions: investments in countries with high rates should be financed by debt. Haufler and Runkel (2011) suggest that such is actually the case. This also brings a disparity in the tax treatment of domestic companies and MNE, in favor of the latter.

In practice, however, the border between debt and capital is ill-defined: an identical operation can be considered as financing through debt in a country and as capital increase in another. It would be easy to prevent MNE from escaping taxation by having tax policies in a country conditioned to those chosen by other countries: a country would deduct (or would exempt) an operation when it is taxed in another country; it would tax when tax is deductible (or exempted) in another country. Johannesen (2014) gives an example in which a country would have no interest in setting up one-sidedly measures. The country which deviates from this situation sees capital cost increase for companies that invest there, and is then confronted to capital flight. If we assume that there is an important capital mobility compared with that of labor mobility, the net remuneration of capital is expected not to vary. As a result, the impact penalizes workers.

Haufler and Runkel (2012) study the interaction between two countries in which a MNE, located in a tax haven, invests. As we've seen, the asymmetry between financing by debt or by capital increase leads the MNE to turn towards debt. However, the EU limits such an option by imposing an upper limit to the part of the financing based on debt ("thin capitalization rule"). In 2011, the Commission introduced the principle of a "common base" (Common Consolidated Corporate Tax Base): when the rates difference is high between countries, the debt is not tax-deductible on companies located in Europe. The basic statement is simple: any limitation of the possibility of turning to debt-financing will convert into an increase of taxation for the MNE. If two countries coordinate their tax rates and the ratio debt/capital, they would make it necessary that financing be entirely made through capital increase: such policy does not change the volume and the distribution of investment, and just reduces the tax base. However, each of them is prompt to tolerate debt-financing to attract capital on its own territory. At equilibrium, the ratio debt/capital is too high. It remains too high even if, as a reference, we consider a situation in which both countries set in a coordinated way only their ratio debt/capital because a reduction in this ratio limits the (harmful) tax competition that they will be engaged into on the rates.

The question raised here is whether digitalization will impact this tax competition. Since their creation, digital companies have taken advantage of easy worldwide localization. The digitalization intensifies capital mobility, the multinationalization of activities and the fragmentation of value chain parts throughout countries. This extreme mobility of activities

disrupts and compels governments to rethink the notion of stable establishment and essential resource, so to restrict tax competition. The digitalization of activities is also translated into growth of intangible assets, specific to the company (patents, data) for which the concept of “transfer price” loses all meaning.

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2.2. Valuation of data literature

2.2.1. Valuation of personal data

With the exception of online sales sites, games and videos, the bulk of digital platforms revenues comes from advertising. Online advertising revenues increased from 8.1 billion US\$ in 2001 to 21.2 billion US\$ in 2007, from 3.2% of ad spending to 8.8% during the same period (Evans, 2009). Initially, most of online advertising was not targeted and was unrelated to the content of the webpage. Gradually, non-targeted ads have been replaced with targeted advertisements. Evans (2009) notes that, between 2000 and 2008, the share of non-targeted online advertising fell from 78% to 33%, while the share of targeted advertisements has increased from 1% to 45%. Such shifts have encouraged economists and marketing analysts to study the value of ad targeting.

To better understand how the benefits of targeted advertising are shared between advertisers and platforms, it is necessary to analyze how the platforms sell their advertising space. Auctions have developed to sell ad space on keywords research. Such ad auctions formats have been studied by Varian (2007), Edelman, Ostrovsky and Schwartz (2007), and more recently by Athey and Ellison (2011), and Chen and He (2011).

According to Edelman, Ostrovsky and Schwartz (2007), the evolution of the ad auction format on search engines has gone through three stages. Between 1994 and 2000, when ads were mainly non-targeted, advertisers paid by number of views ("pay-per-impression") and contracts were negotiated, in each case, as classic advertising contracts. In 1997, a start-up, Overture, offered to link advertising to the search by auctioning off-space related keywords. In this scheme, advertisers submit bids by keyword, and the search engine ranks advertisers according to their bid in the auction, giving advertisers who make a higher offer, a higher position on the web page. Such an innovative mechanism to sell ad space was really quickly adopted by dominant search engines in the late 1990s. When in 2002, Google launched Adwords Select, it decided to change the mechanism and set its own, moving from a first price auction to a second price auction and computing the revenues according to whether the user clicks on the ad or not ("pay per click"). Today, Yahoo and Google both use a second price auction with corrective factors intended to better reflect the chances that the ad actually leads to a click (the "clickthrough rate" or CTR).

As noted by Edelman, Ostrovsky and Schwartz (2007) and Varian (2007), this « position auction » is identical to a Vickrey auction when only one position on the page is sold, but different from Vickrey if the seller sells several positions. The remarkable properties of Vickrey auction –the fact that they lead to an efficient allocation and that participants have no interest in lying and bid their valuation– are not preserved in the position auction. Varian (2007) and Edelman, Ostrovsky and Schwartz (2007) provide a simple recursive formula to calculate the optimal bids of advertisers. He and Chen (2011), as well as Athey and Ellison (2011), incorporate in the analysis of the auction the consumers' search behavior. They assume that consumers are unsure of the compatibility between their search and the product of the advertiser. Only companies know the probability of compatibility between their product and the keyword chosen by the consumer. The consumer pays a cost every time he clicks on an ad. After clicking on the ad, he discovers whether the product meets his expectations. If the product suits him, he immediately buys; if the product doesn't match his query, he then

decides whether or not to click on the following announcement. The strategy of a consumer is therefore an optimal stopping strategy. At the same time, since they get higher compatibility, advertisers are more likely to sell their products, and as they have a higher click value, they are willing to pay more for better placement. Thus, consumers know that ads placed on top of the page are more likely to meet their expectations, and the optimal strategy of a consumer is therefore to click sequentially following the ads hierarchy on the page. In addition, Chen and He (2011) show that the search engine profit is an increasing function of the number of advertisers and non-monotonic in ads average compatibility: profit is higher when keyword compatibility is intermediate. Athey and Ellison (2011) analyze in detail the role of a reserve price in the auction. They show that an increase in the reserve price –or a tax on advertisements– can increase both the search engine profit and social welfare. The reasoning is as follows: by increasing the reserve price, the advertiser decreases the number of advertisers associated with a keyword, leading to a more efficient search and greater want-to-click on the part of consumers.

In the theoretical marketing literature, one of the main contributions has been written by Iyer, Soberman and Villas-Boas (2005), who confront regular (or non-targeted) advertising with targeted advertising. In their model, two companies compete in a market of captive and competitive consumers. When companies use a non-targeted advertising strategy, they waste resources by sending costly messages to attract their competitor's captive customers. However, if companies can target advertising, they will choose to avoid their competitor's captive customers. As the marginal benefit of advertising is higher on the captive segment of the market, companies will always choose to first inform their most loyal customers and only inform the competitive segment of the market with a probability less than one. Iyer, Soberman and Villas-Boas (2005) also show in their simple model, that a policy of price discrimination –leading to choose different prices on the captive market and the competitive market– is less effective than a policy of targeted advertising.

Recent contributions by Bergemann and Bonatti (2011) and Johnson (2013) offer models of targeted advertising more closely inspired by Internet platforms activity. Targeted advertising value comes from a better match between two populations: that of heterogeneous consumers and that of heterogeneous advertisers. Bergemann and Bonatti (2011) assume the presence of a continuum of advertisers and consumers, and introduce an index measuring whether the product is a mass or a niche product. The market for advertising space is competitive, and consumers buy the product if, and only if, there is a positive match between the ad and their taste. Bergemann and Bonatti (2011) analyze two models. In the first model, a conventional advertising market such as TV or magazine, there is only one advertising market for all products. The ads are not targeted and, at equilibrium, only the largest companies have an interest in buying ads. In the second model, inspired by new media like Internet platforms, there is a continuum of individual advertising markets. When targeting becomes more accurate, social welfare increases as the number of successful matches increases. The impact of improved targeting on advertisers depends on the advertisers' size: small and large advertisers benefit from more precise targeting, but midsize advertisers may initially suffer from increased targeting. When targeting increases, the number of firms present on each advertising market decreases: as advertising space on each market is fixed, the decline in the number of advertisers can lead to lower prices even if the value of each ad increases with more precise targeting.

Bergemann and Bonatti (2011) also analyze competition between different media. They assume that each advertiser can choose to send advertising messages on multiple media, and that duplication of messages is possible. Messages sent on two media are perfect substitutes, creating competition between platforms. If one platform sends non-targeted messages, and the other one targeted messages, the prices and profits of advertisers on traditional media decreases. Gradually, as consumers migrate from traditional media to new media, the price of ads on the new media goes down for small businesses and increases for larger companies. It is initially the niche advertisers (low demand and specialized consumers) who benefit from the introduction of new targeted advertising, and mass advertisers will migrate more slowly to the new media.

Johnson (2013) studies the interaction between advertisers who choose targeted advertising and consumers trying to avoid ads. His study relates to models of advertising avoidance on traditional media (see the survey by Anderson and Gabszewicz, 2006; or the models by Anderson and Gans (2011) and Tag (2009) on specific strategies of ad avoidance). Johnson (2013) suggests that before sending an announcement, each advertiser receives a noisy signal on the compatibility between a consumer and a product. As the advertiser must pay a cost per ad, he will choose to target consumers with the highest compatibility signal. For each pushed in ad, consumers suffer a cost, and can choose *ex ante* to install a filter on their computer to block all unwanted ads. In equilibrium, advertisers will choose how many ads to send and consumers whether to block ads in response. Johnson (2013) shows that, at a social optimum, no consumer chooses to block ads. But in equilibrium, advertisers do not internalize the effect of their ads on consumers' behavior and choose to send an excessive amount of ads. Public intervention –such as taxing ad revenues– would restrict the number of ads and have a beneficial effect both on consumers and advertisers. Johnson (2013) also studies the effect of a signal's increased accuracy. Consumer surplus is non-monotonic in the signal accuracy, with high levels for low and high values and low levels for intermediate values. This lack of monotony comes from the existence of two opposite effects: first, improved precision of the signal increases the chances of a good match between the consumer and the advertiser's good –a positive effect; second, better accuracy of the signal increases the volume of ads because advertisers have higher marginal revenue –a negative effect. The balance between the two effects leads to a negative total effect when precision is low and the volume effect dominates, but a positive total effect when precision is high and the pairing effect dominates.

Dynamic data collection and storage not only enables to improve the match between advertisers and consumer needs based on past search histories, but also provides detailed histories on past purchases, which can be used by companies to refine their price strategy. The (in)famous experiment launched by Amazon in September 2000 to set prices according to customers' past shopping history has highlighted the use of personal data for targeted dynamic pricing. Taylor (2004), Akcira and Srinivasan (2005), Acquisti and Varian (2005) and Calzolari and Pavan (2006) study the incentives of two different companies exchanging or selling their data on consumer purchases. Taylor (2004) models a data market between two companies. Consumers visit two companies one after the other and the value of the products sold by the two companies are positively correlated. The first company can sell data about past purchases to the second company, enabling it to price discriminate. Taylor (2004) compares equilibrium when the sale of information is prohibited and when it is allowed. He shows that three situations can arise: either both regimes result in the same outcome, or

consumers are negatively affected by the sale of information, but the first company makes a positive profit on data sales, or some consumers (those with a low value for the product of company 1, but a high value for the product of company 2) prefer a regime of information transmission. Taylor (2004) also takes into account the consumer's reaction to the possible sale of information. Consumers whose value is high in company 1 will hesitate to buy because they know that company 2 will use this information to increase its price. This strategic behavior may actually lead the first company to decide not to sell the information. For some parameters value, the company may prefer a system where the sale of information is prohibited.

In Calzolari and Pavan (2006), consumer values for the two goods are perfectly correlated. They also compare two regimes –one with information transmission and one without. They show that the comparison of profits in both regimes depends on assumptions about the complementarity or substitutability of the two goods. If the two goods are complementary –e.g. being two components of a system–, the first company prefers to share information on purchases. If, however, the goods are perfect substitutes, the first company prefers to keep purchase information private, to itself. Akcira and Srinivasan (2005) consider a reduced form model where the loss experienced by a consumer for information resale is an exogenous parameter. They show that companies may benefit from committing *ex ante* not to resell personal data. Finally, Acquisti and Varian (2005) consider a model of dynamic pricing by a monopoly that uses information on past sales. They show that the monopoly has no incentive to use the information on past sales, unless the consumer value increases when it has already purchased the good. If the firm can offer benefits to past customers (like loyalty cards, discounts on future purchases...), information has a positive value for the monopoly.

2.2.2 Valuation of social networks

The emergence of social networking platforms like Facebook or Myspace has allowed access to social data, opening up new opportunities for companies to develop innovative marketing strategies. The commercial value of digital social networks can be associated with three different sources:

- the use of word-of-mouth as a marketing tool to advertise new products and increase consumers' awareness for existing products;
- the use of social data to target influential agents to accelerate the diffusion of new products;
- the use of social data as a means of discrimination between consumers in the presence of consumption externalities.

The importance of word-of-mouth (WOM) communication as a marketing tool, complementary or substitutable to traditional advertising, has long been recognized as a key subject in the marketing literature. Three recent empirical studies highlight the importance of word-of-mouth communication through digital social networks and its impact on new products dissemination. Godes and Mayzlin (2004) measure the importance of WOM in successful audience rates of new TV series launched in the US in 1999-2000. To measure word-of-mouth they used sample conversations posted on Internet "chatrooms". This pioneering study shows how the ability to spread information through computer social networks increases the marketing importance of word-of-mouth. As for Mobius, Rosenblat and Niehaus (2005), they conducted a controlled experiment about word-of-mouth among

Harvard students by distributing products to a test group, and analyzing social influence in the dissemination of these products to the rest of the student population. For their part, Leskovec, Adamic and Huberman (2007) analyzed 16 million recommendations from 4 million agents on Amazon, between 2001 and 2003, to figure out the importance of word-of-mouth effect on different product types and see, for example, the kind of books most sensitive to WOM.

WOM studies don't consider the precise architecture of the social network. To understand targeting, it is necessary to map out the network and identify the location of influential agents. The data collected through social networking platforms allows companies to target influential individuals and paves the way for viral marketing strategies that differentiate agents and their location. The seminal paper by Domingos and Richardson (2002) uses a linear model (where the probability of adoption of a new product is a linear function of neighbors adoption) to characterize the value of each agent in the network as the solution of a system of linear equations. The problem of targeting influential consumers becomes a linear programming problem and can be solved by a polynomial time algorithm. Kempe, Kleinberg and Tardos (2003) analyze different diffusion models where the probability of adoption depends on the number of agents who have already adopted (threshold model) or the probability that the agent learns about the new product from one of his neighbors (independent cascade model). They show that the identification of the most influential agent in the threshold model and the cascade model is NP-hard and cannot be solved in polynomial time. However, they show that the implementation of a local optimization polynomial algorithm (« greedy algorithm ») allows for a good approximation of the maximal value (1- 1/e rate of total value).

Galeotti and Goyal (2009) suggest an original theoretical model to analyze the behavior of a monopolist seeking to maximize a new product diffusion. They consider both the threshold and cascade models, but assume that information only travels one step to make the model tractable. They first compute the optimal level of (uniform) advertising sent by the monopoly, and show that, as word-of mouth communication and traditional advertising are substitutable; the monopoly chooses a lower degree of advertising in the presence of WOM communication. An increase in the density of the social network leads to contrasting effects in different diffusion models (in a threshold diffusion model, increasing connectivity may paradoxically limit communication because diffusion becomes more difficult). In situations where individuals are sensitive to the advice they receive from their neighbors (as in the case of books, movies or songs), increasing network density benefits the monopoly. But in situations where agents only adopt a product when a sufficient fraction of neighbors has adopted it (as in the case of software or computer operating systems), the monopoly prefers a less dense social network. Galeotti and Goyal (2009) also analyze targeting strategies based on the degree (i.e. the number of neighbors) of each agent. They show that in the cascade model, the monopoly chooses to target individuals with low degrees, whereas in the threshold model, it is more profitable to target individuals with high degree.

Campbell (2013) provides a complementary analysis, by studying how a monopoly controls diffusion of information through the social network by selecting its price. In Campbell's model, consumers only buy the product if the value exceeds its price and only consumers who buy the product can recommend it to their neighbors. Hence, by varying its selling price, the monopoly can control the diffusion of information about its product. The

diffusion model is a percolation model, and Campbell (2013) focuses on situations where a « giant component » emerges, through which all agents become aware of the new product. Campbell (2013) compares the pricing strategy of the monopoly with and without WOM communication and shows that the presence of communication between consumers leads to an increase of demand elasticity, so that the optimal price chosen by the monopoly is lower than in the absence of communication. Thus, consumers as a whole benefit from word-of-mouth communication. However, if there is a strong correlation between the valuation of a consumer and his degree –as in the case of status goods– the relation between price and communication is reversed: the presence of communication leads to an increase in the price of the monopoly. If the monopoly can choose different prices depending on the degree of agents, it will always choose a lower price for the most connected consumers because they are more likely to share information with their neighbors.

When agents benefit from consumption externalities in the network, firms can use information about the social network to price discriminate (these strategies exist in the telephone industry with « friends and family » plans, or in other industries with referral discounts where agents receive money if they make friends buy the product.) Bimpitis, Candogan and Ozdaglar (2012), Bloch and Querou (2013) and Fainmesser and Galeotti (2013) analyze optimal price discrimination in the presence of consumption externalities. The main result obtained independently by Bimpitis, Candogan and Ozdaglar (2012) and Bloch and Querou (2013) is a negative result: when demand and costs are linear, the optimal choice of the monopoly is to choose the same price for all agents in the network and the network therefore has no value. This surprising result stems from a balance between two opposing forces: on the one hand, a monopoly wants to set a higher price for more central consumers because their demand is higher, on the other hand, he wants to set a lower price for more central consumers because the consumption of a central agent has a greater positive externality on other agents. In the linear model, these two effects exactly balance. However, this result is not robust to changes in the model. Thus Bloch and Querou (2013) show that, if costs are quadratic, it is optimal to reduce high consumption and the monopoly will choose higher prices for more central agents. If externalities are directed, it is best to choose a lower price for the agents that most influence others and are themselves less influenced. Bimpitis, Candogan and Ozdaglar (2012) calculate the optimal uniform price when the graph is directed and measure the difference between the benefit of a discriminating monopoly and a monopoly choosing a uniform price, thereby obtaining a value for the social network.

Fainmesser and Galeotti (2013) also compute the difference between the profit made by a monopoly discriminating across agents in the network and a monopoly setting a uniform price. They suppose that the monopoly cannot observe the entire network and only knows the degree of agents. Hence, a discriminating price only depends on the number of neighbors who influence or/and are influenced by an agent. Fainmesser and Galeotti (2013) compare four monopoly pricing policies: a uniform price, a price that depends only on the out-degree (number of agents who are influenced by an agent), a price that only depends on the in-degree (number of agents who influence an agent) and a price that depends on both the in- and out-degrees. They observe that the profit in the discriminatory regime is increasing and convex in the mean and variance of the degrees. In addition, the value of information is also increasing and convex in the average and variance of degrees. Analyzing the effect of discrimination on consumer surplus, Fainmesser and Galeotti (2013) show that

discrimination on the basis of in-degrees favors consumers, whereas discrimination on the basis of out-degrees has an ambiguous effect on consumer surplus.

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2.3. Taxation of two-sided platforms

Unlike standard market where a company provides products to a single group of customers, two-sided markets platforms sell a service to two distinct groups of customers who wish to interact. Platforms create value by allowing interaction between the two groups of consumers. Examples of two-sided market are numerous in the digital economy and include software, e-commerce sites, content sites, search engines and Internet payment systems. For search engines, users are more inclined to use an engine if it references a large number of sites. Conversely, sites prefer to be referenced by a search engine if it attracts more users.

The academic literature about two-sided markets is recent and the definition of two-sided markets is still discussed. Main contributions are due to Rochet and Tirole (2004, 2006), Caillaud and Jullien (2003), Armstrong (2006) and Weyl (2010). The least restrictive definition of a two-sided market is that it serves two distinct groups of end users and that the level of participation of at least one group influences the value of the other group. The interaction between the two groups is characterized by indirect network externalities. Rochet and Tirole (2004) add another criterion to characterize a two-sided market: the fact that the total volume of transactions generated by the platform depends on the distribution of prices between the two parties, and not just their overall level (actual condition of non-neutrality).

Two-sided platforms must consider the interests of two different end-user groups and that has important consequences on pricing. Prices in two-sided markets depend on three elements: (i) demand elasticities on each side of the platform –the side that values most interaction pays more– (ii) marginal production costs and (iii) the strength of the indirect network effects between the two sides –generally, a price rebate is granted to one of the sides of the market to generate more value for the other side. The latter dimension distinguishes two-sided markets from standard markets thus explaining why standard markets optimal taxation results cannot directly be applied to two-sided markets.

Optimal taxation of two-sided monopolistic platforms has been studied by Kind et al. (2008, 2009, 2010), leading to two main results. First, it shows that *ad valorem* taxes (e.g. VAT) do not necessarily dominate unit taxes. The classical result in public finance on the domination of *ad valorem* taxes no longer holds for two-sided markets. Second, the price of a good may decrease with the *ad valorem* tax. The introduction of a tax on the value added for one side of the market can lead to a change in the entire business model of the platform. For example, increasing VAT on the price of access for users could induce the platform to set a zero price for Internet access and switch all its revenues to the advertisers' side.

Kind et al. (2009) show that, in a monopolistic two-sided platform with constant production cost, the switch from a value added tax to a unit tax can increase tax revenues. Keeping tax revenues constant, they show that the transition to a unit tax can increase welfare in the economy. More precisely, they show that if the indirect externality from one group to the other is positive and strong enough, a switch to a unit tax while keeping the quantities constant can lead to more tax revenue and welfare. This contrasts with the usual result on standard markets, where *ad valorem* taxes dominate unit taxes both in terms of tax revenue and welfare. The intuition is that a good's VAT on one side of the market has a negative effect on the amount chosen on the other side because this increase in VAT

increases the marginal cost of producing the good. This effect is not present when the tax is a unit tax.

Using a similar model, Kind et al. (2008) show that the competitive equilibrium can lead to over- or under-production of goods on both sides of the market compared to the social optimum. They compare the choice of the platform to the social optimum, show that this comparison depends mainly on how the platform internalizes externalities between groups with respect to the internalization chosen by a social planner.

Kind et al. (2010) study the effect on pricing of an increase in VAT on one side of the market (e.g. readers of a newspaper), when VAT on the other side of the market is fixed. If readers do not like the ads (or are indifferent to ads), and the value of an additional reader is higher than the marginal cost of serving that reader, an increase in VAT on subscription prices leads to an increase in the quantities sold on both sides of the market. The intuition is that when the platform slightly increases its prices in order to lose exactly one reader, it saves the marginal cost of that reader but loses the opportunity cost of advertising to that reader. If the opportunity cost (the value of the reader to the advertiser) is higher than the marginal cost, then the marginal cost of the reader is negative, and the platform responds to VAT increase by lowering its price in order to keep its readers.

When platforms are competing, a change in *ad valorem* taxes can have new effects due to the strategic interaction between platforms. Kind et al. (2013) consider this issue. They show that under certain conditions a VAT increase on one side of the market may result in decreasing the diversity of content platforms while increasing quality.

Kotsogiannis and Serfes (2010) address the issue of taxation with multi-sided market in terms of tax competition between countries. They consider competition between two countries that choose two tax instruments and the provision of local public goods, taking into account that each instrument is designed to attract both sides of a two-sided market, namely consumers and businesses. Consumers are located along a Hotelling segment, and two platforms are formed at both ends of the segment. Each firm chooses a platform, and consumers choose to go on either platform based on the number of companies on each platform and the distance to the consumer platform. The time sequence of the model is as follows: the two jurisdictions first choose their levels of public good, and their level of taxation, and consumers and businesses simultaneously choose their platforms. Supposing that jurisdiction *A* provides more public goods than platform *B*. If the difference is big, vertical differentiation between platforms is important, and each platform specializes in a segment of the population. If the difference is small, competition between platforms is intense, and it is possible that all consumers and all businesses meet on a single platform. Comparative static results show that an increase in externalities between the two sides of the market may lead to a decrease in the tax rate in both jurisdictions, an increase in the number of firms on platform *A* and a decrease in the number of firms on platform *B*. If externalities increase, the number of consumers on platform *A* increases, which therefore increases the number of firms on platform *A*. The effect of a tax cut is then stronger for *A* than for *B* so that, in equilibrium, both jurisdictions choose lower tax levels. When externalities increase, it is even possible that tax competition leads to no taxation in jurisdiction *B*, while all consumers and businesses join jurisdiction *A*. Once all consumers have joined jurisdiction *A*, an increase of externalities allows the platform to raise taxes as consumers and businesses are captive.

Thus, an increase in externalities between the two sides of the market initially leads to a decline and then to an increase in taxes.

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Taxation and the digital economy: A survey of theoretical models

An overview of the research papers

The digital economy is characterized by large network effects, the presence of two-sided platforms, the collection and exploitation of personal data, and the blurring of territorial lines for economic activities. The five studies contained in the report study the effect of taxation on the digital economy focusing on these specificities.

We organize this summary along the following lines:

- The taxation of network rents and distortive effects of taxation;
- Taxation on two-sided markets and exclusion;
- Taxation and privacy protection;
- Pricing, taxation and the interaction of fiscal instruments;
- Taxation and competition among platforms;
- E-commerce and fiscal competition.

1. The taxation of network rents and distortive effects of taxation

Once they are established, internet platforms collect profits because of the large network effects they generate. Members of social networks, users on either side of a two-sided platform have no incentive to leave, because they immediately lose the benefits generated by network effects. Hence, irrespective of the quality of the service, internet platforms capture rents due to their position as intermediaries –either between agents in social networks or between the two sides of the market. These rents are independent of the use of capital and labor, and hence do not correspond to a classical payment for inputs in the production process. They are more similar to rents generated by the use of fixed factors –like land or exhaustible natural resources. Taxation of network rents thus has no distortive effects on the production process, and is just a financial transfer from internet platforms to the government. This observation suggests that taxing profits of internet platforms can be done with very little negative effects on productive and allocative efficiency.

This reasoning breaks down, however, if one considers investments made by internet platforms to establish service or improve its quality. We need to distinguish between internet platforms relying on complex algorithms which require costly development, and for which taxation of rents could lead to a degradation of the quality of service (search engines?); and internet platforms relying on simpler routines where network rents could effectively be taxed (social networking sites).

Given the negligible marginal cost incurred by internet platforms, taxing profits or revenues results in the same effects on the platform's pricing and quality decisions. If, in

addition, the platform only collects revenues on one side of the market (advertisers), we conclude that taxation of advertising revenues and taxation of profits have the same distortive effects. As taxation of profits is typically neutral and does not distort a firm's production decision, we conclude that taxation of advertising revenues will not generate any negative distortion on productive and allocative efficiency. Again, this reasoning breaks down in the presence of fixed costs, where taxation of profits or of revenues may limit the platform's incentive to develop new services or improve the quality of its service.

Internet platforms collect network rents because of their positions as intermediaries between users or between the two sides of the market. Taxation of profits (or revenues) of internet platforms is just a transfer from the platforms to the government, with no distortive effects on productive and allocative efficiency. In the presence of fixed costs, taxation may generate negative effects on the platform's incentives to develop new services or improve the quality of existing services.

2. Taxation on two sided-markets and exclusion

On two-sided markets, taxation on one side of the market may lead the platform to change its business model, and respond by shifting revenues to the other side of the market. Hence, a tax on advertising revenues may lead an internet platform to start charging a subscription price to users, shifting revenues from the advertiser's side to the users' side. Similarly, a tax on data shifts revenues to the advertisers' side of the market. This effect explains why *ad valorem* taxes on revenues (which do not create distortive effects in one-sided markets) may be worse than unit taxes in the case of two-sided markets. An *ad valorem* tax lowers the margin uniformly on one side of the market, giving the platform an incentive to shift revenues to the other side of the market, possibly resulting in lower tax revenues while a unit tax does not alter the relative margins on the two sides of the market and hence does not lead to a shift in revenues.

A tax charged to the platform on the basis of the flow of data uploaded by users will increase the marginal cost of data for the platform. If users voluntarily upload data, they will not internalize this incremental cost, and data flows may be excessive from the point of view of the platform. As a response, platforms have an incentive to charge a subscription price to users, in order to reduce their participation in the platform and lower the flow of data. Hence, taxes based on data flows may actually result in exclusion of users from the platform.

Similarly, a tax charged to the platform per user will induce the platform to limit access to the users with the lowest values (users with demographic characteristics which are unappealing to advertisers, or with low level of internet use). One way of doing so would be to start charging a subscription price for the service. Hence, a tax per user results in exclusion from the platform. In a similar way, an additional tax charged to the user –for example a specific tax on internet providing services– will discourage users with low value from accessing the platform and result in exclusion.

On two-sided markets, taxation on one side may lead the platform to shift revenues to the other side. This explains why, contrary to classical markets, *ad valorem* commodity taxation may be worse than unit taxation. Charging a tax on advertising revenues may induce the platform to charge a subscription price to users,

resulting in exclusion of users with the lowest values. A tax on data flows may lead the platform to start charging a subscription price in order to limit the amount of data voluntarily uploaded by users. Taxes per user, whether charged to the platform or directly to the user, also result in exclusion of users with the lowest values.

3. Taxation and privacy protection

Internet platforms collect data that are either used internally (e.g. to propose targeted products or advertising) or sold to third parties (intermediaries or advertisers). The revenues of the platform can be decomposed into revenues linked to the one-time user access (e.g. keyword-based advertising on search engines) and revenues linked to data collection (sale of data to third parties or retargeting). Even though users benefit from improved service when their data are used, the level of data collection of the platform is always excessive.

Taxation of internet platforms often results in an increase rather than a decrease in the level of data collection. First, a tax based on revenue or profits does not alter the behavior of the platform. A tax charged per user or per access reduces the marginal cost of data collection (in terms of number of accesses or users on the platform) while leaving the marginal benefit of data collection unchanged: it thus leads the platform to increase its level of data collection. The only effective tax is a tax that differentiates between the two sources of revenues of the platform, fixing a high tax level on revenues generated by data collection and a low level on revenues generated by one-time access.

In order to reduce data collection, the regulator could also ask platforms to offer a « zero option » where the user accesses the platform with no data collection (e.g. the user refuses cookies or geolocation). This binary policy may induce the platform to increase data collection and harm users. The platform could also use prices to discriminate among users, either paying users who accept to upload data or charging users for the zero option. The first discriminatory policy is preferred by both the platform and users to a binary policy with no prices. The second discriminatory policy is preferred by the platform, but not by users, to the policy without prices. More complex menus of data collection and prices could be offered to enable the platform to better discriminate among users according to their internet use and privacy cost.

The revenues of internet platforms can be decomposed into revenues linked to one-time access and revenues generated by data collection. Data collection by platforms is excessive from the point of view of users. Taxes based on the platform's revenues are ineffective, and taxes based on the number of users or accesses result in an increase rather than a decrease in data collection. A tax differentiating between the sources of the revenues of the platform, and imposing a higher tax level on revenues generated by data collection, could lower the level of data collection. Giving the user the possibility to « opt out » may actually harm the average user by inducing the platform to increase data collection on all other users. A pricing policy by which users are paid for data collection improves the welfare of users and of the platform, whereas a pricing policy by which users pay to opt out increases the profit of the platform at the expense of users.

4. Pricing, taxation and interaction between tax instruments

The taxation of data or online advertising, or new regulation on privacy may change the business model of internet platforms. A platform which only extracts revenues on the advertisers' side may start charging a subscription price to users. A platform that only proposed one option may choose to discriminate among users offering different options of data collection at different prices. These changes generate new financial flows between users and the platform. As these flows are generated in the country of residence of users, they can be taxed by fiscal authorities of the country of residence.

Interaction between taxation on data, online advertising and VAT are complex. For example, an increase in data taxation has two distinct effects on fiscal revenues: a direct increase on revenues, and an indirect reduction of VAT due to the exclusion of users and the reduction in the volume of data collected. For small levels of taxation, both on data or advertising revenues, the direct effect dominates the indirect effect and fiscal revenues increase. Taxes on data and advertising are imperfect substitutes, and there is a presumption that a tax on advertising, by distorting the behavior of advertisers, generates a larger welfare loss than a tax on data.

Subscription prices subject to VAT will also arise when the platform offers a menu of access options with different levels of data collection. More interestingly, if the platform chooses to pay users for accepting to upload their personal data, this will give a price to the « free input » that the platform was initially using in exchange for free access to the platform. By monetizing personal data, fiscal authorities create a new tax base, in the form of additional income of resident users. This should allow fiscal authorities to access part of the profits of the platforms, as they are reassigned to resident users.

Taxation of data or online advertising or new privacy regulation may result in a shift in the business models of the platforms. Taxation reduces the volume of activity on the platform, lowering revenues from VAT. However, for small levels of taxation on data or online advertising, the direct effect of the tax dominates the indirect effect on VAT, and fiscal revenues are increased. Taxes on data and advertising are not perfect substitutes, and a tax on advertising results in more distortions than a tax on data. If the platform pays users for uploading personal data, part of the platform's profits can be taxed as additional income received by resident users.

5. Taxation and competition among platforms

Competitions between platforms trying to attract consumers create new effects of taxation. If platforms compete in setting prices and quality, in a Stackelberg game, only the leading firm attracts consumers and sets a level of quality that is the ideal point of the first adopters. If platforms compete simultaneously, there is a probability that one firm invests and attracts no consumer. This inefficiency can be reduced if profits are taxed, as the incentives to invest are lowered when the firm does not internalize all the benefits of the investment. In that case, higher taxes will increase the platform's profits but also reduce quality and harm consumers. The overall effect of taxation depends on the balance between the value of consumers to the platform and of quality to consumers.

Taxation on data collection affects competition between platforms on two-sided markets. If two symmetric platforms compete to attract advertisers, a tax on data shifts profits away from the platform, without affecting the market structure. If platforms are asymmetric in size, the tax will affect the two platforms in a different way, resulting in asymmetric prices.

Taxation also affects the market structure and competition among internet platforms. If platforms invest in quality to attract users, taxation may increase the joint profit of the platforms by preventing unproductive investments, but will result in lower quality for users. On two-sided markets, when two platforms compete to attract users on one side of the market, taxation has no effect on the market structure when the platforms are symmetric, but may distort the sizes of the platforms when the platforms are initially asymmetric.

6. E-commerce and fiscal competition

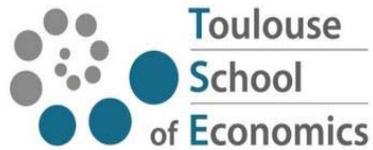
The development of e-commerce affects the choices of rates of VAT through three channels. First, e-commerce reduces transaction costs, in particular cross-border transaction costs, and makes it easier for consumers to buy goods produced in different countries. Second, e-commerce opens up the possibility that buyers evade taxation altogether (by buying from a seller who is also an individual rather than a firm). Finally, with e-commerce, the link between economic agents and geographical locations becomes blurred: platforms of e-commerce, like e-bay, connect buyers and sellers from different locations without any discrimination. This implies in particular that prices on e-bay are the same for all buyers, and sellers cannot price-discriminate according to the buyer's location. Both channels (a reduction in transaction costs and the absence of geographical price discrimination) affect fiscal competition. In addition, fiscal competition depends on the choice of taxation principle, and very different outcomes are obtained under the origin and destination principles.

When e-commerce results in a decrease in cross-border transaction costs and an increase in evasion, consumers have a stronger incentive to buy from a different country. Under the origin principle, consumers will exploit the differences in tax rates and buy from the country with the lower tax. Under the destination principle, consumers cannot take advantage of differences in tax rates between the two countries but still benefit from the fact that they can avoid paying taxes by going on the internet. Clearly, under the origin principle, e-commerce results in stronger competition between the two countries to attract consumers, and hence tax competition is strengthened, resulting in lower levels of VAT in both countries. Under the destination principle, consumers have no incentive to shop in the other country, increasing the level of taxes at the Nash equilibrium of the game of tax competition.

The possibility of third-degree price discrimination based on the buyer's country of residence, results in extreme tax competition where two countries always have an incentive to lower the tax rates to the lowest level. When sellers must sell to all buyers at the same price, tax competition is mitigated and countries are able to set positive tax rates, exploiting the fact that consumers have a different valuation for domestic and foreign products.

The development of e-commerce has changed the conditions for fiscal competition between countries setting their rate of VAT. E-commerce leads to a

decrease in cross-border transaction costs and a possibility of evading taxation, which strengthens competition between countries under the origin principle, resulting in a decrease in VAT rates. Under the destination principle, the emergence of e-commerce reduces cross-border shopping and relaxes tax competition, allowing for higher levels of sales taxes. E-commerce platforms like eBay prevent sellers from price discriminating among buyers according to their country of residence. When price discrimination is banned, and buyers have a bias in favor of domestic goods, tax competition between the two countries is mitigated and tax rates are higher than when sellers can adjust their prices to buyers according to their geographical location.



Taxation and the digital economy: A survey of theoretical models

Final report

February 26, 2015

The five research papers

➤ **Taxing Networks Externalities**

Jacques Crémer

➤ **Digital Platforms, Advertising, and Taxation**

Marc Bourreau, Bernard Caillaud and Romain de Njjs

➤ **Taxation and Privacy Protection on Internet Platforms**

Francis Bloch and Gabrielle Demange

➤ **Tax Competition, Tax Coordination and E-Commerce**

Maya Bacache

➤ **Optimal Discrimination Ban**

Stéphane Gauthier

Taxing network externalities

Jacques Crémer*
(Toulouse School of Economics)

March 5, 2015

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Abstract

In this paper, we study the consequences of the presence of network externalities for the taxation of firms. We analyze the ways in which different forms of competition affect the consequences of this taxation. We also discuss the consequences of this analysis for the current debates on the taxation of the large firms of the digital economy.

Cet article étudie les conséquences de la présence d'externalités de réseau sur la taxation des entreprises. Nous analysons comment la forme de la concurrence affecte les résultats de ces taxes. Nous discutons aussi quelques conséquences de cette analyse pour les débats sur la taxation des grandes entreprises de l'industrie numérique.

1 Introduction

The type of capital which creates the values of platforms is somewhat ephemeral. Facebook is an amazing business — in just above ten years it has succeeded in connecting close to 1.5 billion persons, and to develop a business model which is enabling it to generate substantial profits. However, it is fair to say that its value does not stem so much for this technical prowess and from the business acumen of Mark Zuckerberg but from the fact that it is a focal point for contacts between its consumers. Alice knows that if she wants to show the pictures of her new baby to her high school friends Bob, Caroline and David, they will look at them if she uploads them to her Facebook account. In that sense, the value of Facebook resides in neurone connections of hundred of millions of Alice, Bob, Caroline and Davids. They believe that other people will use their Facebook account, and hence use their Facebook account. The important part of this statement is that even if another firm, FaceNote, offered exactly the same service, as long as its consumers believe that the others will continue to use its platform, Facebook will be just as valuable.

Of course, the statements of the previous paragraph are just a fancy way of describing the presence of network externalities. I presented them in this way because I believe that this makes clearer the fact that network externalities at some level look like economic rents. Notwithstanding its qualities as a business, most of the profits of Facebook seems to stem from the fact it benefits from the converging expectations of its users. Now, it is a constant of economic theory that economic rents can be taxed at no cost to efficiency: taxing pure profits will not distort the decisions of firms and hence should be the favored way of raising government income. The aim of this paper is to present some preliminary exploration of this thesis.

We begin the exploration of the topic in section 2. We assume that there is an incumbent already installed in the industry and we ask ourselves the question: what could be the benefits and the costs of taxing that incumbent. We first show that if there is only one type of consumers, an *ad valorem* and a specific tax will be equivalent. We show that this results hold both for one and two sided platforms. However, as soon as there are two types of consumers this result does not hold true anymore and an *ad valorem* tax will be more efficient. (The comparison of unit and *ad valorem* tax in two sided markets is the object of Kind, Koethenbuerger, and Schjelderup (2009) — they show that the classical result that it is more efficient to tax a monopolist on its profits does not hold anymore for two sided markets).

Facebook faced competition at the begin of its existence. Studying taxation as if the problem of creation of networks did not exist, as most of the

literature¹ does is not satisfactory. We need to make sure that the taxes which we implement do not create undue distortions in the creation of new networks. This is the reason why in section 3 we turn to the consequences of competition *for* the market. In order to do so, we study a number of models, and point out that the consequences of different types of taxation will depend on the type of competition. Generally, if there is Nash competition, there will be overinvestment in the accumulation of a user base and taxation, by moderating this competition, will increase efficiency.

Most of the current discussions on the taxation of the “giants of the Internet” has focussed on the problems of taxation across borders (see the report Colin and Collin (2013), which has been very influential in France, or the recent report OECD (2014)). In this paper, we focus our attention on a different topic: assuming a closed economy, should we tax differently platforms that live of the presence of network externalities? I believe that this analysis also has consequences for the current discussion on the international framework for the taxation of these industries, and will point some of the consequences as we go along.

2 There is already an incumbent

The aim of this section is to analyze optimal taxation if we assume that the existence of platforms is exogenous. We will first show that if users are homogenous, then there is no efficiency loss due to taxation, whether under the form of specific or *ad valorem* taxes both in the case of one sided and two sided platforms. We will then show that the result is different when consumers are heterogenous.

2.1 Homogenous consumers

2.1.1 One sided platforms

Assume that there is a mass α of consumers. For the time being, they are all identical and they have a utility $u(\mu)$ if they belong to the same platform as μ other consumers. They have a utility of 0 if they are the only one on a platform. (For a survey of the literature on network externalities see Farrell and Klemperer (2007).)

There is one incumbent platform, I to which all the consumers belonged in the previous period. If the consumers do not belong to the platform, their

¹See Li (2009), Kind, Koethenbueger, and Schjelderup (2008), Kotsogiannis and Serfes (2010), and Kind, Koethenbueger, and Schjelderup (2010)

utility is 0.² There are no costs of production.

In the absence of any government intervention, and using the selection criterion of Biglaiser and Crémer (2014) in equilibrium the incumbent will charge $p = u(\alpha)$. (If there are entrants, they charge 0). Social welfare is $\alpha \times u(\alpha)$ and is entirely captured by the Incumbent.

Assume now that there is an ad valorem tax at the rate τ . The incumbent will choose a price p which maximizes $(1 - \tau)pN$ subject to the constraint $p \leq u(\alpha)$ (*i.e.*, no consumer has an individual incentive to leave the platform). It is obvious that at equilibrium $p = u(\alpha)$ and the tax creates no distortion.

The same thing is, of course, true if with a specific tax. The incumbent maximizes $(p - t)\alpha$ still subject to the constraint $p \leq u(\alpha)$. We obtain the same price and no distortion.

2.1.2 Two sided platforms

Let us now show that the results of section 2.1.1 holds for two sided platforms.

Consider a two-sided market with a mass α_s of consumers of type s , *i.e.*, on side s of the market for $s \in \{1, 2\}$. All the consumers on side s are identical and have a utility $u_s(\mu_{-s})$ if they belong to the same platform as μ_{-s} consumers of the other type, $-s$. They have a utility of 0 if there are no consumers of type $-s$ on the platform. As above, there is one incumbent platform I , no entrants³ and zero costs.

In the absence of any government intervention, the platform will charge $p_s = u_s(\alpha_{-s})$ to the consumers on side s of the market. Social welfare is $\sum_{s \in \{1, 2\}} \alpha_s \times u_s(\alpha_{-s})$ and is entirely captured by the platform.

It is straightforward that, as above, neither an *ad valorem* nor a specific tax will change the prices charged. Hence, there will be no distortion.

2.2 Heterogenous consumers

Of course, these results are partly due to the fact that consumers are all homogenous. Let us look at what happens when they are not. We use here again the equilibrium selection criterion of Biglaiser and Crémer (2014).

There is a mass α_h of “type h ” or *high network effects* (HNE) consumers and a mass α_ℓ of type ℓ or *low network effects* (LNE) consumers. A consumer of type θ derives utility $u_\theta(\gamma_{i\theta}, \gamma_{i\theta'})$ from belonging to platform i when $\gamma_{i\theta}$ consumers of the same type and $\gamma_{i\theta'}$ consumers of the type $\theta' \neq \theta$ also

²The presence of entrants would change neither the results nor the reasoning in the case of single sided platforms.

³Contrary to section 2.1.1, the presence of entrants would change the analysis considerably.

do. The functions u_θ are strictly increasing in both arguments and satisfy $u_\theta(0, 0) = 0$.

Even though consumers like to have more consumers of both types on the platform to which they belong, they prefer consumers of their own type:

$$\partial u_\theta(\gamma_{i\theta}, \gamma_{i\theta}) / \partial \gamma_{i\theta} > \partial u_\theta(\gamma_{i\theta}, \gamma_{i\theta'}) / \partial \gamma_{i\theta'} \geq 0.$$

(Here, as in the rest of the paper, θ' will always be taken to be “the other type”, different from θ .)

We will assume

$$u_\ell(\alpha_\ell, \alpha_h) < u_h(\alpha_h, 0) - u_h(0, \alpha_\ell). \quad (1)$$

This is condition (SMALLCE) in Biglaiser and Crémer (2014) and is a necessary condition for the fact that two networks can exist..

In the absence of taxes the incumbent can charge any price $p_I \leq u_\ell(\alpha_\ell, \alpha_h)$ and “keep” all the consumers. Indeed, at such a price, an individual LNE consumer will have a utility $u_\ell(\alpha_\ell, \alpha_h) - p$ if he purchases from the incumbent and $u_\ell(0, 0) - 0 = 0$ if he purchases from one of the entrants.

The incumbent can also charge up to $u_h(\alpha_h, 0) - u_h(0, \alpha_\ell)$ and keep only the HNE consumers. Indeed if it charges $p_I \leq u_h(\alpha_h, 0) - u_h(0, \alpha_\ell)$ a HNE consumers will prefer to purchase from the incumbent platform and have a net utility of $u_h(\alpha_h, 0) - p_I$ rather than joining an entrant which yields a utility of $u_h(0, \alpha_\ell) - 0$.

If (1) holds, the incumbent profit will therefore be

$$\max \left\{ \underbrace{(\alpha_h + \alpha_\ell)u_\ell(\alpha_h, \alpha_\ell)}_{\text{sells to all consumers}}; \underbrace{\alpha_h[u_h(\alpha_h, 0) - u_h(0, \alpha_\ell)]}_{\text{sells to HNE consumers}} \right\}.$$

At equilibrium, there will be only one network - which is efficient- if and only if

$$(\alpha_h + \alpha_\ell)u_\ell(\alpha_h, \alpha_\ell) > \alpha_h[u_h(\alpha_h, 0) - u_h(0, \alpha_\ell)]$$

Assume now ad valorem taxes. Profits in all configurations will be multiplied by $(1 - \tau)$ and the neutrality result still holds.

On the other hand, with specific tax, the profits become

$$\max \left\{ \underbrace{(\alpha_h + \alpha_\ell)[u_\ell(\alpha_h, \alpha_\ell) - t]}_{\text{sells to all consumers}}; \underbrace{\alpha_h[u_h(\alpha_h, 0) - u_h(0, \alpha_\ell) - t]}_{\text{sells to HNE consumers}} \right\}.$$

At equilibrium there will be only one network if and only if

$$\begin{aligned} (\alpha_h + \alpha_\ell)[u_\ell(\alpha_h, \alpha_\ell) - t] &\geq \alpha_h[u_h(\alpha_h, 0) - u_h(0, \alpha_\ell) - t] \\ t &\leq \frac{(\alpha_h + \alpha_\ell)u_\ell(\alpha_h, \alpha_\ell) - \alpha_h[u_h(\alpha_h, 0) - u_h(0, \alpha_\ell)]}{\alpha_\ell} \equiv \bar{t}, \end{aligned}$$

where we have

$$u_h(\alpha_h, 0) - u_h(0, \alpha_\ell) \geq \bar{t} \geq u_\ell(\alpha_h, \alpha_\ell).$$

A tax greater than the value of belonging to one network for the LNE consumers will be inefficient, and induce the presence of two networks. This result is similar to the standard result that specific taxes imposed on a monopolist will reduce its production and hence distort production further. There are two differences in this case:

- a) the monopoly without taxes is efficient;
- b) the reduction of production is actually a decrease in the number of connections that the agents enjoy by being on the same networks.

With a continuum of types, a similar result will hold: there will several networks when one would be efficient.

This result can throw some light on the current debate over the taxation of the large Internet based companies. Countries where they offer their services would like to tax their activity. As has been extensively discussed by practitioners and policy makers alike, it is very difficult, if not impossible, to come up with a coherent definition of the profits linked to the activity of one of these firms in any specific country. It is therefore tempting to use a specific tax. The result indicates that this could lead to inefficiencies, which have to be weighted against the benefit of added government revenue.

Future research should tackle two issues linked to this result. First, in the model above we have assumed that the tax was based on the number of members of the network.. There might be ways in which differentiated taxes on HNE and LNE consumers could be levied. For instance, for a messaging network one could charge per message rather than per user. More work is needed to decide whether this would be a good idea. Second, the preceding paragraph derives policy implications for international taxation, but the model is not completely adapted to this issue. A model which takes into account explicitly the presence of several countries would be more appropriate.

3 Ex-ante competition for the market

Section 2 begins the story when there is already an incumbent. What happens when there is none?

3.1 Price competition

Assume first that we are in the setup above where all consumers are similar. At the start there are unattached. We represent this through the following game:

1. The (potential) networks choose a first period price;
2. The consumers choose a network to join in the first period;
3. The networks choose a second period price;
4. The consumers choose from which network to purchase in the second period.

As in Biglaiser and Crémer (2014), it is clear that the consumers will all be on the same platform, both in period 1 and in period 2. Absent taxation, the second period incumbent will charge $u(\alpha)$ and its profit will be $\alpha \times u(\alpha)$. Therefore in the first period, the platforms will be willing to charge $-\delta u(\alpha)$; the consumers will choose one platform⁴ and the total discounted profit of that platform, as well as that of all the others will be 0. Clearly an *ad valorem* tax which allows the firms to deduce from their profits properly discounted loses in previous years will not change the results. The tax revenue will be zero.

The reasoning of the previous paragraph assumes that the platforms can charge negative prices. This is often impossible, for instance because this would attract fake consumption. In this case, in the game of the previous subsection, the platforms would all charge 0 in the first period. The consumers would join one platform whose profit would be $u(\alpha)$ in the second period. The analysis of section 2 would carry through. Taxing network effects would lead to no loss of efficiency.

3.2 Price and quality competition

The analysis becomes more interesting if we consider the more realistic case where the quality of a platform is dependant on an investment which it makes. If the platform spends c in quality investment, the consumers are willing to pay $u(\mu; c)$ to “be” with μ other consumers. We assume that u is increasing in both its arguments, differentiable and concave.

A natural form of the game of acquisition of consumers would have the following format:

1. The (potential) networks choose a price and a quality investment c ;
2. The consumers choose which network to join.

To make the analysis easier in the rest of this section we will assume that there are only two platforms. The profit of platform i is

$$\begin{aligned}
 & p_i \alpha - c_i && \text{if } u(0; c_i) - p_i > u(0; c_j) - p_j, \\
 & 0 && \text{otherwise.}
 \end{aligned}$$

⁴According to the Biglaiser-Crémer methodology, the first consumers who choose a platform will attract the following and hence all consumers will indeed join just one.

There are clearly no pure strategy equilibrium if we assume a Nash game. Because the strategies of the firms are two dimensional, the analysis of the game is quite complex. We therefore turn to the case of Stackelberg competition, which will ensure that we have a pure strategy equilibrium.

To model Stackelberg competition, we assume that platform 1 announces first a price and a quality, followed by platform 2. Notice that this is not equivalent to giving incumbency advantage to platform 1.

Given a pair (p_1, c_1) platform 2 will be able to profitably attract the consumers if and only if there exists (p_2, c_2) such that $u(0, c_2) - p_2 > u(0, c_1) - p_1$ and $p_2\alpha - c_2 \geq 0$. Therefore the problem of firm 1 is

$$\begin{aligned} & \max p_1\alpha - c_1 \\ & \text{s.t. } \{(p_2, c_2) \mid u(0, c_2) - p_2 > u(0, c_1) - p_1 \text{ and } p_2\alpha - c_2 \geq 0\} = \emptyset. \end{aligned}$$

The constraint can be written “for all c_2 and all p_2 such that $p_2 \geq \alpha/c_2$ we have $p_2 \geq u(0, c_2) - u(0, c_1) + p_1$ ”. This is clearly equivalent to “for all c_2 we have

$$\alpha/c_2 \geq u(0, c_2) - u(0, c_1) + p_1 \iff u(0, c_1) - p_1 \geq u(0, c_2) - \alpha/c_2.$$

Define

$$\hat{c} = \arg \min_c u(0, c) - \alpha/c$$

We can rewrite the problem of firm 1 as

$$\begin{aligned} & \max_{p_1, c_1} p_1\alpha - c_1 \\ & \text{s. t. } u(0, c_1) - p_1 \geq u(0, \hat{c}) - \alpha/\hat{c}, \end{aligned}$$

which is in turn equivalent to

$$\max_{c_1} \alpha u(0, c_1) - c_1 - (\alpha u(0, \hat{c}) - \hat{c}).$$

Firm 1 chooses the quality that maximizes $\alpha u(0, c_1) - c_1$ the utility of the consumers if they did not enjoy network effects. Of course efficient quality maximizes $\alpha u(\alpha, c_1) - c_1$.

Although the economic insight is quite interesting (and, as far as I know new to the economic literature): competition between network leads to the quality preferred by the first adopters, and not the quality preferred by the mass of users, the problem is that it is totally uninteresting as far as taxation is concerned: we can tax profit at 100%.

This result would not hold true with the Nash model: in the mixed strategy equilibrium there will exist at least some states of nature such that one of the two firms invested and had no consumer. There will be over-investment in quality. The aim of the rest of this section is to analyze the conditions under which taxation can reduce this over-investment.

3.3 Quality competition

Because, the Nash model above is very complicated to solve, we specialize it in the following way, which, moreover, fits better the reality of some cases. We will assume that the price is fixed, in the sense that platforms obtain a fixed revenue p per consumer. This can be thought as follows: the revenues of the platforms are coming from advertising and p is the advertising revenue per consumer. We can think of this as a short hand for the description of a two sided market.⁵ Classical studies on two sided markets include Caillaud and Jullien (2003), Rochet and Tirole (2003), Rochet and Tirole (2006) and Armstrong (2006).

For purposes of comparison, let us begin by the case where there is no tax. Under the assumptions which we have just discussed, the profit of the firms will be

$$\begin{aligned} p\alpha - c_i & \quad \text{if } u(0; c_i) > u(0; c_j) \iff c_i > c_j, \\ (p\alpha/2 - c_i) & \quad \text{if } u(0; c_i) = u(0; c_j) \iff c_i = c_j, \\ - c_i & \quad \text{otherwise.} \end{aligned} \tag{2}$$

Clearly, there is no pure strategy equilibrium. We will focus our attention on symmetric mixed strategy equilibria, where F is the distribution of investments in quality for each of the firms.⁶

It is easy to see that in any equilibrium the probability that $c_1 = c_2 = c$ must be equal to 0 for any c . We can therefore neglect this case in the analysis, and there must exist a K such that for all c in the support of F we have

$$\begin{aligned} p\alpha F(c) - c &= K \quad \text{for all } c \text{ in the support of } F, \\ p\alpha F(c) - c &\leq K \quad \text{for all } c \text{ not in the support of } F. \end{aligned}$$

Therefore, $F(c) = (K+c)/(p\alpha)$. 0 must belong to the support of F ; otherwise there would be not point in spending \underline{c} , the lower bound of the support of F . Hence $K = 0$ and the investment strategies are uniform on $[0, p\alpha]$, with an expected profit of 0. The expected investment of each firm is $p\alpha/2$ and the distribution of the maximum quality, that is the quality of the platform which attracts the consumers, satisfies

$$F^{\max}(c) = F^2(c) = \frac{c^2}{\alpha^2 p^2} \implies f^{\max}(c) = \frac{2c}{\alpha^2 p^2}.$$

⁵Of course this requires some assumption on the demand for advertising.

⁶The game of investment in quality is similar to the game in de Cornière and Taylor (2014).

Therefore social welfare will be

$$SW = \int_0^p u(\alpha, c) \frac{2c}{\alpha^2 p^2} dc - \alpha p.$$

(This assumes that there is no surplus on the “other” side of the market, which would be consistent with enough demand for access to the consumers.)

Note that because the amount of investment does not depend on $u(\alpha, c)$, there is no reason to believe that the amount of investment will be either too large or too small. Taxes will increase social welfare when the investment is too large and decrease it when the investment is too small.

We now turn to the consequences of a tax on profits of platforms when there is investment in quality.

If we assume both that there is a tax on profits and that the losing platform can recover the tax on its losses, nothing will change in equilibrium as (2) becomes

$$\begin{aligned} (1-t)(p\alpha - c_i) & \quad \text{if } u(0; c_i) > u(0; c_j) \iff c_i > c_j, \\ (1-t)(p\alpha/2 - c_i) & \quad \text{if } u(0; c_i) = u(0; c_j) \iff c_i = c_j, \\ -(1-t)c_i & \quad \text{otherwise.} \end{aligned}$$

Exactly the same investments in quality will be chosen at equilibrium as when the tax rate is equal to 0, and nothing will be changed in terms of social welfare. Because the expected profits of firms are equal to 0, the tax revenue will be nil.

On the other hand, the analysis becomes much more interesting in the more realistic case where there is no recovery of losses for the platforms which do not succeed in entering the market (because for instance it is small firms that invest in new networks and they have no profit to deduct their losses from). We will spend the rest of this section analyzing this case.

Without recovery of cost, (2) becomes⁷

$$\begin{aligned} (1-t)(p\alpha - c_i) & \quad \text{if } u(0; c_i) > u(0; c_j) \iff c_i > c_j, \\ (1-t)(p\alpha/2 - c_i) & \quad \text{if } u(0; c_i) = u(0; c_j) \iff c_i = c_j, \\ -c_i & \quad \text{otherwise} \end{aligned} \tag{3}$$

⁷Depending on the tax code, on the length of time in which losses can be carried over and the length of time before investment becomes productive, it could happen that even the firm which enters successfully is not able to recover its cost. In this case equation (3) becomes

$$\begin{aligned} (1-t)p\alpha - c_i & \quad \text{if } u(0; c_i) > u(0; c_j) \iff c_i > c_j, \\ (1-t)p\alpha/2 - c_i & \quad \text{if } u(0; c_i) = u(0; c_j) \iff c_i = c_j, \\ -c_i & \quad \text{otherwise.} \end{aligned}$$

I conjecture that this formulation will not change the fundamental results of the analysis that follows.

As above, the probability that we have $c_1 = c_2$ is essentially equal to 0, and there exists a K such that for any c in the support of F we have

$$(1-t)(p\alpha - c)F(c) - c(1 - F(c)) = K,$$

which implies

$$F(c) = \frac{K + c}{(1-t)\alpha p + tc}.$$

As above, it is clear that 0 must belong to the support of F ; otherwise there would be no point in spending \underline{c} . Hence $K = 0$ and \bar{c} the upper bound of c satisfies

$$\frac{\bar{c}}{(1-t)\alpha p + t\bar{c}} = 1 \implies \bar{c} = \alpha p.$$

The upper bound on the distribution of c is therefore, and somewhat surprisingly, independent of t and we have

$$F(c) = \frac{c}{(1-t)\alpha p + tc}$$

and

$$f(c) = \frac{(1-t)\alpha p}{((1-t)\alpha p + tc)^2}.$$

When $t = 0$, $f(c) = 1/(\alpha p)$, which is consistent with the results obtained above in the absence of any taxation.

The expected investment $E[I]$ of each firm satisfies ⁸

$$\begin{aligned} E[I] &= \int_{c=0}^{c=\alpha p} c \frac{(1-t)\alpha p}{((1-t)\alpha p + tc)^2} dc \\ &= \frac{(1-t)\alpha p}{t^2} \left[\frac{(1-t)\alpha p}{(1-t)\alpha p + tc} + \ln((1-t)\alpha p + tc) \right]_{c=0}^{c=\alpha p} \quad (4) \\ &= \frac{(1-t)\alpha p}{t^2} [(1-t) + \ln(\alpha p) - [1 + \ln((1-t)\alpha p)]] \\ &= \frac{(1-t)\alpha p}{t^2} [-t - \ln(1-t)] \\ &= -\frac{(1-t)\alpha p}{t^2} [t + \ln(1-t)] > 0 \end{aligned}$$

⁸Equation (4) is a consequence of the following computation:

$$\begin{aligned} \frac{d}{dc} \left[\frac{(1-t)\alpha p}{(1-t)\alpha p + tc} + \ln((1-t)\alpha p + tc) \right] &= -\frac{t(1-t)\alpha p}{((1-t)\alpha p + tc)^2} + \frac{t}{(1-t)\alpha p + tc} \\ &= \frac{-t(1-t)\alpha p + t((1-t)\alpha p + tc)}{((1-t)\alpha p + tc)^2} = \frac{t^2 c}{((1-t)\alpha p + tc)^2}. \end{aligned}$$

This investment is decreasing⁹ in t , equal to $\alpha p/2$ when $t = 0$ and to 0 when $t = 1$.

We now compute social welfare.

The distribution of the maximum of the c_i s is

$$F^{\max}(c) = F^2(c) = \frac{c^2}{((1-t)\alpha p + tc)^2}. \quad (5)$$

Because we have $c \leq \alpha p$, it is immediate that F^{\max} is increasing in t . An increase in the tax rate leads unambiguously to a decrease in the amount of investment in quality, in the sense of first order stochastic dominance.

From (5), it is straightforward that the density of the investment of the “winning” platform is

$$\begin{aligned} f^{\max}(c) &= 2F(c)f(c) = 2 \frac{c}{(1-t)\alpha p + tc} \times \frac{(1-t)\alpha p}{((1-t)\alpha p + tc)^2} \\ &= \frac{2c\alpha p(1-t)}{((1-t)\alpha p + tc)^3}. \end{aligned}$$

Neglecting the second side of the two sided market, where we assume that there is a close substitute to the technology which we are considering, social welfare is equal to the utility of the consumers minus the investment cost.

$$\begin{aligned} SW &= \int_{c=0}^{c=\alpha p} u(\alpha, c) f^{\max}(c) dc - 2 \times \left[-\frac{(1-t)\alpha p}{t^2} [t + \ln(1-t)] \right] \\ &= \int_{c=0}^{c=\alpha p} u(\alpha, c) f^{\max}(c) dc + 2 \times \left[\frac{(1-t)\alpha p}{t^2} [t + \ln(1-t)] \right] \\ &= SW_c + SW_f \end{aligned}$$

⁹Investment is decreasing in t because

$$\begin{aligned} \frac{d}{dt} \frac{1-t}{t^2} [t + \ln(1-t)] &= \frac{-t^2 - (1-t) \times 2t}{t^4} [t + \ln(1-t)] + \frac{1-t}{t^2} \left[1 - \frac{1}{1-t} \right] \\ &= \frac{t^2 - 2t}{t^4} [t + \ln(1-t)] - \frac{1}{t} = \frac{t-2}{t^3} \ln(1-t) - \frac{2}{t^2} = \frac{-2t + (t-2) \ln(1-t)}{t^3}. \end{aligned}$$

Let $g(t) = -2t + (t-2) \ln(1-t)$. We have

$$\begin{aligned} g'(t) &= -2 - \frac{t-2}{1-t} + \ln(1-t) = -1 + \frac{1}{1-t} + \ln(1-t) \\ &\implies g''(t) = \frac{1}{(1-t)^2} - \frac{1}{1-t} = \frac{t}{(1-t)^2} > 0 \end{aligned}$$

Because $g''(t) > 0$ and $g'(0) = 0$, $g'(t) \geq 0$ for all t . We also have $g(0) = 0$, and therefore the derivative of $\frac{1-t}{t^2} [t + \ln(1-t)]$ is positive, which proves the result.

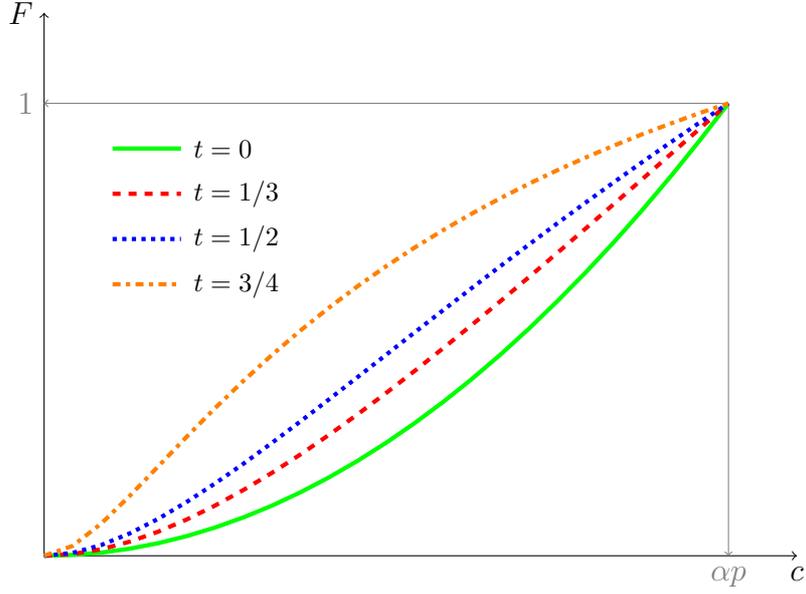


Figure 1: The consequences of changes in taxation on the distribution of the maximum quality of the platforms.

One has:

$$\begin{aligned}
& \frac{d}{dt} \frac{1-t}{((1-t)\alpha p + tc)^3} \\
&= \frac{-1 \times ((1-t)\alpha p + tc)^3 - 3(1-t)(c - \alpha p)((1-t)\alpha p + tc)^2}{((1-t)\alpha p + tc)^6} \\
&= \frac{-((1-t)\alpha p + tc) + 3(\alpha p - c)(1-t)}{((1-t)\alpha p + tc)^4} \\
&= \frac{(1-t)(2\alpha p - 3c) - tc}{((1-t)\alpha p + tc)^4}.
\end{aligned}$$

and therefore

$$\frac{df^{\max}}{dt} = 2c\alpha p \frac{(1-t)(2\alpha p - 3c) - tc}{((1-t)\alpha p + tc)^4}.$$

When $t = 0$ this expression is equal to

$$2c \frac{2\alpha p - 3c}{(\alpha p)^3}.$$

Hence when $t = 0$, the derivative of the consumer's surplus with respect to t

is

$$\frac{dSW_c}{dt} = \int_{c=0}^{c=\alpha p} u(\alpha, c) 2c \frac{2\alpha p - 3c}{(\alpha p)^3} dc.$$

To get a better feel for this assume that $u(\alpha, c)$ can be written under the form $k_0(\alpha) + k_1(\alpha)c^\ell$. It is natural to assume that both k_0 and k_1 are positive. Then we have

$$\begin{aligned} \frac{(\alpha p)^3}{2} \frac{dSW_c}{dt} \Big|_{t=0} &= \int_{c=0}^{c=\alpha p} (k_0(\alpha) + k_1(\alpha)c^\ell) (2\alpha p - 3c)c dc \\ &= \left[k_0(\alpha)(\alpha p c^2 - c^3) + k_1(\alpha) \left(2\alpha p \frac{c^{\ell+2}}{\ell+2} - 3 \frac{c^{\ell+3}}{\ell+3} \right) \right]_{c=0}^{c=\alpha p} \\ &= k_1(\alpha)(\alpha p)^{\ell+3} \left(\frac{2}{\ell+2} - \frac{3}{\ell+2} \right) = -k_1(\alpha)(\alpha p)^{\ell+2} \frac{2+\ell}{(\ell+1)(\ell+2)}. \end{aligned}$$

Therefore

$$\frac{dSW_c}{dt} \Big|_{t=0} = -2k_1(\alpha)(\alpha p)^{\ell-1}/(\ell+1) < 0.$$

A small increase in taxation leads to a decrease in the utility of the consumers. This is obvious, as quality is decreasing. To see the effect of the small increase of t on social welfare, note that, doing a Taylor expansion, we obtain that for small t

$$E[I] \approx -\frac{(1-t)\alpha p}{t^2} [t + (-t - t^2/2)] = -(1-t)\alpha p/2 \approx -\alpha p/2.$$

Let us take the case $\ell = 1$. We have

$$\frac{dSW_c}{dt} \Big|_{t=0} = -k_1(\alpha).$$

A small increase in t increases welfare if and only if $\alpha p > 2k_1(\alpha)$. The left hand side of this inequality is the value of consumers to the platforms. If this value is very large compared to the value of quality for the consumers, then taxation improves social welfare by reducing excess investment. This makes sense. The more valuable the consumers, the more the firms will have incentives to overinvest.

4 Conclusion

The aim of this paper has been to throw some light on the way in which Internet industries should be taxed. Like the rest of the literature on corporate

taxation, our work is hindered by the fact that there is not good theoretical basis for corporate tax: firms are eventually owned by their stockholders and it is not clear why it is not stockholders who should be taxed. However, given that corporate taxation is here to stay, it is important to study its consequences. And modern studies of corporate taxation should take into account the evolution of the nature of capital in the XXIst century.

Much work needs to be done. The reader will have noted, as we have progressed, the places where the analysis is still much too sketchy. It would also be very important, given the current policy debate, to explicitly introduce in the analysis the problems of cross border taxation.

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Digital Platforms, Advertising and Taxation*

Marc Bourreau[†] Bernard Caillaud[‡] Romain De Nijs[§]

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Abstract

This paper investigates the consequences of specific taxes on data or on advertising on the business models of digital two-sided platforms that provide service to users and offer targeted advertising windows to advertisers. In the case of a monopolistic platform, the paper compares both specific taxes in the presence of a VAT and show how they affect fiscal revenues and welfare. In the case of competition between two platforms on the advertising market with the possibility of multi-homing, the paper shows how a tax on data impacts the market structure.

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[†]Telecom ParisTech; Email: marc.bourreau@telecom-paristech.fr.

[‡]Paris School of Economics - Ecole des Ponts ParisTech; Email: caillaud@pse.ens.fr.

[§]Paris School of Economics - Ecole des Ponts ParisTech; E-mail: romain.denijs@gmail.com.

1 Introduction

The major companies in the digital economy are as of today the most profitable firms in the global economy. In 2014, Google earned revenues of \$16.52 billion, a 20% rise over 2013. Facebook's stock value has more than doubled since its initial public offering in 2012, reaching \$215 billion in January 2015. Yet, these giant companies are well-known for their low effective rate of taxation. Their ability to design worldwide fiscal strategies to exploit fiscal competition internationally and evade taxation is one of the explanation of this fact. Another view is also that their business models enable them to easily escape the bulk of taxation and that standard fiscal instruments may have perverse or unexpected effects on these platforms and on the fiscal revenues that are collected.

The business models in the digital economy vary but most of them rely on advertising to generate a revenue stream. They constitute examples of two-sided platforms that, on one side, provide services to web-users and, on the other side, sell advertising slots to online sellers.¹ Web-users get potential benefits from being targeted with relevant advertising, that is, advertising for products that meet their needs. Online sellers benefit from the large audience of a major platform, particularly when this platform relies on personal data, collected on each user, that help it provide a better targeting technology and therefore more efficient advertising campaigns for sellers.

Colin-Collin (2013) argue that this type of business model implies that most of the value created by a platform comes from the data input that is provided by users, an input that is free for the platform. This view has lead them to propose specific taxes on digital platforms that collect personal data. Others rather consider that, since advertising is the main source of revenue of these major digital platforms, it should be considered as a potential basis for a specific tax on online advertising revenues. To the best of our knowledge, there does not however exist any formal analysis of the effects of these alternative tax instruments.

This paper proposes a model that takes explicitly into account the two-sided nature of digital platforms and uses it in order to assess the likely impacts of a tax on data collection and a tax on advertising. The approach is positive: given the fiscal environment, mainly consisting of a VAT, we investigate how a tax on data and a tax on online advertising

¹General references on two-sided markets include Caillaud and Jullien (2003), Rochet and Tirole (2003) and Armstrong (2006). Papers more specifically focused on advertising-based business models include Anderson and Coate (2005) and Peitz and Valletti (2008).

affect the pricing strategies of digital platforms and, consequently, how it modifies the fiscal revenues.

We first consider a monopolistic platform and we show that both types of taxes exhibit a standard trade-off between increasing the tax rate and reducing the tax base; locally, introducing either one of these taxes would generate additional fiscal revenues. On top of these effects, both taxes induce a reduction in the use of the platform and in the amount of data collected, which triggers a decrease in the total value created in the economy. The reduction in the platform's profit, and therefore in the VAT collected on the platform, is not strong enough to invalidate the result that the introduction of a small specific tax, either on data or on advertising, generates additional revenues. However, the loss in VAT collected upstream on the supply chain, that is, on online sellers and their suppliers, may invalidate the result, especially if they capture a large part of the surplus and if many of them sell online physical goods. We also show that a tax on data is an imperfect substitute to a tax on advertising, and there is a presumption that a tax on advertising, by inducing a distortion both on the amount of advertising and on users' activity on the platform, generates larger a welfare loss for given fiscal revenues than a tax on data, which does not affect the equilibrium on the advertising market.

In the second part of the paper, we consider a simple model of competition between two platforms. These platforms are supposed to offer separate compatible services to the users so that users may well multi-home on the two platforms. Platforms, however, compete to attract advertisers on their advertising slots. Advertisers may also multi-home because the targeting technology that can be offered on either platform is not perfect and cannot ensure that a profitable match is generated with probability one; so, there is value in multi-homing, to the extent that it enables an advertiser to get a second chance to hit a user with whom to trade profitably. In this setting, we consider how a tax on data collection may change the pattern of competition between the two platforms. We show that the equilibrium is not sensitive to this tax, although both platforms' profits are reduced and partially captured by taxation. This suggests that taxation on data has some neutrality in terms of market structure, while provided fiscal revenues to the public authority.

The analysis of taxation in two-sided economies is relatively scarce. The extant literature has mainly focused on the comparison between value-added or ad valorem taxes

and unit or excise taxes, concluding that in two-sided environments, ad valorem taxes do not necessarily dominate unit taxes in terms of fiscal revenues or welfare.² Moreover, the literature points out the sometimes counter-intuitive price or quality effects of ad valorem taxes in two-sided environments.³ But all these papers consider very general forms of two-sided environments and do not try to formalize precisely the cross-network externalities that characterize digital platforms with an advertising-based business model. Moreover, no existing paper investigate other forms of specific taxation such as a tax on data.

2 Taxation of a monopolist platform

2.1 Model of a monopolist platform

We consider a monopolistic web-player, say a dominant content provider or platform, whose services are proposed (and possibly charged) to an heterogeneous population of users. The platform relies on personal data from users to provide users with a valuable personalized service and to offer the possibility of targeted advertising to a heterogeneous population of sellers / advertisers. This is a two-sided platform as users care about the amount and the relevance of the ads they receive and advertisers care about the platform's audience. Fiscal instruments are the following: a standard value-added tax (VAT), a tax on data in the spirit of Colin-Collin (2013) and a tax on advertising.

Let $x \in [0, 1]$ denote the amount of data concerning a given consumer that is collected / uploaded on the platform. The platform offers the consumer a service of value $v(x)$, increasing in x . Moreover, data x help the platform perform targeted advertising: we summarize this targeting by $\lambda(x)$, the probability per active seller that the user is reached by a relevant ad from this seller. By "relevant ad", we mean an ad that generates a transaction between this seller and this user with associated gross surplus s for the user and associated (fixed, exogenous) net transaction price p paid by the user to the seller, where we assume that $0 < p < s$; $\lambda(\cdot)$ is increasing. So, if n^S advertisers post ads through the platform, the user will have a relevant match with probability $\lambda(x)n^S$, where a relevant match means that the user is hit with an ad that generates some valuable

²See Kind et al. (2008) and (2009).

³See Kind et al. (2010) and (2013).

transaction for both the advertiser and the user.

Users are indexed by θ , their marginal disutility of increasing the amount of personal data collected on the platform. This can reflect the disutility of having data collected by the platform or the cost of an additional privacy loss. We assume that θ is distributed according to the cdf $F(\theta)$ on $[0, 1]$.

Assume that the platform charges the user a subscription fee, possibly contingent on the amount of data that is transmitted to the platform; let $A \geq 0$ denote the net subscription paid by the user when enjoying the services and advertising from the platform.⁴ The user's overall utility is then given by:

$$U = v(x) - \theta x + \lambda(x)n^S(s - p) - A.$$

Online sellers benefit from a relevant match with a user as they cash in the price p . They pay the platform on a pay-per-click basis, assuming that all clicks are relevant match, at a unit net price equal to a and they incur a cost c paid to suppliers. Letting N^U denote the set of participating users, n^U the number of participating users and t VAT rate, the expected profit of each seller is given by:

$$\frac{(p - a - c)}{(1 + t)} \int_{\theta \in N^U} \lambda(x(\theta)) dF(\theta),$$

since advertisers are able to reclaim the VAT proceeds on their intermediate consumption (advertising and production cost). Sellers can be considered to be heterogeneous with respect to their production cost: c is distributed according to $G(\cdot)$ on $[0, p]$. Suppliers of pure online services can be viewed as having low production costs while sellers of physical goods who advertise online have to physically produce their output at a non-trivial (net) cost. It follows that the sellers' participation is given by: $n^S = G(p - a)$.

Simply assuming that the operating costs of the platform are negligible, the platform's profits are given by:

$$\Pi = \frac{A}{1 + t} n^U - \phi \int_{\theta \in N^U} x(\theta) dF(\theta) + \left(\frac{a}{1 + t} - \zeta \right) n^S \int_{\theta \in N^U} \lambda(x(\theta)) dF(\theta),$$

⁴We will normalize subscription charges to be non-negative. In principle, they could be negative to the extent that the platform could provide users with a free additional service. In this model, however, negative subscription fees do not increase the flow of data compared to a null subscription fee. Hence, we discard this possibility.

where ϕ is the tax rate on the amount of collected data and ζ is the tax rate on successful clicks, both paid by the platform on top of the amount paid through the VAT. It is convenient to use $\psi \equiv (1 + t)\phi$ and $\xi \equiv (1 + t)\zeta$, so that:

$$\Pi = \frac{1}{1 + t} \int_{\theta \in NU} \{(A - \psi x(\theta) + (a - \xi)n^S \lambda(x(\theta)))\} dF(\theta).$$

In order to assess the performance of fiscal instruments, we can characterize the total tax proceeds that accrue to the fiscal authority, which are given by:

$$R = \frac{1}{1 + t} \int_{\theta \in NU} \{tA + \psi x(\theta) + (tp + \xi)n^S \lambda(x(\theta))\} dF(\theta).$$

consisting of the VAT on subscriptions, the tax on data, the VAT on goods sales generated by online advertising and the tax on advertising. In fine, the social desirability of tax instruments should be evaluated on the basis of social welfare. Social welfare will be viewed as the sum of users' surplus, sellers profits and the platform's profit, provided it falls within the jurisdiction that is considered. To take into account the possibility of a foreign platform, we will impose a weight $\alpha \in [0, 1]$ on the platform's profit in the social objective function.

In a first attempt to explore this setting, we analyze a version of the model with the following functional forms.

Assumption 1: We assume that $v(x) = vx$ and $\lambda(x) = \lambda x$ for any $x \in [0, 1]$, and that $F(\cdot)$ is uniform on $[0, 1]$.

This functional form implies a strong restriction, namely that the user's decision only consists in whether he participates in the platform or not (given the linearity in x), and not in the amount of data that he allows the platform to collect.

We will also assume that in response to the fiscal environment, the monopolist platform simply charges a users' subscription fee, denoted A , and a price-per-click for advertising, denoted a , without any possibility of discriminating through prices.

2.2 Homogeneous online sellers

For this sub-section, let us simplify drastically the model and assume that all sellers have the same cost $c < p$; that is, $G(\cdot)$ is the step function at c . Assuming de facto

homogeneity of sellers implies that they all participate if $a \leq p - c$ or none of them participate in the market if $a > p - c$. Advertising inducing only a positive externality on users, it is immediate that the platform will optimally charge $a = p - c$ as the unit price-per-click and all sellers will participate. So, $n^S = 1$. We will use the following simplifying notation:

$$\omega \equiv v + \lambda(s - p) \text{ and } \rho = \lambda(p - c).$$

ω denotes the value of the platform for a (marginal) user, that the platform can capture through its pricing, and we will assume that $\omega < 1$ so that the participation of users will not be degenerate; ρ denotes the value of the platform for an online seller. User θ 's decision simply consists in choosing $x = 1$ if and only if $\omega - \theta \geq A$, and $x = 0$ otherwise. Assuming that $A \leq \omega$, the number of participating users n^U corresponds to the threshold type who decides to participate, i.e.: $n^U \equiv \omega - A$. Unsurprisingly, a higher subscription fee reduces the participation of users.

Let us now turn to the platform's optimal pricing problem. Given the fiscal policy implied by (t, ψ, ξ) , the platform aims at maximizing profit through its pricing decisions taking into account the anticipated consumers' behavior. Admittedly, many platforms today have a business model that relies on advertising and provides an access to users free-of-charge; i.e., $A = 0$. But one cannot take this pricing as given if one introduces a major change in the fiscal framework such as the introduction of a tax on data. The platform profit can therefore be written as follows:

$$\begin{aligned} \Pi(A, \psi, \xi) &= \frac{1}{1+t} \int_0^{n^U} \{A - \psi + \lambda(p - c - \xi)\} d\theta \\ &= \frac{1}{1+t} n^U \{A - \psi + \lambda(p - c - \xi)\}. \end{aligned}$$

This can be written in terms of quantity, i.e., as a function of n^U or as a function of price A , using the demand function $n^U = \omega - A$. Both approaches deliver the following conclusion.

Proposition 1 *Under Assumption 1 and whenever the population of sellers is homogeneous, the platform's optimal strategy consists in charging a subscription fee that is a non-increasing function of $(\psi + \lambda\xi)$. More precisely, the optimal subscription fee is $A = \frac{\omega - \rho + \psi + \lambda\xi}{2}$, consisting in serving $n^U = \frac{\omega + \rho - (\psi + \lambda\xi)}{2}$ users, provided $\omega + \rho \geq \psi + \lambda\xi$ and*

$\omega + \psi + \lambda\xi \geq \rho$ (i.e., provided $A \geq 0$ and $n^U \geq 0$ at the optimum). If $\omega + \psi + \lambda\xi < \rho$, then it is optimal to set $A = 0$. If $\omega + \rho < \psi + \lambda\xi$, then the platform does not operate.

Proof. Immediate from the fact that Π is proportional to $n^U(\omega - \psi + \lambda(p - c - \xi) - n^U)$.

■

In this analysis, we focus on potentially small values for the new fiscal instruments that we consider, hence on values for (ψ, ξ) small enough such that the platform operates: in other words, taxation cannot exhaust more than the sum of the values of the platform for the users and the online sellers. The optimal subscription fee charged by the platform may be null whenever the value of the platform for users is smaller than the value of the platform on the sellers' side, i.e., if $(p - c)$ and λ are large enough so that $\omega < \rho$. In such a case, it is optimal for the platform to attract as many users as possible since the revenues it earns on the sellers' side is critical and depends (multiplicatively) on the users' participation; the platform has then a purely advertising-financed business model. Note that in this configuration, increasing the taxation rates on data or on advertising does not affect users' participation locally and only reduces the platform's profits. It is therefore immediate that both fiscal instruments help increase fiscal revenues without any change in the users' surplus or the sellers' profits.

In the interior case, letting $\epsilon_A^U = -\frac{d \ln n^U}{d \ln A}$ denote the elasticity of the participation, the FOC for profit maximization naturally corresponds to a Lerner formula (dropping indices):

$$\frac{A + \rho - \psi - \lambda\xi}{A} = \frac{1}{\epsilon_A^U},$$

where the marginal opportunity cost of increasing participation takes into account the additional tax to be paid on the data uploaded by the marginal user but also the additional benefit from an increase in the number of relevant clicks net of the tax on advertising. So, introducing a tax on data or a tax on advertising compared to a situation where there are no such taxes leads to an increase in subscription fees, hence a decrease in users' participation, and consequently a decrease in the platform's advertising revenues.

Looking at the fiscal revenues, we have :

$$R(\psi, \xi) = \frac{n^U}{1+t} [tA + \psi + \lambda(tp + \xi)],$$

which can be rewritten as:

$$R(\psi, \xi) = t\Pi(A, \psi, \xi) + \frac{t}{1+t}\lambda cn^U + (\psi + \lambda\xi)n^U.$$

Given the envelope theorem, we know that:

$$\begin{aligned}\frac{d\Pi}{d\psi} &= \frac{\partial\Pi}{\partial\psi} = -\frac{n^U}{1+t}, \\ \frac{d\Pi}{d\xi} &= \frac{\partial\Pi}{\partial\xi} = -\frac{\lambda n^U}{1+t}.\end{aligned}$$

So, overall, we obtain:

$$\begin{aligned}\frac{dR}{d\psi} &= \frac{n^U}{1+t} + \left[\frac{t}{1+t}\lambda c + (\psi + \lambda\xi) \right] \frac{dn^U}{d\psi}, \\ \frac{dR}{d\xi} &= \frac{\lambda n^U}{1+t} + \left[\frac{t}{1+t}\lambda c + (\psi + \lambda\xi) \right] \frac{dn^U}{d\xi}.\end{aligned}$$

In our specific model, the conclusion follows:

Proposition 2 *Under Assumption 1 and whenever the population of sellers is homogeneous, introducing some additional taxation, either on data or on advertising, generates additional fiscal revenues provided $v + \lambda(s - (1+t)c) > 0$; both instruments ψ and ξ are perfect substitutes, profit, fiscal revenues and welfare only depend upon $\tau = \psi + \lambda\xi$, and τ and the VAT rate t are substitutes.*

Proof. The proof is immediate given that:

$$\frac{dR}{d\psi} = \frac{v + \lambda(s - (1+t)c) - (2+t)(\psi + \lambda\xi)}{2(1+t)} = \frac{1}{\lambda} \frac{dR}{d\xi}.$$

■

This result shows that whenever the VAT rate is small enough, introducing taxation on either side of the platform generates additional fiscal revenues. This of course comes at the cost of introducing a distortion in the market allocation, namely, that fewer users will participate in the platform and less (beneficial) advertising will take place. When the goods sold online are physical goods that generate upstream activity from suppliers in the economy (i.e., c is high), the loss due to the reduction of online sales induces a reduction in the VA generated at this level and therefore a loss in fiscal revenues, and

this loss can annihilate the benefit of introducing some taxation on data or advertising; this effect is more powerful, the higher the VAT rate.

2.3 Heterogeneous online sellers

We now consider that the sellers are heterogeneous with respect to the cost of producing and delivering the good or service they propose online: so, we assume from now on that sellers are indexed by c which is distributed uniformly on $[0, s]$.

As a first step, note that a seller with cost c decides to advertise on the platform provided the price-per-click is low enough so as to leave the seller with a non-negative profit for any unit sale. It follows that the demand for advertising comes from all the sellers such that: $c \leq p - a$. The quantity of sellers advertising on the platform is given by $n^S = G(p - a) = \frac{p-a}{p}$, which is non-increasing in a . Alternatively, if n^S sellers advertise actively on the platform in equilibrium, it must be that the price of advertising is given by the inverse demand: $a = p - G^{-1}(n^S) = p - pn^S$

We will now extend the simplifying notation with $\omega(a) = v + \lambda(s - p)G(p - a) = v + \lambda(s - p)\frac{(p-a)}{p}$, which denotes the marginal utility of participating in the platform for a user, and $\rho(a) = \lambda a G(p - a)$, the platform's revenue per additional user on the advertising market. We maintain the assumption that $\omega(0) < 1$ so that the participation of users will not be degenerate. User θ 's decision simply consists in choosing $x = 1$ if and only if $\omega(a) - \theta \geq A$, and $x = 0$ otherwise. Assuming that $A \leq \omega(a)$, the number of participating users n^U corresponds to the threshold type who decides to participate, i.e.: $n^U \equiv \omega(a) - A$. A higher subscription fee reduces the participation of users; similarly, a higher price for advertising reduces the users' expected benefit from participating, hence their participation. Alternatively, if the platform proposes to serve n^S sellers and n^U users, with $n^U \leq \omega(p - pn^S)$, the subscription fee must meet the inverse demand function: $A = \omega(p - pn^S) - n^U$; moreover, the platform can never serve more than $\omega(p - pn^S)$ users when n^S sellers advertise on it.

Let us turn to the platform's optimal pricing problem. Given the fiscal policy implied by (t, ϕ, ξ) , the platform aims at maximizing profit through its pricing decisions taking into account the anticipated consumers' behavior. The platform profit can therefore be

written as follows:

$$\begin{aligned}\Pi &= \frac{1}{1+t} \int_0^{n^U} \{A - \psi + \lambda(a - \xi)n^S\} d\theta \\ &= \frac{n^U}{1+t} [A - \psi + \lambda(a - \xi)n^S].\end{aligned}$$

This can be written in terms of quantities only, i.e., as a function of (n^U, n^S) , or as a function of prices (A, a) , using the demand system characterized above. Both approaches deliver the following conclusion. Formally,

$$\Pi = \frac{n^U}{1+t} [\omega(p - pn^S) - \psi + \rho(p - pn^S) - \lambda\xi n^S - n^U].$$

Proposition 3 *Under Assumption 1 and whenever sellers' types are uniformly distributed on $[0, s]$, the platform's optimal strategy consists in fixing the price for advertising and the users' subscription fee as non-decreasing functions of (ψ, ξ) . More precisely, the platform chooses $a = a^* \equiv \sup\{p - \frac{s-\xi}{2}; 0\}$, i.e., $n^S = \inf\{\frac{s-\xi}{2p}; 1\}$, and $n^U = \frac{1}{2} [\omega(a^*) + \rho(a^*) - \psi - \lambda\xi G(p - a^*)]$, or alternatively $A = \frac{1}{2} [\omega(a^*) - \rho(a^*) + \psi + \lambda\xi G(p - a^*)]$, provided $\omega(a^*) + \rho(a^*) \geq \psi + \lambda\xi G(p - a^*)$ and $\omega(a^*) + \psi + \lambda\xi G(p - a^*) \geq \rho(a^*)$ (i.e., provided $A \geq 0$ and $n^U \geq 0$ at the optimum). If $\omega(a^*) + \psi + \lambda\xi G(p - a^*) < \rho(a^*)$, the optimal strategy is to fix $A = 0$ and $a = \arg \max_{a'} \omega(a') [\rho(a') - \lambda\xi G(p - a') - \psi]$. If $\omega(a^*) + \rho(a^*) < \psi + \lambda\xi G(p - a^*)$, the platform remains inactive.*

Proof. The profit function is quadratic wrt to n^U and wrt to n^S . It must be maximized over the convex polygonal set: $\{(n^U, n^S); 0 \leq n^U \leq \omega(p - sn^S), 0 \leq n^S \leq 1\}$. ■

Corollary 4 *Under the assumptions of Proposition 3, if the optimal policy corresponds to the interior solution and $\frac{s-\xi}{2p} \leq 1$, it is given by $n^S = \frac{s-\xi}{2p}$, $n^U = \frac{1}{2} \left[v - \psi + \lambda \frac{(s-\xi)^2}{4p} \right]$ and $A = \frac{1}{2} \left[v + \psi + \lambda \frac{s-\xi}{4p} (3s + \xi - 4p) \right]$; the quantity of advertising is non-increasing in the tax rate ξ and independent of ψ , users' participation is non-increasing in both rates.*

Corollary 5 *Under the assumptions of Proposition 3, if the optimal policy corresponds to the boundary solution with $A = 0$, it corresponds to $n^U = v + \lambda(s - p)n^S$ and n^S is a non-increasing function of both tax rates (ψ, ξ) .*

Assuming that the tax rates on data and on advertising are small enough, the platform will be active. Its pricing policy can be to charge a non-degenerate subscription fee and a

price for advertising, or it can be such that the platform is free to access by users ($A = 0$) when the advertising revenue generated by an additional user is large compared to the value of participating for a user since then, it is more important for the platform to have as many users on board as possible rather than to try to extract the users' value through a subscription fee.

In the interior case, the optimal policy comes directly from two FOC that can be rearranged as follows:

$$\frac{A + \rho(a) - \psi - \lambda\xi n^S}{A} = \frac{1}{\varepsilon_A^U},$$

$$\frac{a - \xi + \frac{A - \psi + \lambda(a - \xi)n^S}{n^U} \frac{\partial n^U}{\partial n^S}}{a} = \frac{1}{\varepsilon_a^S}.$$

Both equations are Lerner formulas. The first one corresponds to the subscription fee and the elasticity of participation of users when all taxes are taken into account as well as the additional advertising revenue generated by an additional user, which reduces the opportunity cost of attracting an additional user. The second one performs the same analysis with respect to the price of advertising and the elasticity of participation by sellers when the opportunity cost of attracting one additional seller is appropriately computed taking into account the impact on additional users' participation evaluated through the net subscription revenues that are consequently generated.

To summarize the effect of new taxes in the interior solution, i.e., when the platform does not provide free access to users:

- an increase in the tax rate on data ψ corresponds to an increase in the marginal cost of serving one user, which is partially passed through as an increase in the subscription fee and correlatedly a decrease in users' participation; this affects the volume of transactions generated by online advertising, hence the total sellers' profits but not the price of advertising per click (or per user for that matter);
- an increase in the tax rate on advertising ξ corresponds to an increase in the marginal cost of ads and therefore translates into an increase in the price of advertising and a reduction in the amount of ads; moreover, this increase in ξ leads to a reduction in the value of participating in the platform for users such that, in combination with the other effects, it results in a reduction in users' participation.

In the case of a boundary solution, $A = 0$, the users' participation and the amount of advertising are co-monotonic: both taxes leads to smaller n^U and n^S . The effect of an increase in ξ is natural and similar to the interior case. The effect of an increase in the tax on data is that it becomes more costly to serve users so that the platform induces a reduction in the number of users through its only non-degenerate pricing instrument, namely, by increasing the price of advertising and therefore reducing the volume of relevant ads and the value of participation for the users.

Let us now turn to the impact on fiscal revenues. We have :

$$R(\psi, \xi) = \frac{n^U}{1+t} [tA + \psi + \lambda(tp + \xi)n^S],$$

which can be rewritten as:

$$R(\psi, \xi) = t\Pi(A, \psi, \xi) + \frac{t}{1+t} \lambda c n^U + (\psi + \lambda\xi)n^U.$$

From this, it comes:

$$R(\psi, \xi) = t\Pi(A, \psi, \xi) + \frac{t}{1+t} \lambda n^U n^S (p - a^*) + (\psi + \lambda\xi n^S)n^U.$$

Using the same approach as in the previous sub-section, we obtain the following result:

Proposition 6 *Under Assumption 1, whenever sellers' types are uniformly distributed on $[0, s]$ and the platform's optimal pricing corresponds to the interior solution, the introduction of a small tax on data always generates additional fiscal revenue, while the introduction of a small tax on advertising generates additional fiscal revenue only if the VAT rate is low enough, namely only if: $(1-t)v + \lambda \frac{s^2}{4p}(1-2t) > 0$.*

The intuition behind the Proposition is the following. Introducing a small tax on data or on advertising has first a positive direct effect on collected revenue, with unchanged pricing policy by the platform. But the platform adapts its prices so that the volume of economic activity, participation and advertising, decreases, which generates a loss in collected VAT proceeds. This loss is only particularly taken into account by the platform when it designs its pricing policy. In particular, the platform does not internalize the decrease in VA by all active online sellers and suppliers. Indeed, one can rewrite the

fiscal revenues as follows:

$$R = t\Pi + t\Pi^{up} + (\psi + \lambda\xi n^S)n^U,$$

where Π^{up} corresponds to the sum of the profits of all economic agents in the supply chain upstream from the platform, namely of all online sellers and all upstream suppliers. So, a new tax rate on data or on advertising induces:

- a positive direct effect corresponding to the increase (starting from 0) of the proceeds from this new tax, i.e., the increase in the third term;
- a negative impact on the platform's profit, corresponding to the change in the first term, but it can be shown that this effect is always smaller than the positive effect on tax proceeds previously mentioned;
- a negative impact on all other agents' profits, corresponding to the decrease in the second term: there, if the VAT rate is large, this effect may well annihilate the positive sum of the first two effects in which case the introduction of the new tax indeed reduces the total amount collected because the decrease in VAT proceeds is drastic and dominates the increase in the proceeds of the new tax.

On the other hand, if one considers, as in the previous subsection, that there is little heterogeneity among online sellers and that most of them sell pure digital goods or services with low marginal cost, the third negative effect described above is small and a new tax is likely to generate additional fiscal revenues.

Comparing the relative merits of a tax on data and a tax on advertising, it is worth noticing that for the interior solution a tax on data does not affect the advertising market while a tax on advertising affects both sides of the platform. More precisely, a tax on data only induces a decrease in n^U in the term $\Pi^{up} = \frac{\lambda}{1+t}n^U n^S(p - a^*)$, while a tax on advertising reduces n^U as well as n^S and increases a^* ; so, the overall effect in term of reduction of VAT proceeds is stronger with a tax on advertising so that, for our specification, introducing a small tax on advertising may not generate additional fiscal revenues while introducing a small tax on data always generates additional fiscal revenues.

2.4 Price discrimination on users

In the context of Assumption 1, the platform cannot engage in more sophisticated pricing that fixed prices on both sides that determine the cutoff type for participation. If, however, we reintroduce some distinction between users' participation and the amount of data they allow the platform to collect, users can be discriminated on the basis of their "activity" x .

In this subsection we therefore explore the possibility that the platform charges a discriminating tariff $A(x)$ on users and a simple advertising price a . There is no loss of generality in assuming a simple advertising price-per-click given that, in our model, the sole decision of online sellers is whether to advertise or not on the platform. On the users' side, however, introducing a discriminating tariff is equivalent to charging a direct truthful pricing mechanism $(A(\cdot), x(\cdot))$ thanks to the revelation principle. Using $u(\theta, n^S) = v(x(\theta)) + \lambda(x(\theta))(s - p)n^S - \theta x(\theta) - A(\theta)$, adapting straightforwardly the theory of screening, one can show that a direct truthful mechanism is described by a non-increasing allocation function $x(\cdot)$ and $u(\theta, n^S) = \int_{\theta}^1 x(\theta)d\theta + \bar{u}_1$. From this, the platform must choose $(x(\cdot), n^S, \bar{u}_1)$ so as to maximize its expected profit Π given by:

$$\begin{aligned} (1+t)\Pi &= \int_0^1 \{A(\theta) + \lambda(x(\theta))(a - \xi)n^S - \psi x(\theta)\} dF(\theta) \\ &= \int_0^1 \{v(x(\theta)) + \lambda(x(\theta))(s - p + a - \xi)n^S - (\theta + \psi)x(\theta) - u(\theta, n^S)\} dF(\theta), \end{aligned}$$

subject to $n^S = G(p - a)$, the implementability constraint and the participation constraint: $u(\theta, n^S) \geq 0$ for all θ . This leads naturally to $\bar{u}_1 = 0$, and to the two interior FOC:

$$\begin{aligned} 0 &= v'(x(\theta)) + \lambda'(x(\theta))(s - G^{-1}(n^S) - \xi)n^S - (\theta + \psi + \frac{F(\theta)}{f(\theta)}) \\ n^S &= \arg \max_n (s - \xi - G^{-1}(n))n. \end{aligned}$$

Assuming these FOC actually characterize the optimal platform's policy, note first that the second equation can be written as: $a^* = \arg \max_a G(p - a)(a - \xi + (s - p))$, which can be interpreted as in the previous subsection in light of the two-sided nature of the platform: the price on advertising obeys a Lerner formula that takes into account the opportunity cost of having additional ads, which incorporates the surplus $(s - p)$ that

can be extracted on users from additional ads. Note that, as in the previous subsection, n^S or a^* do not depend on the tax rate on data, but depend negatively on the tax rate on advertising provided $G(\cdot)$ is well-behaved, i.e., has a monotone likelihood ratio.

Assuming that $v(\cdot)$ and $\lambda(\cdot)$ are increasing concave and the likelihood ratio $F(\theta)/f(\theta)$ is increasing, the allocation function is indeed non-decreasing in θ , non-decreasing in ψ and in ξ , perhaps up to a threshold value of θ above which $x(\theta) = 0$, i.e., users do not participate in the platform.

Assuming as an example that $G(\cdot)$ is uniform on $[0, p]$, $v(x) = v_0(x - \frac{x^2}{2})$, $\lambda(x) = \lambda_0(x - \frac{x^2}{2})$, it comes:

$$\begin{aligned} a^* &= p - \frac{s - \xi}{2}, n^S = \frac{s - \xi}{2p} \\ x(\theta) &= 1 - \frac{\theta + F(\theta)/f(\theta) + \psi}{v_0 + \lambda_0 \frac{(s - \xi)^2}{4p}} \end{aligned}$$

provided all these variables are positive.

As for the impact on fiscal revenues, it follows the same lines as in the previous section. Fiscal revenues can be written as:

$$R = t\Pi + t\Pi^{up} + \int_0^1 [\psi x(\theta) + \xi n^S \lambda(x(\theta))] dF(\theta).$$

The loss of VAT collected on the platform is smaller than the gain from introducing a small additional tax (on data or on advertising), but the loss in VAT collected from the upstream chain of production may cancel the benefit of a small tax. Moreover, as in the previous subsection, the impact of a small tax on data is limited to a reduction in the users' activity $x(\cdot)$ while the impact of a small tax on advertising bears on users' activity, on the volume of advertising and on the upstream margin, all three effects add up to reduce Π^{up} ; fiscal revenues are therefore more likely to increase with a tax on data than with a tax on advertising. Note finally that smaller value of the VAT rate make new taxes (on data or on advertising) more valuable for public finance that is, there is some substitutability between t and (ψ, ξ) .

The price discriminating scenario therefore leads to results that are similar to the ones presented in the previous subsection.

3 Taxation with platform competition

In this section, we introduce platform competition in our framework, and investigate whether our main findings still hold in a competitive environment. We first consider the case of symmetric platforms, and then we briefly discuss the case of asymmetric platforms.

3.1 Symmetric platforms

We consider two ex-ante symmetric platforms, platform 1 and platform 2. The two platforms provide complementary services to users, such as news and travel information, but compete on the advertising side. As a first step, as in Section 2.2, we simplify the model and assume that online sellers are homogeneous. They all have the same cost c , and we assume furthermore that $c = 0$. It follows that the two platforms set optimally a per-click price $a = p$ to sellers, and that all sellers participate at this price, i.e., $n^S = 1$. We make an additional simplification, and ignore the tax on advertising.

Under Assumption 1, and since $n^S = 1$, a user of type θ obtains the net utility $U_i = -\theta + v + \lambda(s - p) - A_i$ if she single homes on platform i . Since there are two available platforms with complementary content, the user can also decide to multi home, that is, to join both platforms, in which case she obtains the net utility $U_{12} = -2\theta + 2v + \lambda(2 - \lambda)(s - p) - A_1 - A_2$. The net utility from multi homing, U_{12} , reads as follows. First, joining a second platform provides an additional benefit v to the user, and an additional privacy cost, $-\theta$. Second, the second platform offers an additional benefit from matching, $\lambda(1 - \lambda)(s - p)$. Indeed, the user is not matched with a relevant ad on platform 1 with probability $1 - \lambda$. In this case, the user can receive a relevant ad on platform 2, which happens with probability λ .

Consumer demand. To determine consumer demand, assume without loss of generality that $A_1 \leq A_2$. Since platform 1 is cheaper, a user prefers single homing on platform 1 than single homing on platform 2. User θ prefers to single home on platform i than to stay outside the market if and only if $U_i \geq 0$, that is, if and only if

$$\theta \leq v + \lambda(s - p) - A_i \equiv \tilde{\theta}_i.$$

Finally, the user prefers multi homing than single homing on platform 1 if and only if $U_{12} \geq U_1$, that is, if and only if

$$\theta \leq v + \lambda(1 - \lambda)(s - p) - A_2 \equiv \tilde{\theta}_{12}.$$

Note that $\tilde{\theta}_{12} \leq \tilde{\theta}_1$, as $\tilde{\theta}_{12} - \tilde{\theta}_1 = -\lambda^2(s - p) \leq 0$. The figure below characterizes the consumer demand when $A_1 \leq A_2$. The users that are the less sensitive to collected data (i.e., with low θ 's) multi home. Users with intermediate costs of privacy single home on platform 1, the cheapest platform. Users with high privacy costs do not join any platform.

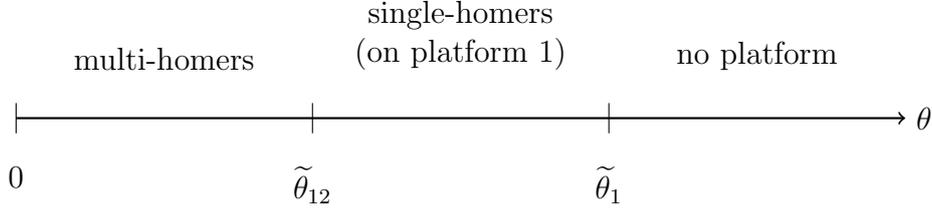


Figure 1: Consumer demand with competing platforms

Platforms' profit functions. Assuming that $A_1 \leq A_2$, platform 2's profit is given by

$$\Pi_2(A_1, A_2) = \frac{1}{1+t} \int_0^{\tilde{\theta}_{12}} \left[A_2 - \Psi + p\lambda \left(1 - \frac{\lambda}{2} \right) \right] dF(\theta).$$

For each multi homing user, platform 2 receives the subscription fee A_2 minus the tax on data Ψ (since $x = 1$ for all participating users) and finally the advertising revenues from a relevant match. Under Assumption 1, $F(\cdot)$ is uniform, and we have then $\Pi_2(A_1, A_2) = \tilde{\theta}_{12} [A_2 - \Psi + p\lambda(1 - \lambda/2)] / (1+t)$. For platform 1, we have

$$\Pi_1(A_1, A_2) = \frac{1}{1+t} \int_0^{\tilde{\theta}_{12}} \left[A_1 - \Psi + p\lambda \left(1 - \frac{\lambda}{2} \right) \right] dF(\theta) + \frac{1}{1+t} \int_{\tilde{\theta}_{12}}^{\tilde{\theta}_1} [A_1 - \Psi + p\lambda] dF(\theta).$$

With the uniform distribution, $\Pi_1(A_1, A_2) = (\tilde{\theta}_1 [A_1 - \Psi + p\lambda] - \tilde{\theta}_{12} p\lambda^2/2) / (1+t)$.

Equilibrium. Let $\bar{A} = \arg \max_{A_2} \Pi_2$, and $\underline{A} = \arg \max_{A_1} \Pi_1$. We find that

$$\bar{A} = \frac{v + \Psi + \lambda(1 - \lambda)s - \lambda(2 - 3\lambda/2)p}{2},$$

and that

$$\underline{A} = \frac{v + \Psi + \lambda s - 2\lambda p}{2}.$$

Note that we have $\bar{A} \geq \underline{A}$ if and only if $p \geq 2s/3$. However, even if this condition holds, $\{\underline{A}, \bar{A}\}$ is not an equilibrium. Indeed, either the profit of the platform that serves the single homers at price \underline{A} is higher, in which case the two platforms start competing à la Bertrand to become the leading platform. Or, the profit of the platform that focuses on multi homers at price \bar{A} is higher, in which case each platform starts offering a slightly higher price to obtain this position. It turns out that the equilibrium is only symmetric. Define A^* such that $\tilde{\theta}_{12} = 1$. We have

$$A^* = v + \lambda(1 - \lambda)(s - p) - 1.$$

To characterize the equilibrium, we make the following assumptions:

Assumption 2: $v > 1$.

Assumption 3: $v + \lambda(1 - \lambda)(s - p) \geq 2 - p\lambda(1 - \frac{\lambda}{2})$.

Assumption 2 implies that $A^* > 0$. Assumption 3 ensures that $\{A^*, A^*\}$ is an equilibrium. Note that Assumption 3 holds in particular if $v > 2$.

Lemma 1 *Under Assumptions 1-3, $\{A^*, A^*\}$ is the unique equilibrium in subscription fees.*

Proof. We first show that $\{A^*, A^*\}$ is an equilibrium **(i)**, and then we show that it is unique **(ii)**.

(i) To show that $\{A^*, A^*\}$ is an equilibrium, we show that if platform 1 sets $A_1 = A^*$, platform 2's best response is to set $A_2 = A^*$. To begin with, if platform 2 sets $A_2 = A^*$, it obtains the profit

$$\begin{aligned} (1 + t) \Pi_2(A^*, A^*) &= A^* - \Psi + p\lambda \left(1 - \frac{\lambda}{2}\right) \\ &= v - 1 - \Psi + s\lambda(1 - \lambda) + p\lambda^2/2. \end{aligned}$$

If $v > 1$ (Assumption 2) and Ψ is sufficiently small, then we have $\Pi_2(A^*, A^*) > 0$.

A first possible deviation for platform 2 from the candidate equilibrium $\{A^*, A^*\}$ is to set a lower fee $A_2 < A^*$. However, since all consumers multi home at the candidate equilibrium, platform 2 does not attract additional consumers by charging a lower fee. Since its demand remains constant, its profit always decreases if it lowers its subscription fee.

The second possible deviation for platform 2 is to set a higher fee $A_2 > A^*$. By increasing its fee above A^* , platform 2 becomes the more expensive platform, and therefore it now determines the marginal multi homer $\tilde{\theta}_{12}$. Furthermore, since $A_2 > A^*$, not all consumers multi home, that is, we have $\tilde{\theta}_{12} < 1$. If $A_2 > A^*$, platform 2's profit is therefore given by

$$(1+t)\Pi_2(A^*, A_2) = \left[A_2 - \Psi + p\lambda \left(1 - \frac{\lambda}{2} \right) \right] [v + \lambda(1-\lambda)(s-p) - A_2].$$

We find that

$$(1+t) \frac{d\Pi_2}{dA_2} \Big|_{A_2=A^*} = 1 + \Psi - A^* - p\lambda \left(1 - \frac{\lambda}{2} \right).$$

Developing and rearranging this expression, we have $d\Pi_2/dA_2|_{A_2=A^*} \leq 0$ if and only if

$$v + \lambda(1-\lambda)(s-p) \geq 2 + \Psi - p\lambda \left(1 - \frac{\lambda}{2} \right), \quad (1)$$

which holds under Assumption 3 if Ψ is sufficiently small. If this condition holds, then $\{A^*, A^*\}$ is an equilibrium of the price game. Note also that Condition (1) implies that $\bar{A} < A^*$. If (1) does not hold, then Π_2 increases at A^* and therefore $A^* \leq \bar{A}$.

(ii) If Condition (1) holds, then $\{A^*, A^*\}$ is the unique equilibrium. Indeed, if $A_2 < A^*$, $\Pi_1(A_1, A_2)$ is increasing over $[0, A^*]$ and Π_1 decreases at A^* under Assumption 3. Therefore, platform 1's best response is A^* , and in turn, platform 2's best response is also A^* . Now, consider the case where $A_2 > A^*$. Define \tilde{A}_1 such that $\tilde{\theta}_1 = 1$. We have $\tilde{A}_1 > A^*$. Since platform 1's demand is constant over $\left[0, \inf \left\{ \tilde{A}_1, A_2 \right\} \right]$, its profit increases over this interval. Furthermore, we have $\tilde{A}_1 - \underline{A} = (v - 2 + s\lambda) > 0$ under Assumption 3. Therefore, platform 1's profit decreases at \tilde{A}_1^+ . If $A_2 > \tilde{A}_1$, then platform 1's best response is to set \tilde{A}_1 . If $A_2 \in (A^*, \tilde{A}_1]$, since $\underline{A} < A^*$, platform 1's best response is to set $A_2 - \epsilon$. Turning to platform 2, this analysis shows that platform 2 has an incentive to decrease its fee until A^* is reached. ■

This Lemma shows that though our model allows the presence of multi homers and single homers, in equilibrium all users multi home and the market is fully covered. Since the equilibrium price is determined by users' incremental utility from multi homing, subscription prices do not depend on the tax on data. We have therefore the following result.

Proposition 7 *When platforms compete on the advertising side, the tax on data does not affect platforms' subscription prices and the number of participating users. However, a higher tax on data decreases platforms' profits (and therefore decreases total welfare).*

Since the tax on data does not affect subscription fees and the number of participating users, it operates only through the platforms' margins. Therefore, a higher tax on data reduces platforms' profits. Since consumer surplus is unaffected, it also decreases total welfare.

3.2 Asymmetric platforms

We assume in this subsection that one of the two platforms, say platform 1, provides a higher quality of service than the other; that is, $v_1 > v_2$. A user of type θ then prefers to single home on platform 1 than on platform 2 if and only if $v_1 - A_1 \geq v_2 - A_2$, that is, if and only if $A_2 \geq A_1 - (v_1 - v_2)$. If this condition holds, the users with a privacy cost $\theta \in [0, \tilde{\theta}_{12}]$ multi home, while the users with $\theta \in [\tilde{\theta}_{12}, \tilde{\theta}_1]$ single home, where

$$\tilde{\theta}_{12} = v_2 - A_2 + \lambda(1 - \lambda)(s - p)$$

and

$$\tilde{\theta}_1 = v_1 - A_1 + \lambda(s - p).$$

If $A_2 < A_1 - (v_1 - v_2)$, the users with a privacy cost $\theta \in [0, \tilde{\theta}_{21}]$ multi home, while the users with $\theta \in [\tilde{\theta}_{21}, \tilde{\theta}_2]$ single home, where

$$\tilde{\theta}_{21} = v_1 - A_1 + \lambda(1 - \lambda)(s - p)$$

and

$$\tilde{\theta}_2 = v_2 - A_2 + \lambda(s - p).$$

Let A_2^* be the value of A_2 such that $\tilde{\theta}_{12} = 1$; similarly, A_1^* is defined such that $\tilde{\theta}_{21} = 1$. We have therefore

$$A_2^* = v_2 - 1 + \lambda(1 - \lambda)(s - p)$$

and

$$A_1^* = v_1 - 1 + \lambda(1 - \lambda)(s - p) = A_2^* + (v_1 - v_2) > A_2^*.$$

Finally, we make the following assumptions, which are similar to Assumptions 2 and 3 in the symmetric case:

Assumption 2': $v_2 > 1$.

Assumption 3': $v_2 + \lambda(1 - \lambda)(s - p) \geq 2 - p\lambda\left(1 - \frac{\lambda}{2}\right)$.

Lemma 2 *Under Assumptions 1, 2' and 3', $\{A_1^*, A_2^*\}$ is the unique equilibrium in subscription fees.*

Proof. The proof follows the lines of the proof of Lemma 1. If $A_1 = A_1^*$, setting a fee $A_2 < A_2^*$ is not a profitable deviation for platform 2, because all users multi home. If $A_2 > A_2^*$, platform 2's profit is given by

$$(1 + t)\Pi_2(A_1^*, A_2) = \left[A_2 - \Psi + p\lambda\left(1 - \frac{\lambda}{2}\right) \right] [v_2 + \lambda(1 - \lambda)(s - p) - A_2].$$

We have $d\Pi_2/dA_2|_{A_2=A_2^*} \leq 0$ if and only if

$$(1 + t) \frac{d\Pi_2}{dA_2} \Big|_{A_2=A_2^*} = 1 + \Psi - A_2^* - p\lambda\left(1 - \frac{\lambda}{2}\right).$$

Developing and rearranging this expression, we have $d\Pi_2/dA_2|_{A_2=A_2^*} \leq 0$ if $v_2 + \lambda(1 - \lambda)(s - p) \geq 2 - p\lambda\left(1 - \frac{\lambda}{2}\right)$ and Ψ is sufficiently small. Finally, the proof for unicity is similar than in Lemma 1. ■

As in the symmetric case, in equilibrium all users multi home and the market is covered. However, the equilibrium is asymmetric; the platform with the highest quality (platform 1) can charge a higher price than its rival, and therefore obtains a higher profit.

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Taxation and Privacy Protection on Internet Platforms*

Francis Bloch[†] Gabrielle Demange[‡]

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Abstract

This paper studies data collection by a monopolistic internet platform. We show that the optimal strategy of the platform is either to cover the market or to choose the highest data exploitation level, excluding users with high privacy costs from the platform. Users' welfare is maximized at lower levels of data exploitation. We show that user-based taxes lead to an increase in data collection and the exclusion of users. Taxation with different rates according to the source of revenues, with higher tax level for revenues generated by data exploitation can reduce data collection. We also analyze the effect of "opting out", allowing a user to access a lower quality service with no data collection.

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[†]Université Paris 1 and Paris School of Economics, 106-112 Boulevard de l'Hopital, 75647 Paris CEDEX 13, France. Email francis.bloch@univ-paris1.fr.

[‡]Paris School of Economics-EHESS, 48 Boulevard Jourdan, 75014 Paris, France . Email demange@pse.ens.fr.

1 Introduction

The precipitous decline in the cost of data collection and storage linked to the development of Information Technologies has transformed business models in advertising and commerce. While records on customers and sale histories have always existed, the digital economy now enables firms to exploit data at a much larger scale, opening up new opportunities for profit as well as concerns about privacy and exploitation of personal data. Large sales platforms can now use detailed records of past sales histories to target consumers and engage in discriminatory dynamic pricing. Other platforms, like search engines or online social networks, use data on immediate search to auction off advertising spaces to clients, or sell search histories to intermediaries who accumulate data to better target or retarget dynamically users with ads. In fact, business models of all giant internet platforms rely at different degrees on the collection and exploitation of personal data. The use of personal data is clearly one of the main specificities of the digital sector in modern industrial economies.

The development of "big data" and its potential exploitation raises two separate questions. First, data are a valuable input for internet platforms, but users voluntarily upload their data without any payment. One can argue that internet platforms are engaged in a barter agreement, where platforms deliver a valuable service (targeted proposals for products, targeted ads, outcomes of search, access to friends) in exchange for the uploading of data. But absent any price and financial transaction, it is difficult to assess whether this barter is "fair" and if users receive a fair share of the surplus. The immense profits of (some not all) internet platforms suggests that it may not be the case and that platforms benefit from a "free" input which is not paid at its true value. Furthermore, in the absence of financial transaction, governments cannot properly tax the benefit of personal data, creating a distortion with respect to other sectors, clouding the territoriality principle for the taxation of profits, and leading to extremely low levels of taxation

of internet platforms through a clever use of transfer prices and the absence of records of financial transaction in countries where users reside. Second, users are rightly afraid that the collection of personal data infringes on their privacy. In addition, the resale of data to unknown intermediaries through opaque arrangements results in a loss of control on the dissemination of personal data to third parties. The exploitation of data, while it provides a valuable service to users by improving targeting, also necessarily involves a cost in privacy loss.

Even though the two problems of the absence of fair payment of data and privacy loss seem unrelated at first glance, they are in fact closely connected. In this paper, we study how regulatory instruments, and in particular taxation, can be used to solve both problems at once. We first investigate the effect of different forms of taxation – corporate profit taxation, taxation based on users or data flows, specific tax paid by users, revenue taxation based on differentiated rates according to the origin of the platform revenues. We then study regulation which forces platforms to offer a service without data collection (letting for example users decide whether they want to leave cookies or not), either with no financial transaction, or with two forms of financial transaction: one where the platform pays users for data collection, and one where the platform makes users pay for the option without data collection.

We construct a model where users are differentiated along two dimensions: the value they create to the platform (through their demographic characteristics or pattern of internet usage) and their privacy cost. The collection of data enables the platform to better target offers to users and users to products or advertisers, resulting in an increase in the service to users as well as the value of users to advertisers or to the firm. Initially, we suppose, following current usage in the digital industry, that platforms do not charge users for their service and that their entire revenue comes from the other side of the market (advertisers or sales of future goods). A monopolistic platform chooses (and commits to) a degree of data exploitation balancing two effects: on the one hand, an increase in

data collection increases revenues by increasing the value of the user to advertisers or for targeted pricing, on the other hand, an increase in data collection may deter users with high privacy cost to access the platform.

In this model, we first compute the optimal level of data exploitation chosen by the platform and the users. We show that the platform either chooses to "cover the market" making sure that all users access the platform, or chooses the maximal level of data exploitation, thereby excluding some users from the platform. This results in excessive data exploitation from the point of view of users. Users always prefer a lower level of data collection and always prefer a situation where the market is covered – in some situations, their optimal degree of data exploitation is below the maximal value under which the market is covered, in others they prefer the maximal level under which the market is covered to the maximal degree of exploitation chosen by the platform.

Given that the platform chooses an excessive degree of data exploitation, we then study how different forms of taxation affect data collection. We first observe that a tax on profits (or equivalently a tax on revenues because variable costs are negligible) does not affect the choice of the platform. A tax paid by the platform per user does not affect the marginal benefit of data exploitation, but it reduces the profit made on the marginal consumer accessing the platform, thereby reducing the cost of data collection. Hence, a tax per user (or per flow of data as users do not choose the level of data they upload), results in an increase in data exploitation. A specific tax paid by users (like a tax on internet service providers) produces ambiguous effects on the degree of data exploitation, but examples suggest that it might also increase the degree of data exploitation. The only tax which allows to correct for excessive data collection is a tax on revenues which treats differentially platform's revenues accruing from one-time use (like auction revenues based on current keywords) and revenues linked to data collection (like resale of data to intermediaries). If fiscal authorities charge a higher tax level on resale of data than on auction revenues, taxes deter the platform from exploiting the data, playing the classical

role of a Pigovian tax correcting for externalities.

We then explore the effect of the introduction of an option for the users to access the platform with no data collection, called hereafter zero-option. This allows the platform to collect revenues (linked to the intrinsic value of the service to users) from those consumers who choose the zero-option, segmenting the market into two groups with different revenue levels. Users will now all access the platform – some with data collection and others without. We show that this changes the level of data collection chosen by the platform, resulting in a decrease in the maximal level of data exploitation for which the market is covered, but in an increase in the region of parameters for which the platform chooses the maximal degree of data exploitation. Hence, both from the point of view of the platform and from the point of view of users, the introduction of a zero-option has ambiguous effects. When the access value to users is small, both the platform and the users benefit from the introduction of the zero-option, but when the access value to users is large, users are indifferent and the platform prefers the uniform policy.

We then allow for further discrimination between the different types of users by allowing the platform to use pricing instruments. We first consider the case where the platform transfers money to users choosing the positive data collection option. In that case, the platform can use payments to increase the degree of data exploitation acceptable to users, and typically selects a higher level of data collection than when payments are not possible. The platform may also, under some conditions, select the maximal degree of data exploitation but lower the price so that some users select the zero-option. Notice that, because the platform can always choose to make a zero payment to users whose data are collected, it cannot lose by switching from a régime without pricing to a régime with pricing. Furthermore, we show that users always benefit from the switch, because the extra payment they receive exceeds the loss possibly due to an increase in the level of data exploitation. We then reverse the direction of the transfer and consider the case where the platform charges a price for the zero-option. In that case, the platform can

simultaneously increase data exploitation and prices while keeping the number of users accessing the platform constant, and the result is that the platform will either choose the maximal level under which the market is covered, not making any profit on the zero-option, or to segment the market and extract profits from users choosing the zero option. While the platform is always better off than in a régime without pricing, we show that users weakly lose from the introduction of this pricing scheme, because it increases the region of parameters for which the market is not covered and results in a financial loss for users who choose the zero option.

Our analysis of the effect of taxation and regulation on data collection relies on an original model, but is related to two strands of the literature. First, it is related to the literature on the economics of media, which considers a media (television, newspaper) as a platform in a two-sided market connecting readers with advertisers. (see Gabsewicz, Laussel and Sonnac (2001) and (2004) for early contributions to the literature and the survey by Anderson and Gabszewicz (2006)). Advertisement in these models play the same role as data collection in ours. As in our model, users are assumed to suffer a linear cost from advertisements. In the initial papers in the literature, the platform only collects revenues from the advertising market. (Later papers, like Peitz and Valletti (2008), Choi (2006) or Crampes, Haritchabalet and Jullien (2009)) also allow for subscription prices charged to viewers, and compare regimes of "free-to-air" with "pay-for-view" televisions.) Most of the literature (with the exception of Anderson and Coate (2005)) considers competition between platforms, which are horizontally differentiated. Anderson and Coate (2005) analyze the behavior of a monopolistic platform when the market is not covered. In their model, consumers are differentiated by their intrinsic benefit from the good and not their aversion to advertising, resulting in very different demand functions and different conclusions – for example, they find that platforms typically choose too little advertising whereas we observe that the level of data collected by the platform is excessive. Another difference stems from the shape of the utility that users obtain from ads. All models,

with the exception of Crampes, Haritchabalet and Jullien (2009) assume that users suffer a linearly increasing utility loss for ads, whereas we assume that, in addition to a linearly decreasing loss, they obtain a concave utility gain due to improved service. (Crampes, Haritchabalet and Jullien (2009) allow users to have a positive value for low levels of ads, which is similar but not equivalent to our assumption.) The main difference between our analysis and the literature on media as two-sided platforms stems from the questions raised. The literature on media focuses on program differentiation and competition, while we are mostly interested in regulatory régimes and taxation to improve privacy protection. In that sense, our paper is more closely connected to recent work on ad-avoidance (Anderson and Gans (2011), Tag (2009) and Johnson (2013)), but differences in the models preclude a direct comparison between our results. Second, our paper is more distantly related to the literature on taxation on two-sided markets (see Kind et al. (2008), (2010a), (2010b), Kind et al. (2013) and Kotsogiannis and Serfes (2010)), but again the focus of the analyses are different, as we focus on the effect of taxes on privacy protection rather than revenues and distortion.

The rest of the paper is organized as follows. We introduce our model in the next Section. Section 3 is devoted to the baseline model of a uniform data collection policy. Section 4 analyzes the effect of different tax instruments. Section 5 considers the introduction of a free option to access the platform with no data collection ("option zero"). Section 6 studies the binary model with financial transfers (either the platform paying users for data collection or users playing the platform for option zero). Section 7 contains our proofs.

2 The Model

2.1 Platform and users

We consider an internet platform which provides services to and collects data from users. The platform collects revenues either directly or from third parties. Some of the revenues are collected immediately and independently of the past history of platform access, whereas other revenues are collected either from exploiting directly or selling to third parties data collected from past histories of platform access. We suppose that the platform commits to the degree of exploitation of personal data, denoted $x \in [0, 1]$. The degree x can be interpreted along different dimensions. It can represent the duration of time during which personal histories are stored by the platform, the fraction of personal data which are sold by the platform to third parties or kept for direct exploitation, or any specified limitation on the use of personal data.

We suppose that users are differentiated along a privacy cost $\theta \in [0, 1]$ measuring the user's aversion to the exploitation of personal data by the platform. We let $F(\cdot)$ the distribution of the privacy cost θ and assume that θ is independently distributed for any user, θ is observed by the user but not the platform.

The revenue generated by a consumer to the platform choosing degree of data exploitation x is denoted by $V(x)$, where $V(x) = V(0) + v(x)$ with $v(0) = 0$: V is decomposed into the basic revenue generated by the user in the absence of data exploitation, $V(0)$, (for example the sales to a user accessing the platform without any targeting, or the advertisement revenues based on instantaneous search) and the benefit linked to data exploitation (price targeting or targeted advertisement based on past access histories). We assume that the benefit function v is strictly increasing and concave. Once established, the platform does not incur any cost, so that the profit of the platform is given by

$$\pi(x) = V(x).$$

Users derive a benefit from using the platform which is denoted by $U(x)$, where $U(x) = U(0) + u(x)$ with $u(x) = 0$: U is decomposed into the access valuation $U(0)$, representing the utility of accessing to the service of the platform, and the payoff that depends on the data collected by the platform, $u(x)$, representing the improvement in the service due to a better matching between the user and the product or service he accesses through the platform. We assume that the payoff function u is strictly increasing and concave. The user also incurs a privacy cost from parting with personal data, which we assume to be linear in the degree x with a slope equal to the user's characteristic θ (such a user is called a θ -user). Collecting terms, the utility of a θ -user on the platform is

$$W(x) = U(x) - \theta x.$$

A user who does not access the platform derives a reservation value that we normalize to 0.

2.2 Taxation

We investigate the incidence of different fiscal instruments on the choice of the platform and the welfare of users. We consider the following fiscal instruments:

- A tax τ levied on the profit (or equivalently the revenues) of the platform
- A tax t_P levied on the platform for each user
- A differentiated revenues tax system, with τ_1 and τ_2 different tax rates applied to the revenues generated without data exploitation, $V(0)$, and with data exploitation $v(x)$
- A tax t_U levied on each user for accessing the platform.

In addition, we assume that any other financial transaction on the territory, like subscriptions paid by users to access the service, are subject to VAT at the regular rate.

2.3 Privacy protection options

We consider an alternative to taxes to regulate the degree of data exploitation, in the form of binary policies where the platform proposes two options: (i) a regular access with data exploitation degree x and (ii) a privacy-protecting access, with no data collection. We analyze both situations where the privacy-protecting access is offered for free, and when it is charged to users at a subscription price q . Alternatively, we consider a situation where the platform refunds users for the exploitation of their data at a refund price p . Finally, we will consider situations where the platform only offers the regular access but faces entry by a competitor proposing the privacy protecting service at a fee.

3 Data collection and exploitation

We first analyze a benchmark model where no tax is levied, and the platform commits to a uniform policy x for all users. We assume that the platform's benefit v and the users's payoff u are iso-elastic functions of the degree of data exploitation x , and that the distribution of privacy costs is uniform.

Assumption 1 *Suppose that $v(x) = bx^\beta$ and $u(x) = ax^\alpha$ with $a, b > 0$ and $\alpha, \beta \in [0, 1]$. In addition, let the distribution $F(\theta)$ be uniform over $[0, 1]$.*

Figure 1 illustrates the value of a user to the platform and the benefit of a user as a function of the degree of data exploitation x , for $V(0) = 0.1, b = 0.5, U(0) = 0.2, a = 0.3, \alpha = \beta = 0.5$ and $\theta = 0.5$. The value of a user to the platform is monotonically increasing in x whereas the benefit of the user is concave, first increasing and then decreasing to 0 when $x = 1$.

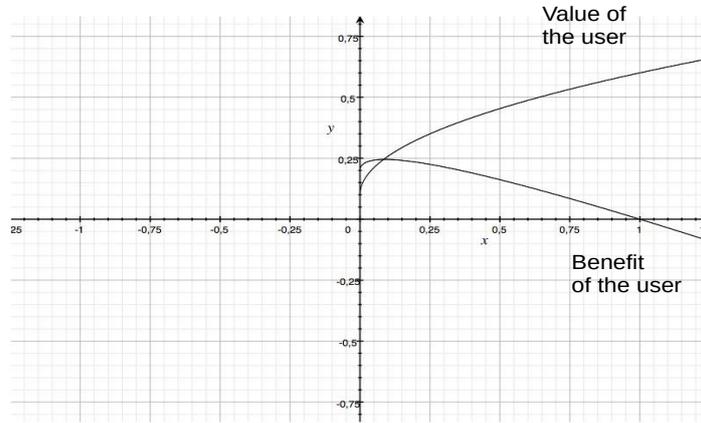


Figure 1: Value and benefit of users $V(x)$ and $U(x)$

Given any level of data exploitation x , we can characterize the user with the highest privacy cost accessing the platform,

$$T(x) \equiv \max\{\theta | U(x) - \theta x \geq 0\}$$

or

$$T(x) = \min\left(\frac{U(x)}{x}, 1\right).$$

If $U(1) = U(0) + a \geq 1$, the market is covered for all values of x : all users access the platform and $T(x) = 1$. We will say that the market is *saturated*. When the market is not saturated, $U(0) + a - 1 < 0$, there is a maximal value x_0 such that all users access the platform, i.e. the solution to¹

$$U(0) + ax^\alpha - x = 0. \tag{1}$$

Under Assumption 1, the profit of the platform is given by

$$\begin{aligned} \pi(x) &= V(x)F(T(x)), \\ &= V(x)T(x), \\ &= [V(0) + bx^\beta][\min\{\frac{U(0) + ax^\alpha}{x}, 1\}]. \end{aligned}$$

We will call $T(x)$ the *demand* at x .

3.1 Platforms' choice

When the market is saturated, $T(x) = 1$ for any x . As $V(x)$ is everywhere increasing, we immediately obtain that *the platform chooses the maximal degree of data exploitation*, $x_U = 1$.

Now consider the more interesting case where the market is not saturated, $U(0) + a - 1 < 0$. The platform will never choose a level of data exploitation $x < x_0$ and will always prefer x_0 . This follows from the arguments as for a saturated market since the demand is constant equal to 1 for $x \leq x_0$. Consider next the platform's choice over the interval

¹Because $U(0) > 0$, $U(0) + a - 1 < 0$ and $U(0) + ax^\alpha - x$ is concave, this equation has a unique solution. We immediately check that the unique solution x_0 is increasing in the parameters $U(0)$, a and decreasing in α .

$[x_0, 1]$. For $x \geq x_0$, $T(x) = \frac{U(x)}{x}$ and

$$\frac{T'(x)}{T(x)} = \frac{1}{x} \left[\frac{u'(x)}{T(x)} - 1 \right]$$

The demand, measured by $T(x)$, is decreasing in x since the marginal benefit is smaller than the average benefit by concavity of u . Now consider

$$\begin{aligned} \frac{\partial \pi}{\pi \partial x} &= \frac{V'(x)}{V(x)} + \frac{T'(x)}{T(x)} \\ &= \frac{1}{x} \left[\frac{xV'(x)}{V(x)} + \frac{u'(x)}{T(x)} - 1 \right]. \end{aligned}$$

Figure 2 illustrates the shape of the profit of the platform as a function of x when the market is not saturated. Under Assumption 1, the term inside the square brackets, the elasticity of the profit, can be written as

$$\phi(x) = \frac{\beta}{\frac{V(0)}{b}x^{-\beta} + 1} + \frac{\alpha}{\frac{U(0)}{a}x^{-\alpha} + 1} - 1.$$

The elasticity of the profit is increasing, due to the fixed terms $V(0)$ and $U(0)$, which play a similar role to a fixed cost in production. This implies that the level of data exploitation x_U maximizing the firm's profit is one of the two extreme points x_0 or 1. It is surely $x_U = x_0$ if $\phi(1) \leq 0$ since then the profit is decreasing over the interval $[x_0, 1]$, $x_U = 1$ if $\phi(x_0) \geq 0$ since then the profit is increasing over the entire interval. Otherwise, the computation of the optimal choice of the platform thus involves a direct comparison between $\pi(x_0)$ and $\pi(1)$. We summarize our findings in the following Proposition

Proposition 1 *The platform optimally chooses a degree of data exploitation $x_U \in \{x_0, 1\}$. It always chooses $x_U = 1$ when the market is saturated. When the market is not saturated, it chooses the lower level x_0 when $\frac{V(0)}{b} \geq \nu \equiv \frac{U(0)+a-x_0^\beta}{1-U(0)-a}$.*

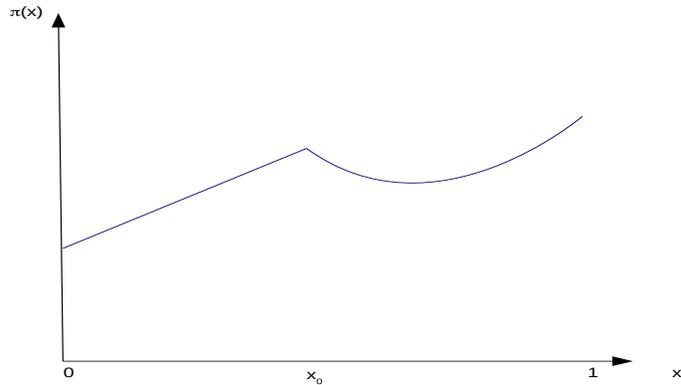


Figure 2: Profit of the platform $\pi(x)$

Proposition 1 shows that the profit-maximizing degree of data exploitation is increasing in the basic revenue per user $V(0)$ and decreasing in the share of value b depending on x . There exists a bound to $\frac{V(0)}{b}$, denoted ν such that the platform chooses full data exploitation (resulting in some users not accessing the platform) when the basic revenue $V(0)$ relative to the importance of targeting as reflected by b is lower than ν , and chooses to lower data exploitation so as to cover the market when the relative revenue is greater than ν .

The optimal level of degree exploitation depends both on the shape of the revenues

(through $V(0)/b$ and β) and the demand (through ν , which depends on demand through $U(0)$ and a). ν can be negative, which is a possible case as stated in the next Corollary. In that case, the platform chooses a low level of data exploitation whatever the value of $V(0)$ or b . When ν is positive, if the fixed part of the value is large relative to the part depending on x , the objective of the platform is to maximize the number of users, and it will thus choose a low level of data exploitation. If most of the value comes from the exploitation of personal data, the platform will instead choose the highest degree of data exploitation, even if it reduces the number of users on the platform. We now compute the effect of the parameters on the bound ν recalling the effect of the parameters on x_0 :

variable	effect on ν	effect on x_0
β	+	0
$U(0)$? (-)	+
a	?(-)	+
α	+	-

An increase in β reduces x_0^β , thereby increasing the bound ν , and unambiguously increasing the degree of data exploitation. An increase in α lowers x_0 , thereby reducing x_0^β and making it more likely that the platform chooses full data exploitation. On the other hand, when α increases, x_0 decreases so that the platform chooses a lower degree of data exploitation when $\frac{V(0)}{b} \geq \nu$, so that the total effect of an increase in α is unclear. Changes in the intrinsic benefit $U(0)$ and in the parameter a produce ambiguous effects on the bound ν : on the one hand, they result in a direct increase in ν ; on the other hand, they result in an increase in x_0 , leading to an indirect reduction on ν .

In order to quantify the balance between the direct and the indirect effects, we first

consider the two extreme cases where $U(0)$ is close to 0 and $U(0)$ is close to $1 - a$.

Corollary 1 *Let $U(0) = 0$. Then $x_0 = a^{\frac{1}{1-\alpha}}$ and $\nu = \frac{a-a^{\frac{\beta}{1-\alpha}}}{1-a}$. Thus, if $\alpha + \beta \leq 1$, ν is negative and the platform chooses $x_U = x_0$ whatever value for $V(0)$ or b .*

Let $U(0)$ be smaller but close to $1 - a$. Then x_0 tends to 1 and ν to $\frac{\beta}{1-a\alpha} - 1$. Thus, x_0 is optimal if $a\alpha + \beta \leq 1$, whatever value for $V(0)$ and b .

The condition $\beta + \alpha \leq 1$ requires β and α to be small. The smaller β is, the more concave the revenue from data collection. When β is small, the revenue due to a small value in data collection is large and the additional revenue from the maximal extraction is small. The smaller α is, the steeper the average user's utility for data collection, i.e. the steeper the threshold function T ($T(x) = u(x)/x$ since $U(0) = 0$) the loss of consumers due to an increase in data extraction is large. This explains why, whatever the value of $V(0)$, $x_U = x_0$. Let $U(0)$ be smaller but close to $1 - a$. Then x_0 tends to 1 and ν to $\frac{\beta}{1-a\alpha} - 1$. Thus x_0 is optimal if $a\alpha + \beta \leq 1$, whatever value of $V(0)$ and b , or if $a\alpha + \beta \geq 1$ and $V(0)/b \leq \frac{\beta}{1-a\alpha} - 1$. x_0 is more often chosen than for $U(0) = 0$. This may seem counterintuitive since the consumers are more eager to access the platform. This is explained however by the fact that x_0 is very close to 1.

In order to quantify the balance between the direct and the indirect effects, we resort to an example fixing $\alpha = \frac{1}{2}$ (for which the value x_0 can be analytically computed).

Example 1 *Let $\alpha = \frac{1}{2}$. The equation defining x_0 is the quadratic equation $x - a\sqrt{x} - U(0) = 0$, with positive root $\sqrt{x_0} = \frac{a + \sqrt{a^2 + 4U(0)}}{2}$. We compute*

$$\begin{aligned} \frac{\partial \nu}{\partial U(0)} &= \frac{1}{(1 - u(0) - a)^2} [1 - 2\beta \left[\frac{a + \sqrt{a^2 + 4U(0)}}{2} \right]^{2\beta-1} \frac{1 - u(0) - a}{\sqrt{a^2 + 4U(0)}}] \\ &- \left[\frac{a + \sqrt{a^2 + 4U(0)}}{2} \right]^{2\beta}. \end{aligned}$$

Notice that $\frac{\partial \nu}{\partial U(0)}|_{U(0)=0} = 1 - 2\beta a^{2\beta-2}(1-a) - a^{2\beta}$ and $\frac{\partial \nu}{\partial U(0)}|_{U(0)=1-a} = 0$. Next, we observe that the sign of $\frac{\partial^2 \nu}{\partial U(0)^2}$ is the same as the sign of

$$a + \sqrt{a^2 + 4U(0)} - (2\beta - 1)\sqrt{a^2 + 4U(0)} = a + 2(1 - \beta)\sqrt{a^2 + 4U(0)} > 0,$$

so that $\frac{\partial \nu}{\partial U(0)}$ is everywhere increasing. As $\frac{\partial \nu}{\partial U(0)}|_{U(0)=1-a} = 0$ this shows that the threshold ν is decreasing in $U(0)$ for all β , suggesting that an increase in the intrinsic benefit $U(0)$ reduces the threshold, making it more likely that the platform chooses x_0 . (Remember however that x_0 is increasing in $U(0)$, so that, whenever the platform chooses the low degree of data exploitation, an increase in $U(0)$ results in an increase in data exploitation. Notice also that, for $\beta = \frac{1}{2}$, we have $\nu = 0$ when $U(0) = 0$, so that we conclude that the threshold ν is everywhere negative, and that the platform always chooses $x_U = x_0$. As $\frac{\partial \nu}{\partial \beta} > 0$, this also shows that $\nu < 0$ everywhere when $\beta < \frac{1}{2}$. By a similar computation, we can show that ν is decreasing in a but only for $\beta \leq \frac{1}{2}$, which corresponds to the region where the platform optimally chooses x_0 .

3.2 Users' welfare

We now turn to the characterization of the degree of data exploitation which maximizes the welfare of users, W . The welfare is defined as the sum of the utility levels of all users. As those who do not access the platform, namely users with privacy costs lower than $T(x)$, obtain a null utility level the welfare of users is

$$W(x) = \int_0^{T(x)} [U(0) + ax^\alpha - x\theta] d\theta$$

For $x \leq x_0$, $T(x) = 1$, so that

$$W(x) = U(0) + ax^\alpha - \frac{x}{2}$$

and for $x \geq x_0$, $T(x) = \frac{U(0)+ax^\alpha}{x}$ so that

$$\begin{aligned} W(x) &= [U(0) + ax^\alpha]T(x) - \frac{1}{2}T(x)^2 \\ &= \frac{1}{2}T(x)^2. \end{aligned}$$

Since the threshold T is decreasing in x , we immediately obtain that users' welfare is optimal for a degree of data exploitation for which the market is covered, namely for a level in the interval $[0, x_0]$. On that interval, the welfare is concave and the optimum easily characterized. As the platform always prefers a degree of data exploitation in $[x_0, 1]$ and furthermore sometimes has an incentive to exclude users, we conclude that this results in excessive data exploitation from the users' perspective.

Proposition 2 *The welfare of users is maximized at the minimum of x_0 and $\hat{x} = (2a\alpha)^{\frac{1}{1-\alpha}}$. In particular, if $\alpha \leq \frac{1}{2}$, the user welfare is maximized at \hat{x} .*

Proposition 2 characterizes the optimal degree of data exploitation x^o from the point of view of users. It shows that users may prefer a low level of data exploitation, \hat{x} , which is lower than the minimal choice of the platform x_0 . The optimal choice of users is always lower than the optimal choice of the platform. When $U(0) + a > 1$, as $x_0 = 1$, the user's optimal degree of data exploitation is 1 if $2a\alpha > 1$ and $x^o = \hat{x}$ otherwise: the platform always chooses 1 whereas users either choose 1 or $\hat{x} < 1$. When the market is not saturated, users never choose the maximal degree of data exploitation: they either choose the level \hat{x} or the largest level for which the market is covered x_0 .

We next analyze how the parameters $U(0)$, a and α affect the optimal choice of users.

The following table characterizes the comparative statics effects of change in the parameters on \hat{x} :

Variable	Effect on \hat{x}
$U(0)$	0
a	+
α	? -

An increase in $U(0)$ leaves \hat{x} unaffected but increases x_0 : it simultaneously increases the likelihood that \hat{x} is chosen, and increases the value of x_0 when x_0 is preferred. An increase in a simultaneously increases \hat{x} and x_0 , and hence results in an increase in the degree of data exploitation if it does not lead to a switch between a régime where x_0 is chosen to a régime where \hat{x} is chosen. An increase in α reduces x_0 but has an ambiguous effect on \hat{x} . For low values of α , \hat{x} is decreasing in α , and increasing for high values of α if $2a > 1$, decreasing throughout the entire range of parameters when $2a < 1$. We know that for low values of α (lower than $\frac{1}{2}$), users always choose \hat{x} , and for high values of α (α greater than $\frac{1}{\sqrt{2}}$), they always choose x_0 which is decreasing in α .

Finally, we consider total welfare, the sum of the platform's profit and consumer surplus. First suppose that the market is covered, $x \leq x_0$. Then

$$S(x) = V(0) + v(x) + U(0) + u(x) - \frac{x}{2}.$$

Total surplus is concave in x and achieves a maximum at \tilde{x} . Furthermore, because $v'(x) > 0$, $S'(x) > W'(x)$ for all x , so that the degree of data exploitation maximizing total welfare, \tilde{x} is always larger than the degree of data exploitation maximizing consumer surplus, \hat{x} . Next, if the market is not covered, $x > x_0$,

$$S(x) = [V(x) + J(x)]T(x),$$

we compute the derivative of total welfare in elasticity form,

$$\begin{aligned}\frac{\partial S}{S \partial x} &= \frac{V'(x) + J'(x)}{V(x) + J(x)} + \frac{T'(x)}{T(x)}, \\ &= \frac{1}{x} \left[\frac{\frac{1}{2} a \alpha x^\alpha + b \beta x^\beta}{\frac{1}{2} [U(0) + a x^\alpha] + V(0) + b x^\beta} + \frac{a \alpha x^\alpha}{U(0) + a x^\alpha} - 1 \right].\end{aligned}$$

As the term in the square brackets is increasing in x , total surplus is first increasing and then decreasing in x , so that the optimal degree of data exploitation is either achieved at x_0 or 1.

Proposition 3 *Total surplus is either maximized at \tilde{x} , the unique solution to $\alpha a x^{\alpha-1} + \beta b x^{\beta-1} = \frac{1}{2}$, or at x_0 or at x_1 . It is maximized at \tilde{x} if $\tilde{x} \leq \min\{x_0, 1\}$ and*

$$V(0) + b \tilde{x}^\beta + U(0) + a \tilde{x}^\alpha - \frac{\hat{x}}{2} \geq \frac{(U(0) + a)(V(0) + b + U(0) + a)}{2}.$$

It is maximized at x_0 if $x_0 < \min\{1, \tilde{x}\}$ and

$$V(0) + b x_0^\beta + \frac{U(0) + a x_0^\alpha}{2} \geq \frac{(U(0) + a)(V(0) + b + U(0) + a)}{2}.$$

Proposition 3 indicates that the degree of data exploitation maximizing total surplus lies in between the degree maximizing user welfare and the platform's profit. Whenever users and the platform both choose the same degree of data exploitation, x_0 or 1, this degree maximizes total surplus. When the optimal choice of the user and the platform differ, users always select a degree which is lower than the platform's so the platform's choice is excessive from a total surplus viewpoint. This can happen under the following situations: if the platform chooses 1 and users choose x_0 , total surplus is either maximized at x_0 or 1. If the platform chooses x_0 and users \hat{x} , total surplus is either maximized at x_0 or $\tilde{x} > \hat{x}$. If the platform selects 1 and users \hat{x} , total surplus can be maximized at \tilde{x}, x_0

or 1. We record the comparative statics effects of the parameters on the minimal value \tilde{x} in the following table:

Variable	Effect on \tilde{x}
$V(0)$	0
b	+
β	?
$U(0)$	0
a	+
α	?

4 Taxation

In this Section, we analyze the effect of the imposition of a tax on the optimal data exploitation strategy of a platform. Because the imposition of different taxes can be interpreted as changes in the parameters of the model, the comparative statics effects of the imposition of a tax on the degree of data exploitation x_U are easily deduced from the comparative statics analysis of the previous Section and can be summarized in the following Proposition.

Proposition 4 *The imposition of a tax has the following effects on the degree of data exploitation by the platform:*

- *An ad valorem tax τ on the profits or revenues of the platform has no effect on the degree of data exploitation*
- *A tax paid by the platform per user t_P results in an increase in the degree of data exploitation*

- *In a differentiated revenues tax system, a tax τ_1 on the basic revenues results in an increase in the degree of data exploitation, whereas a tax τ_2 on the benefits generated by data exploitation results in a decrease in the degree of data exploitation*
- *A tax paid by users for accessing the platform t_U has an ambiguous effect on the degree of data exploitation but is likely to result in an increase in the degree of data exploitation.*

Proposition 4 shows that most taxes are likely to induce the platform to increase its degree of data exploitation. The only exception is a differentiated tax on revenues, which targets profits due to the use of personal data and, as any Pigouvian tax, leads to a reduction in data exploitation. As the platform's degree of data exploitation is excessive, we see that the imposition of an ad valorem or user based tax will not improve the exploitation of personal data by the platform. (Of course, this observation is based only on the consumer surplus generated by access to the platform, and does not take into account the potential redistribution effects due to taxation.) With the exception of the tax on users which generates ambiguous results, all other tax effects are robust and hold for general benefit and payoff functions. Clearly, a uniform tax on profits is neutral, and does not affect the platform's choice of data exploitation, as it uniformly reduces the profit per user. A tax per user paid by the platform has no effect on the marginal benefit of data exploitation on the users accessing the platform, but it lowers the loss of not serving the marginal user who chooses not to access on the platform. Hence a tax per user results in a higher degree of data exploitation.² A tax targeted at the revenues linked to data exploitation necessarily leads to a reduction in the ratio $\frac{xV'(x)}{V(x)}$ while leaving the effect on demand unchanged. It thus reduces the platform's incentive to collect and exploit data and results in a lower optimal value of data exploitation.

²Similarly, a tax τ_1 on the intrinsic value of users leaves the marginal benefit of data exploitation unchanged but reduces the loss of not serving the marginal user.

The imposition of a tax per user t_P may induce another negative effect on users when users are differentiated along an additional dimension: a value $\eta \in [0, \bar{\eta}]$ parametrizing the revenue of the user to the platform (measured for example in frequency of access or demographic characteristics). If the legal system allows the platform to exclude some users from access, it will optimally choose to exclude users with low value, namely those users for whom

$$\eta_i V(x) \leq t_U,$$

Any user with low value who accesses the platform will thus switch from a positive benefit $U(x) - \theta(x)$ to a benefit of 0: exclusion following the imposition of a tax per user will further reduce the welfare of users.

5 Binary policy without payment

In this section, we suppose that the platform is forced to propose a privacy-protecting access for free, called the zero-option. This results in a binary policy with two different options: one where users agree to data collection x and one where they don't. Users freely choose between the two options. For example, users select whether or not they allow the use of cookies during their navigation on the platform. As each consumer prefers the free service with no data collection to the outside option, $U(0) > 0$, all consumers access the platform. We examine the optimal choice of data collection and investigate whether the platform has to be forced to propose the privacy-protecting access for free. Indeed, since the zero-option helps to discriminate between the consumers and nevertheless provides the basic revenue $V(0)$ on each consumer, the profit of the platform might be improved.

A θ -consumer chooses the positive data collection x instead of 0 if and only if

$$u(x) + U(0) - \theta x \geq U(0).$$

Thus, the highest privacy cost for which the user chooses to provide his data is

$$T_B(x) = \min\left(\frac{u(x)}{x}, 1\right).$$

All the agents with $\theta \leq T_B(x)$ choose x , the other 0. The demand T_B of those who choose the option x is the same as T for $U(0) = 0$: with the zero-option, less individuals choose x since they can access the service with a benefit of $U(0)$ instead of 0 in the absence of the zero-option.

The profit is

$$\pi(x) = V(x)F(T_B(x)) + V(0)[1 - F(T_B(x))]$$

or

$$\pi(x) = V(0) + v(x)T_B(x).$$

The profit is composed of two terms: the basic revenue on each consumer, $V(0)$, and the additional revenue drawn from data exploitation from those consumers who choose the option x , $v(x)T_B(x)$.

To compute the optimal level of data collection, we can thus isolate the basic revenues and the benefits generated by data exploitation. Furthermore, since the demand T_B is now independent of $U(0)$, the optimal data collection policy of the platform can be computed as in the previous Section, assuming that both $U(0)$ and $V(0)$ are null. For the isoelastic benefit and payoff functions, one immediately obtains the optimal platform's choice by application of Proposition 1. The next proposition states this optimal choice denoted x_B and compares the profits of the platform under the optimal binary policy and the optimal uniform policy. To simplify the next statement, let us restrict attention to $a < 1$, i.e. the market is not saturated for $U(0) = 0$. Observe that the collection level under which the market is covered is $x_B = a^{\frac{1}{1-\alpha}}$, which is lower than all the levels x_0 since the user's demand for x is the lowest, as if $U(0)$ was null.

Proposition 5 *Consider a binary policy, in which the platform has to offer the option without data collection for free. The optimal degree of data collection is maximal, $x_B = 1$, when $\alpha + \beta \geq 1$. It is minimal, $x_B = a^{\frac{1}{1-\alpha}}$, when $\alpha + \beta < 1$, in which case all users choose to provide their data.*

The platform prefers the uniform policy to the binary policy if the market is saturated or if $\alpha + \beta < 1$. Otherwise, there exists a positive threshold value u_B for $U(0)$ under which the platform strictly prefers the binary policy and above which it prefers the uniform policy.

Proof See Section 7.

As we have seen, the optimal binary policy does not depend on the basic revenue $V(0)$ nor the access value $U(0)$. According to the proposition, the choice to cover the market only depends on the concavity of the benefit and payoff functions through the value $\alpha + \beta$ (but the level x_B depends on a). When the benefit and revenue functions are sufficiently concave, $\alpha + \beta \leq 1$, so that the marginal return to increase x accounting for the decrease in demand is low enough, the platform chooses to cover the market. Thus, though the zero-option is not used, it forces the platform to choose a very low degree of exploitation since the level x_B is the lowest possible level for x_0 . The platform can only be hurt.

The case of a saturated market, $a + U(0) \geq 1$, is easy to understand. The uniform policy chooses maximal exploitation and all consumers access the platform. If the binary policy also chooses maximal exploitation, ($\alpha + \beta \geq 1$), there are users who choose the 0-option (as $a < 1$), thereby providing the revenue $V(0)$ instead of $V(0) + b$ at the uniform policy; this explains why the latter is preferred. If the binary policy chooses $a^{\frac{1}{1-\alpha}}$, ($\alpha + \beta \leq 1$), no consumer chooses the free option so that the same outcome could be obtained under the uniform policy: the uniform's profit can only be higher.

Now observe that the binary policy and its profit are independent of $U(0)$, whereas the profit at a uniform policy is increasing in $U(0)$. It thus suffices to investigate the extreme values of $U(0)$, 0 or $1 - a$. From the just above argument, we know that the uniform policy

is preferred to the binary policy for $U(0)$ equal to $1 - a$ since the market is saturated. Let us now investigate the conditions under which the binary policy is preferred for a null value of $U(0)$.

When $U(0) = 0$, $T = T_B$: whatever x , the consumers who choose not to access the platform under the uniform policy are exactly those who choose the zero-option under the binary policy; the zero-option thus allows the platform to grasp $V(0)$ on these consumers, without cannibalizing the option x . Thus, the platform's profit can only be at least as large at the binary policy than at the uniform one (a fortiori if they do not choose the same x by a revealed preference argument). Furthermore profits can be equal only if both choose to cover the market. In that case, they choose the same level $a^{\frac{1}{1-\alpha}}$ in either policy, and obtains the same profit since no user chooses the zero-option. This case occurs when $\alpha + \beta \leq 1$ (recall that ν is negative in that case, so the value of $V(0)/b$ does not matter).

Users' Welfare We now turn to users and ask whether users benefit from the switch from a uniform to a binary policy. This comparison must take into account the different categories of users. If in the uniform policy, the platform chooses 1 and the market is not covered, some users who did not access the platform, and received a utility of 0 will now receive at least $U(0)$ with the binary policy: they gain from the creation of the new option. On the other hand, users who access the platform under a uniform policy may loose if the degree of data exploitation increases with the introduction of the zero-option. This shows that the comparison of the two situations from the point of view of users is not trivial, and the following Proposition details situations under which the uniform and binary options are preferred by users.

Proposition 6 *For $\alpha + \beta \leq 1$, users' welfare is larger at the binary policy than at the uniform policy only if the uniform one chooses the maximal degree of data exploitation $x_U = 1$ and $U(0)$ is not too large.*

For $\alpha + \beta \geq 1$, users' welfare is larger at the binary policy than at the uniform policy when $x_U = 1$, and smaller when $x_U = x_0$.

Proof See Section 7

Proposition 6 shows that users do not always favor the introduction of the zero-option, as this may lead to an increase in the level of data collection resulting in a loss for all users. This situation happens when the market is covered under the uniform option, and the creation of the second option segments consumers into some consumers accessing with the zero option, and other consumers at the x option. This situation arises when the benefit and payoff functions are not too concave – $\alpha + \beta \geq 1$, and the relative basic revenue $V(0)/b$ is sufficiently high.

6 Binary policy with payment by the platform to agents to use their personal data

6.1 Paying users for data exploitation

In this section, we suppose that the platform must still propose for free the access to the platform with no data collection, but can decide to pay a user to exploit his data. Clearly, the reason why a platform may implement this policy is that it increases data collection by paying users. The binary policy is thus characterized by the data exploitation degree x and the price p . As previously, consumers self-select and choose between the two options, and furthermore, all consumers access the platform.

A θ -consumer chooses the positive data collection x instead of 0 if and only if

$$u(x) + U(0) - \theta x + p \geq U(0).$$

Thus, defining

$$T_B(x, p) = \min\left(\frac{u(x) + p}{x}, 1\right)$$

all the agents with $\theta \leq T_B(x, p)$ choose x , the other 0. The highest privacy cost for which the user chooses to provide his data is $T_{Bp}(x)$. Let $x_B(p)$ be the largest value such that all consumers chooses option x , i.e. the largest x such that $\frac{u(x)+p}{x} \geq 1$. Notice that $x_B(p)$ is increasing in p : if the price is higher, the level of degree exploitation under which all users choose to sell their data increases.

The profit is

$$\pi(x, p) = (V(x) - p)F(T_B(x, p)) + V(0)[1 - F(T_B(x, p))]$$

or

$$\pi(x, p) = (v(x) - p)T_B(x, p) + V(0).$$

We now characterize the optimal policy of the platform, showing that either it offers to buy data from all users, or it chooses maximal exploitation at the optimal price of data collection.

Proposition 7 *Under a binary policy where the platform can propose to pay for data collection, the platform will either buy data from all users at a price p_B and propose a level of data collection x_B solving the system of equations*

$$\begin{aligned} ax^\alpha - x + p &= 0, \\ \alpha ax^{\alpha-1} + \beta bx^{\beta-1} &= 1 \end{aligned}$$

(with $p_B = 0, x_B = a^{\frac{1}{1-\alpha}}$ when $\alpha + \beta ba^{\frac{\beta-1}{1-\alpha}} \leq 1$ and $p_B = 1 - a, x_B = 1$ when $\alpha a + \beta b \geq 1$), or choose the maximal degree of data exploitation $x_B = 1$ and a price $p_B = \frac{b-a}{2}$ (when $b > a$ and $a + b \leq 2$).

Proposition 7 shows that, under a policy of paying users for their data, the platform typically selects a higher degree of data exploitation than when users are not paid. The idea is that the platform uses payment to keep users accessing the platform while increasing the degree of data exploitation. The platform trades off the cost of paying users with the benefit of raising the degree of data exploitation to increase its value, and this trade-off may result in positive prices and higher levels of data exploitation. The platform typically faces a choice between making option x acceptable to all users (ranging from fixing a price 0 and a level of data exploitation $x_0 = a^{\frac{1}{1-\alpha}}$ to fixing a price $1 - a$ and the maximal level of data exploitation) or choosing to segment the market between users who are paid for maximal exploitation, and users whose data are not collected. The choice between these options depends on the parameters, but we observe that the platform will always segment the market when $\alpha a + \beta b \geq 1$, $b > a$ and $a + b \leq 2$, suggesting that the platform is more likely to segment the market when a is small relative to b or when α is small relative to β .

We finally compare the welfare of users under a binary régime with no payment for data and a régime with payment for the data. If the degree of data exploitation is the same for the platform in the two régimes, users prefer a régime with payment, as the two options they can choose from are better than without payment. If the régime with payment results in higher data exploitation, the final effect of allowing payments on users is unclear. On the one hand, users receive a payment p , on the other hand, they suffer from a higher level of data exploitation. In that case the degree of data exploitation is always chosen to be equal to $x_B(p)$ so that the effect of an increase in p on user i is given by

$$\frac{\partial W_i}{\partial p} = 1 + [u'(x_B(p)) - \theta_i]x'_B(p) = 1 - \frac{\theta_i - u'(x_B(p))}{1 - u'(x_B(p))} \geq 0,$$

so that users always benefit from the payment option. As the platform clearly prefers the

option with voluntary payment (it can always choose $p = 0$), we conclude that both the platform and users benefit from the possibility that users are paid for data collection. In addition, this possibility opens up financial transactions between users and the platform, resulting in an income for the user which can be taxed in his country of residence.

6.2 Charging the privacy-protecting access

We analyze here the situation where the platform charges a subscription price q for the privacy-protecting access. A θ -consumer chooses option x if

$$u(x) + U(0) - \theta x \geq \max(U(0) - q, 0).$$

It is easy to see that it is never optimal for the platform to charge a price larger than $U(0)$: For $q > U(0)$, agents who do not choose x do not access the platform at all. By charging the price $q = U(0)$ (or slightly lower) they would access the platform, generating a revenue equal to $U(0) + V(0)$. Thus we assume $q \leq U(0)$.

Using similar arguments and notation as in the previous section let

$$T_{Bq}(x) = \min\left(\frac{u(x) + q}{x}, 1\right)$$

and the profit is

$$\pi(x, q) = V(x)F(T_{Bq}(x)) + V(0) + q[1 - F(T_{Bq}(x))]$$

or

$$\pi(x, q) = (v(x) - q)T_{Bq}(x) + V(0) + q.$$

We now compute the optimal choice of the price q and the degree of data exploitation x of the platform:

Proposition 8 *Under a binary policy where the platform charges for the privacy-protecting access, the platform either chooses the minimal level of exploitation $x_0 = a^{\frac{1}{1-\alpha}}$ (and all users access with the x_0 option), or it chooses the maximal level of exploitation $x = 1$. If it chooses the maximal level of exploitation, and $a + b > 1$, all users access with the high option ; if $a + b \leq 1$, the platform segments the market and charges a price $q = \min\{U(0), \frac{b-a+1}{2}\}$ for users who choose option 0.*

Proof See Section 7

Proposition 8 shows that the behavior of the platform is very different when it pays users or when it asks for a transfer from users to choose option zero. In the latter case, it will never choose an intermediate degree of data exploitation, $x_0 < x < 1$. The intuition for this result is clear: if only a fraction of users access with option $x < 1$, the platform can simultaneously increase x and q while keeping T_{Bq} constant, thereby increasing its profit. (When the platform pays the user, increasing p results in a loss for the platform, so this strategy is not profitable.) Comparing the situation with a binary option with a free "zero" option, we observe that the platform will choose the maximal degree of data exploitation more often when the zero option comes at a price. The reason is clear: whenever the platform is indifferent between choosing x_0 (with all users accessing) and 1 (with market segmentation) with the free binary option, it must prefer the maximal degree of data exploitation when it collects additional revenues from users choosing the zero option. Hence, making users pay for privacy results in an increase in the degree of data exploitation. This also shows that users are always harmed by the switch from a régime with a free zero option to a régime where users have to pay for privacy. If the maximal degree of data exploitation is chosen in both régimes, users have worse options when they must for privacy. If the minimal degree of data exploitation x_0 is chosen in both régimes, no user will pay for privacy and they are indifferent. If the platform selects x_0 with a free binary option but 1 when privacy is costly, users are worse off ; those who

choose the x option are harmed by the increase in x and those who choose the 0 option receive a lower utility than the utility they obtained at x_0 .

Final remarks. One can consider the two instruments p and q . In that case it is easy to check that $\frac{\partial \pi}{q} = \frac{\partial \pi}{p} + 1$ when $q < U(0)$. This implies that p can be positive only if q is equal to $U(0)$, i.e. that $a + b > 1$.

Observe also that a binary policy with a fee equal to $U(0)$ is surely at least as good as a uniform policy: whatever x for the uniform policy, consider the binary policy with the same level for x . The consumers who choose the option x are the same in the two policies but those who do not access the platform under the uniform policy now generate the additional revenue $U(0) + V(0)$.

7 Proofs

Proof of Proposition 1: We know that the platform optimally chooses the maximal degree of data exploitation, $x_U = 1$ if $U(0) + a \geq 1$. Assuming $U(0) + a < 1$ we compare $\pi(x_0)$ and $\pi(1)$. As $T(x_0) = 1$ and $T(1) = U(0) + a$, we have

$$\pi(x_0) = V(0) + bx_0^\beta \text{ and } \pi(1) = (V(0) + b)(U(0) + a) \quad (2)$$

This immediately gives that x_0 is chosen when $\frac{V(0)}{b} \leq \nu$. ■

Proof of Corollary 1: From Proposition 1, we know that the platform optimally chooses the maximal degree of data exploitation, $x_U = 1$, if $U(0) + a \geq 1$ or if $U(0) + a < 1$ and $\frac{V(0)}{b} \leq \nu$. We analyze the case where $U(0) + a < 1$. Surely $a < 1$. For a fixed value of the sensitivity parameter a , $U(0)$ ranges between 0 and $1 - a$. Let us consider the extreme values.

The case $U(0) = 0$. We have $x_0 = a^{\frac{1}{1-\alpha}}$ hence $\nu = \frac{a-a^{\frac{\beta}{1-\alpha}}}{1-a}$.

As $a < 1$, $\nu \leq 0$ iff $\frac{\beta}{1-\alpha} \leq 1$ or equivalently iff $\beta + \alpha \leq 1$. In that case, whatever the value of $V(0)$, the degree of data exploitation covering the market is optimal : $x_U = x_0$.

The case $U(0)$ close to $1 - a$. We know that x_0 becomes close to 1. Define $\delta = 1 - (U(0) + a)$. Thus $\delta \geq 0$ tends to zero. The equation satisfied by x_0 writes as : x_0 is the largest value of x for which

$$1 - x - a(1 - x^\alpha) - \delta \geq 0.$$

We have $\lim_{\delta \rightarrow 0} x_0 = 1$, so that $\frac{1-x_0^\alpha}{1-x_0} \approx \alpha$ which implies

$$\frac{1 - x_0}{\delta} \approx \frac{1}{1 - a\alpha}.$$

and

$$\frac{1 - x_0^\beta}{\delta} \approx \frac{\beta}{1 - a\alpha}.$$

We can now evaluate $\lim_{\delta \rightarrow 0} E(U(0), a)$. Using the previous notation $\nu = \frac{1-\delta-x_0^\beta}{\delta}$ so that

$$\lim_{\delta \rightarrow 0} \nu = \frac{\beta}{1 - a\alpha} - 1.$$

Thus for $\beta + a\alpha \leq 1$, $x_U = x_0$ is optimal whatever value for $\frac{V(0)}{b}$ when $U(1) = U(0) + a$ is close to 1, i.e. users' valuation for the service is large enough so that almost all of them prefer maximal data exploitation to the absence of access to the platform. ■

Proof of Proposition 2: We know that the degree maximizing welfare is on the interval $[0, x_0]$ where

$$W(x) = U(0) + ax^\alpha - \frac{x}{2}.$$

Differentiating with respect to x ,

$$W'(x) = a\alpha x^{\alpha-1} - \frac{1}{2}.$$

The function $W(x)$ is thus concave over the interval $[0, x_0]$, increasing at $x = 0$ and hence either achieves a maximum either at the upper bound x_0 if $W'(x_0) \geq 0$ or at the interior value $\hat{x} = (2a\alpha)^{\frac{1}{1-\alpha}}$ if $W'(x_0) < 0$. ■

Proof of Proposition 4: An ad valorem tax on revenues affects all revenues in a uniform way, and obviously has no effect on the optimal choice of x . A tax per user results in a decrease in $V(0)$, making it more likely that the platform chooses $x_U = 1$. Similarly, a tax on the revenues generated by $V(0)$, τ_1 , increases the chance that the platform chooses $x_U = 1$ whereas a tax on the revenues generated by data use can be interpreted as a decrease in b which results in a decrease in the value x_U . Finally, a tax paid by the user is equivalent to a reduction in $U(0)$. While this effect cannot be signed in general, the computation of the example when $\alpha = \beta = \frac{1}{2}$ suggests that a decrease in $U(0)$ results in a higher value x_U .

Proof of Proposition 5: The optimal level x_B under the binary policy is the same as the optimal one under a uniform policy when both $V(0)$ and $U(0)$ are nul. We immediately obtain that $x_B = x_0 = a^{\frac{1}{1-\alpha}}$ and that this is optimal if $0 > \nu = \frac{a-a^{\frac{\beta}{1-\alpha}}}{1-a}$, which is equivalent to $\alpha + \beta \leq 1$. The optimal profit under the binary policy is $V(0) + b \max(a^{\frac{\beta}{1-\alpha}}, a)$.

The comparison between the profits at the uniform and binary policy has been made in the text. We nevertheless check the formulas. When $\alpha + \beta \leq 1$, we compare $V(0) + ba^{\frac{\beta}{1-\alpha}}$ and $\max(V(0) + bx_0^\beta, (V(0) + b)(U(0) + a))$. As $x_0 \geq a^{\frac{1}{1-\alpha}}$ the uniform policy is preferred.

When $\alpha + \beta > 1$, we compare $V(0) + ba$, and $\max(V(0) + bx_0^\beta, (V(0) + b)(U(0) + a))$. The uniform policy's profit increases with $U(0)$. For $U(0) = 0$, it equals $\max(V(0) + ba^{\frac{1}{1-\alpha}}, (V(0) + b)a$. Since $a > a^{\frac{1}{1-\alpha}}$ and obviously $V(0) + ba > (V(0) + b)a$, the binary

policy is preferred. For $U(0) = 1 - a$, x_0 equals 1, hence the opposite is true. This gives a threshold value u_B for $U(0)$ under which the binary policy is preferred. ■

Proof of Proposition 6: If $U(0) + a > 1$, the platform chooses $x_U = 1$ under both policies, all users access and obtain the same utility levels under both policies .

If $\alpha + \beta \leq 1$, the platform chooses $x_B = a^{\frac{1}{1-\alpha}}$ which is lower than the degree of data exploitation chosen in the uniform policy. If $x_U = x_0$, market is covered under both policies, and one needs to compare the position of the two levels with respect to \hat{x} . If $x_U = 1$, the expected welfare under the uniform policy is

$$W = (U(0) + a)^2$$

whereas the expected welfare of a user under the binary policy is

$$W' = U(0) + \frac{1}{2}a^{\frac{1}{1-\alpha}}$$

The conclusion follows.

If $\alpha + \beta \geq 1$, $x_B = 1$. If x_U is also equal to 1, users surely benefit from the free option (by a preference argument) If $x_U = x_0$, which arises when $V(0)/b \geq \nu$, the expected welfare under the uniform policy is

$$W = U(0) + ax_0^\alpha - \frac{x_0}{2},$$

whereas the expected welfare of a user under the binary policy is

$$W' = U(0) + \frac{a^2}{2},$$

The conclusion follows. ■

Proof of Proposition 7: First consider the optimal choice of p for a fixed x . The optimal choice maximizes $(v(x) - p)T_B(x, p)$, i.e. $(v(x) - p)(\frac{u(x)+p}{x})$ for $x \geq x_B(p)$, and $(v(x) - p)$ for $x \leq x_B(p)$. Clearly, $x < x_B(p)$, is never optimal (as usual). For $x \geq x_B(p)$, the derivative is equal to $\frac{v(x)-u(x)-2p}{x}$.

We first show that if $x > x_B(p)$, i.e. not all users choose option x , we must have $x = 1$. Suppose to the contrary that the optimum is reached for $p > 0$ and $x_B(p) < x < 1$. Because $p = \frac{v(x)-u(x)}{2}$, the profit of the platform (as a function of x) is

$$\pi(x) = \frac{(v(x) + u(x))^2}{4x}.$$

We compute

$$\frac{\partial \pi}{\partial x} = \frac{1}{x} \left[2 \frac{x[v'(x) + u'(x)]}{v(x) + u(x)} - 1 \right].$$

and observe that the term inside the square brackets is always increasing in x , so that the derivative of profit with respect to x is first decreasing, then increasing in x or continuously decreasing in x over the interval $[x_B(p), 1]$, implying that either $x = x_B(p)$ or $x = 1$, a contradiction.

Hence, the only candidate optimum when some users do not choose option x is $x_B = 1$ and $p_B = \frac{b-a}{2}$, which only exists when $b > a$ and $\frac{a+b}{2} \leq 1$.

Next consider possible optima when $x = x_B(p)$. We now compute the derivative of profit with respect to p , when $x = x_B(p)$:

$$\frac{\partial \pi}{\partial p} = -1 + v'(x_B(p))x'_B(p).$$

Note that because $u(x_B(p)) - x_B(p) + p = 0$, $x'_B(p) = \frac{1}{1-u'(x_B(p))}$. Hence

$$\frac{\partial \pi}{\partial p} = -1 + \frac{v'(x_B(p))}{1 - u'(x_B(p))}.$$

Showing that π is a strictly concave function of p , achieving its maximum when $v'(x_B(p)) + u'(x_B(p)) = 1$, except at the boundaries when profit is decreasing in prices when $p = 0$ or increasing in prices when $x_B(p) = 1$. ■

Proof of Proposition 8:

We first fix x and consider the optimal choice of q . If $x \geq x_B(q)$ the derivative is equal to $\frac{v(x)-u(x)-2q+x}{x}$ and for $x \leq x_B(q)$, the derivative is equal to zero, as no user will choose the zero option. Now recall that $T_B(x, q)$ is decreasing in x –fewer users choose the x option when x increases– and increasing in q – more users choose the x option when q increases. Hence, for any x, q such that $x_B(q) < x < 1$, we can simultaneously increase x and q while leaving the number of users choosing the x option unchanged. Now, if $T_{Bq}(x)$ is constant, the platform’s profit is increasing in x and q . Hence, whenever $x_B(q) < x < 1$, the platform can increase its profit by simultaneously increasing x and q while leaving the number of users choosing the x option constant. Now suppose that $x = x_B(q)$. As all users choose the x option, the platform makes no profit on the 0 option and, as in the case of a binary option with no transfers, the profit is maximized either at $x = x_0 = a^{\frac{1}{1-\alpha}}$ or at $x = 1$. At $x = 1$, we compute the profit maximizing charge as $q^* = \frac{b-a+1}{2}$. If $a + b \geq 1$, $a + q > 1$ so that at the platform prefers to serve all users with option 1. If $a + b \leq 1$, the platform optimally selects the minimum of q^* and $U(0)$. ■

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Tax competition, tax coordination and e-commerce

Maya Bacache

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Abstract

On the one hand, e-commerce puts downward pressure on taxes because of fiscal leakages but, on the other hand, it could help collecting a more efficient tax. We develop a model to understand the impact of on-line sales on taxes at the Nash equilibrium and tax coordination. We show how taxation, tax revenues, and conditions for tax coordination depend on whether indirect taxation is origin-based or destination-based.

1 Introduction

Internet is perceived as a tax haven that allows economic agents, both firms and consumers, to avoid paying taxes. This is due to many causes: either because sales taxes don't apply to on-line shopping or because sellers are households that are not compelled to declare their economic activities thus are not liable to taxes such as VAT. Those leakages don't benefit any government and e-commerce can be a threat that decreases tax revenues for all countries. On one hand, Internet puts downward pressure on taxes because of those leakages but, on the other hand, it could help collecting a more efficient tax: it increases information on consumers, on their location, and more important, it allows to tax sales following the destination principle which was impossible in an integrated Europe. In that sense, Internet could help fighting cross-border shopping and tax evasion. Hence, the development of e-commerce is expected to alter tax competition and tax coordination. Internet is expected to impact taxes levels at the Nash equilibrium and the conditions of optimality of tax coordination. This paper addresses the impacts of on-line sales on tax competition between countries and consequently on tax coordination.

Though the economic literature on fiscal competition is substantial, papers on fiscal competition and e-commerce are scarce. Fiscal competition with taxes on sales is studied in the well-known and simple model of Kanbur and Keen (1993). A clear and general version of this model is designed in Nielsen (2001). An extensive literature studies variations of this first setting and a thorough review of the literature is to be found in Keen and Konrad (2012).

The literature on e-commerce is mainly empirical. It focuses on price elasticities of on-line shopping: Goolsbee (2000) establishes that e-commerce would fall dramatically if sales taxes were to be enforced on the Internet. Goolsbee, Lovenheim and Slemrod (2010) study cigarette sales and show an increasing sensitivity to taxes with the spread of Internet use during the period they studied. Einav *et al.* (2014) estimate that a 1% increase in sales taxes raises online purchases by 2% and decreases online purchases from home-state retailers by 3 to 4%.

A narrow literature focuses on leakages on the Internet: Bruce and Fox (2000) estimate that e-commerce will cause 10 billion dollars tax revenue losses in the US in 2003. Alm and Melnik (2010) study transactions on eBay and show that seller's compliance to sales tax is low but that of established sellers is rather high. Alm and Melnik (2012) study cross-border shopping on eBay USA and estimate that out-of-state purchases amount to 94% of the volume of transactions.

Few theoretical papers (Bruce, Fox and Murray 2003, Fox and Murray 1997, Goolsbee and Zittrain 1999) study the optimal taxation on e-commerce and insist on the compliance cost of sales tax on the Internet. Keen (2002) for example suggests exempting from sales tax all transactions for which collecting and controlling taxes exceeds the amount of income tax. In practice, the use of tax on e-commerce raises the question of detecting the exchange and its tracability.

To our knowledge, the only paper that addresses specifically the impact of e-commerce on tax competition is Agrawal (2013) which is an econometric paper that quantifies the impact of e-commerce on tax levels. Agrawal shows that Internet penetration puts a downward pressure on taxes and has a differentiated impact on small and large countries taxes.

This paper examines, through a Nielsen (2001) setting, the impact of on-line shopping on taxes and tax coordination. We assume that when buying on the Internet a consumer faces a probability of not paying taxes (because of leakages and private households-sellers). The equilibrium depends on the principle of indirect taxation, meaning taking into account whether taxation is origin-based or destination-based.

We show that if the origin principle is applied - that is when sales are taxed at the producer's state tax rate - on-line shopping supplants cross-border shopping. We show that if the destination principle is applied - that is when sales are taxed at the consumer's residence rate - Internet sales don't always supplant cross-border shopping. This depends on the relative cost of cross-bording to shopping on-line, on the probability to avoid taxes and on the difference between taxes. Moreover the share of e-commerce is higher under the origin principle than under the destination principle.

If the origin principle is applied, we show that the probability of not paying taxes on the Internet doesn't always drive all taxes down: taxes are increasing with small probability of leakage on the Internet and, beyond a threshold, decreasing with this probability. The threshold is higher for the small country. The large country's tax revenues follow the

same evolution first increasing with the leakage probability then decreasing; but the small country's tax revenues are always decreasing with this probability of not paying taxes. Taxes revenues are lower with e-commerce than without; but the small country's taxes may be higher if relative transport cost are high enough.

When the destination principle is applied and shopping on-line supplants cross-border shopping, taxes are decreasing with the leakage probability. Taxes and taxes revenues in both countries may be higher or lower than without Internet, depending on the probability of leakage. This is because the destination principle reduces tax competition between countries. This Pareto improvement is asymmetric: the large country benefits more than the small country from a destination based taxation and efficient taxation of on-line sales. Taxes revenues are always higher under the destination principle than under the origin principle. But the small country's taxes may be lower or higher depending on the leakage probability. When the destination principle is applied but cross-border shopping coexist with e-commerce, taxes are first increasing then decreasing with the leakage probability for both countries.

We show that in the case of origin-based taxation, the range for a Pareto-improving tax can be larger. Coordination schemes such as a minimum tax requirement reduces tax differences. Under the destination principle and if on-line shopping supplants the cross-border shopping, tax coordination on tax rates is no longer needed. Hence coordination could be increased on Internet leakages, for instance on transparency and on VAT liabilities conditions (*e.g.* the minimum level of sales that makes a seller liable to VAT). Under the destination principle and if cross-border shopping remains at the equilibrium, then coordination may be harmful and a minimum tax could paradoxically end in divergence in taxes.

2 Setting of the model: tax competition with e-commerce

2.1 The structure of the model

We follow Kanbur and Keen's (1993) basic model of tax competition, simplified by Nielsen (2001), to which we add on-line shopping.

There are two countries located on the interval $[-1, 1]$, the larger country goes from -1 to b ($b > 0$) the border, and the smaller from b to 1 . With density of population set to 1 in both countries, population size of the larger country is $1 + b$, and that of the smaller country is $1 - b$. Consumers are located uniformly on $[-1, 1]$, at a distance s from the border.

There is one composite good and each consumer buys one unit of this good (we assume that the consumer's reservation price is high enough). The reservation price may differ between countries; we denote this reservation price by V for the large country, and v for the small country. In this basic model production costs are normalized and set to zero.

The sellers have no market power; hence the price of the good is merely the tax on that good.

Governments levy taxes on this consumption good, T for the large country and t for the small country.

Consumers consume the good in a brick-and-mortar shop either at home or travel and cross the border to shop at their neighboring country. If they do so, they benefit from the tax levied abroad. In this model, cross-border shopping is only due to tax trade-off. Eventually, we assume there is a cost to travel, δ , per unit of distance.

We add to this standard tax competition model the possibility for the consumer to shop on-line. There is no transportation cost in the brick-and-mortar economy when a consumer buys a good at home; so it is not less costly to buy on the Internet than to buy at home. When a consumer goes on line, he bears a positive cost μ : he must search for the good on the Internet, and can face a reputation risk from the buyer, etc. We make the assumption that μ is the cost of a unit of distance to the border, in the same way as δ . The cost of buying on the Internet is function of the distance to the border because like cross-border shopping it includes transportation cost. It also includes transaction cost of searching for information in the same way as cross-border costs. We assume that $\mu < \delta$, the private travelling cost is higher than transport and information cost on the Internet.

We also assume that on the Internet, there is an exogenous probability θ to buy the good from a seller that can avoid tax. This is either because he can cheat or because his total amount of sales lies below the tax threshold ("small" buyers are not liable to VAT). This leakage is either legal (households don't pay VAT if they are occasional sellers) or illegal. This assumption captures the fact that the Internet can be considered as a tax haven where consumers avoid taxation. Hence the consumer faces a probability $(1 - \theta)$ to buy from a seller that is liable to taxation.

2.2 Consumer's behavior

A consumer makes one choice: where to buy a unit of the composite good. He can choose to buy it either in a brick-and-mortar shop at home or in the neighboring country, or on the Internet. Consider a consumer in the large country. If he buys the good at home he gets the value net of local taxes:

$$V - T$$

If he crosses the border and shops from a brick-and-mortar shop, he gets the value net of taxes and travel costs:

$$V - t - \delta s$$

If he goes on the Internet, the taxation he bears depends on the principle of taxation, either the destination or the origin principle.

If indirect tax (VAT) is designed according to the origin principle, it is levied in the

producer's location. Hence if the consumer buys from a foreign seller he gets $(1 - \theta)(V - t) + \theta V - \mu s$, and if he buys from a local seller he gets $(1 - \theta)(V - T) + \theta V - \mu s$. Hence when the VAT follows the origin principle, the consumer chooses a foreign seller if and only if $t \leq T$ and gets the expected net value:

$$(1 - \theta)(V - t) + \theta V - \mu s$$

If VAT is designed according to the destination principle, he gets, whether he buys from a local or a foreigner seller, the net value:

$$(1 - \theta)(V - T) + \theta V - \mu s$$

The consumer must choose where to buy the good, at home, abroad or on the Internet. First let's consider the trade-off between buying at home in a brick-and-mortar shop and traveling abroad.

We note s^{CB} the share of consumers crossing the border. All consumers located at a distance $s < s^{CB}$ cross the border, s^{CB} is such as:

$$\begin{aligned} V - t - \delta s &> V - T \\ s^{CB} &= \frac{T - t}{\delta} \end{aligned}$$

Symmetrically, consider a consumer of the small country, he will cross the border only if he is located at a distance smaller than $\frac{t-T}{\delta}$ from the border. If $t \leq T$ no consumer goes from the small to the large country to benefit from lower taxes. If local taxes are lower than abroad, no consumer travels to the foreign country. But when local taxes are higher, all consumers located between the border and s^{CB} are cross-borderers.

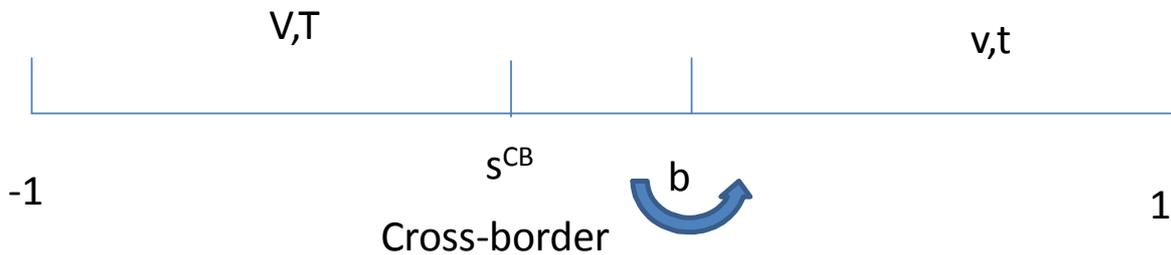


Figure 1: Basic model

Consider now the trade-off between buying at home or on the Internet, for a consumer in the large country.

The share of consumers that use e-commerce when the origin principle is applied is

s^{ecO} such as all consumers located at a distance $s < s^{ecO}$ buy on the Internet:

$$\begin{aligned} (1 - \theta)(V - t) + \theta V - \mu s &> V - T \\ s^{ecO} &= \frac{T - t(1 - \theta)}{\mu} \end{aligned}$$

The share of consumers that use e-commerce when the destination principle is applied is s^{ecD} such as

$$\begin{aligned} (1 - \theta)(V - T) + \theta V - \mu s &> V - T \\ s^{ecD} &= \frac{\theta}{\mu} T \end{aligned}$$

Consider now the consumer of the small country, we showed that if $t \leq T$, no consumer travels. However now there is the possibility for e-commerce where consumers can evade taxation. Under both principles, the consumer of the small country buys from a local producer on the Internet. Hence he chooses to e-commerce rather than to go to the brick-and-mortar shop if:

$$\begin{aligned} (1 - \theta)(v - t) + \theta v - \mu s &> v - t \\ s &= \frac{\theta}{\mu} t \end{aligned}$$

2.3 How do those locations spread?

It is straightforward to write that:

$$s^{ecO} = s^{ecD} \frac{t}{T} + \frac{\delta}{\mu} s^{CB}.$$

Hence, if the cost of shopping on-line is smaller than that of travelling, which is a plausible assumption, ($\frac{\delta}{\mu} > 1$), then $s^{ecO} > s^{CB}$, *i.e.* the share of consumers going on the Internet is always higher than the share of cross-borderers under the origin principle of taxation. This is because, buying on the Internet allows benefitting from the lower taxation abroad (like cross-bording) and moreover to benefit from the fiscal leakage due to a share of buyers that are not liable to taxes on the Internet.

Besides, the share of consumers buying on the Internet is always higher under the origin principle than under the destination principle $s^{ecO} > s^{ecD}$, this is straightforward because on the Internet consumers can avoid taxes under both taxation principle and can benefit from a lower taxation abroad if the origin principle applies.

However, the location of s^{CB} relative to s^{ecD} depends on the parameters:

$$s^{ecD} > s^{CB} \iff t > \left(1 - \frac{\delta\theta}{\mu}\right)T$$

The share of consumers going on the Internet doesn't rely anymore on the difference between the levels of taxes since the consumer pays his local tax even when shopping on-line. Hence the trade-off between going on-line and going abroad depends only on the relative cost of cross-bording ($\frac{\delta}{\mu}$) and on the probability to avoid taxes (θ). If the cost of shopping on the Internet is equal to the cost of travelling abroad $\mu = \delta$, then $s^{ecD} > s^{CB} \iff t > (1 - \theta)T$, it is worth buying on the Internet rather than to travel if the level of taxes abroad is higher than the actual level of taxes on the Internet (the local taxes at the probability to pay taxes).

We can wonder which case is more likely to happen. In Europe, VAT is between 25% and 17% (in January 2015). In this European context, on-line shopping will prevail and cross-bording shopping disappears if $\frac{\delta\theta}{\mu} > 0.32$. The share of private sellers not reliable to VAT is rather limited on platforms such as eBay: for instance on January 2015, on eBay France the share of private sellers is between 25% for clothes and less than 4% for electronic equipment. In this case, the cost of travelling needs to be between 1.28 and 800 times higher than the cost of going on-line. One can estimate that under the destination principle, e-commerce is more profitable than cross-bording if the share of non liable sellers is rather high, higher than 20-25%.

The shares of cross-borderers spread as represented in Figures 2 and 3.

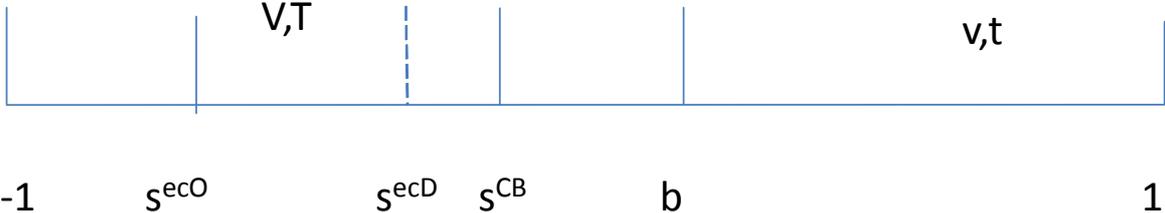


Figure 2: Cross-border and on-line shopping, case 1

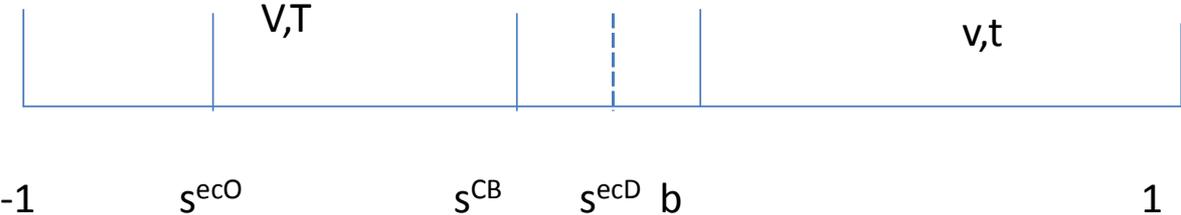


Figure 3: Cross-border and on-line shopping, case 2

3 Computing Nash Equilibria

3.1 Nash Equilibrium with cross-border shopping without e-commerce

Let's recall what happens if there is no trade on-line (Nielsen 2001). This case is labelled the *CB* case (cross-border without Internet).

We assume that governments want to maximize tax revenues. Without the threat of cross-bording or e-commerce they would set $t^* = v$ and $T^* = V$. With the possibility of traveling, the optimal tax depends on the neighbor's tax.

We note r the tax revenue of the small country, and R that of the large country. Without e-commerce, only cross-borderers affect tax revenue. A government's tax revenue streams from his local population $(1-b)$ for the small country or $(1+b)$ for the large country and from the additional cross-borderers leaving or coming across the bord. Governments' revenues write:

$$\begin{aligned} R &= T \left[1 + b - \frac{T - t}{\delta} \right] \\ r &= t \left[1 - b + \frac{T - t}{\delta} \right] \end{aligned}$$

Governments set their taxes to maximize the tax revenues. The optimization program gives the following response functions:

$$\begin{aligned} T &= \frac{\delta(1+b) + t}{2} \\ t &= \frac{\delta(1-b) + T}{2} \end{aligned}$$

Therefore, we can compute the tax levels at the Nash equilibrium without e-commerce:

$$\begin{aligned} T^N &= \delta \left(1 + \frac{b}{3} \right) \\ t^N &= \delta \left(1 - \frac{b}{3} \right) \end{aligned}$$

One can check that $t^N < T^N$. At those taxes at the Nash equilibrium, governments' revenues are:

$$\begin{aligned} R(T^N, t^N) &= \delta \left(1 + \frac{b}{3} \right)^2 \\ r(T^N, t^N) &= \delta \left(1 - \frac{b}{3} \right)^2 \end{aligned}$$

The well-known results, without on-line sales, are that the Nash commodity taxes are

proportional to the transportation cost δ and that the large country has a higher tax level that increases with the country size b .

3.2 Nash Equilibrium with e-commerce and taxation under the origin principle

Now we add the possibility to buy on-line and compute the Nash equilibrium. Let's consider first the case when the origin principle applies. This case is labelled the ECO case (electronic commerce with the origin principle of taxation)

We showed that $s^{ecO} > s^{CB}$, *i.e.* no one travels from the large country to the small country anymore and, instead, shops on-line. Hence the large country loses Ts^{ecO} tax revenues. On the contrary, the small country benefits from the on-line shopping of those foreign consumers. Besides, there is fiscal leakage on-line so the small country only gets a share $1 - \theta$ of these on-line sales from the large country consumers. Moreover, the local consumers can also buy on the Internet and avoid taxes so the small country also loses a share θ of its citizens avoiding taxes on the Internet. Hence governments' revenues now are:

$$\begin{aligned} R &= T \left[1 + b - \frac{T - t(1 - \theta)}{\mu} \right] \\ r &= t \left[1 - b + (1 - \theta) \frac{T - t(1 - \theta)}{\mu} - (\theta) \frac{\theta}{\mu} t \right] \end{aligned}$$

Governments set their taxes to maximize the tax revenues. The optimization program now gives the response functions:

$$\begin{aligned} T &= \frac{\mu}{2}(1 + b) + \frac{t}{2}(1 - \theta) \\ t &= \left(\frac{1}{(1 - \theta)^2 + \theta^2} \right) \left[\frac{\mu}{2}(1 - b) + \frac{T}{2}(1 - \theta) \right] \end{aligned}$$

In order to ease the interpretation, we note $\Theta_1 = \frac{1}{3 + 7\theta^2 - 6\theta}$, $\Theta_2 = \theta^2(4 + 4b) + \theta(-5 - 3b) + 3 + b$ and $\Theta_3 = 3 - b - \theta(1 + b)$. The Nash equilibrium (for the origin principle case and e-commerce) is hence given by:

$$\begin{aligned} T_{ecO}^N &= \mu\Theta_1\Theta_2 \\ t_{ecO}^N &= \mu\Theta_1\Theta_3 \end{aligned}$$

The revenues at the Nash equilibrium write:

$$\begin{aligned}
R(T_{ecO}^N, t_{ecO}^N) &= \frac{T_{ecO}^{N2}}{\mu} = \mu(\Theta_1\Theta_2)^2 \\
r(T_{ecO}^N, t_{ecO}^N) &= \frac{t_{ecO}^{N2}}{\mu}((\theta - 1)^2 + \theta^2) = \mu\Theta_1^2\Theta_3^2(1 - 2\theta + 2\theta^2)
\end{aligned}$$

3.3 Nash Equilibrium with e-commerce and taxation under the destination principle

- Assume that $s^{ecD} > s^{CB} \iff t > (1 - \frac{\delta\theta}{\mu})T$. This case is labelled the ECD1 case (electronic commerce with the destination principle of taxation without cross-borderers).

In this case, all cross-borderers shop on the Internet and pay the tax set by their own government. Both countries loose a share θ of sales done on the Internet.

$$\begin{aligned}
R_{ecD1} &= T \left[1 + b - \frac{\theta^2}{\mu}T \right] \\
r_{ecD1} &= t \left[1 - b - \frac{\theta^2}{\mu}t \right]
\end{aligned}$$

Governments set their taxes to maximize tax revenues. The optimization program now under the destination principle doesn't depend on the other player's behavior and yields:

$$\begin{aligned}
T_{ecD1}^N &= \frac{\mu}{2\theta^2}(1 + b) \\
t_{ecD1}^N &= \frac{\mu}{2\theta^2}(1 - b)
\end{aligned}$$

Taxes revenues at the Nash equilibrium are:

$$\begin{aligned}
R(T_{ecD1}^N, t_{ecD1}^N) &= \frac{\mu}{4\theta^2}(1 + b)^2 \\
r(T_{ecD1}^N, t_{ecD1}^N) &= \frac{\mu}{4\theta^2}(1 - b)^2
\end{aligned}$$

- Assume now that $s^{ecD} < s^{CB} \iff t < (1 - \frac{\delta\theta}{\mu})T$. This case is labelled the ECD2 case (electronic commerce with the destination principle of taxation with cross-borderers)

Now not all cross-borderers shop on the Internet. Hence governments' revenue for the large country are diminished due to Internet leakage $\frac{\theta^2}{\mu}T$ but also because of cross-borderers $\frac{T-t}{\delta} - \frac{\theta}{\mu}T$. Government's revenue for the small country are reduced because of

Internet leakage of its own consumers but benefit again from cross-borderers. Revenues now are:

$$R_{ecD2} = T \left[1 + b - \frac{\theta^2}{\mu} T - \left(\frac{T-t}{\delta} - \frac{\theta}{\mu} T \right) \right]$$

$$r_{ecD2} = t \left[1 - b - \frac{\theta^2}{\mu} t + \left(\frac{T-t}{\delta} - \frac{\theta}{\mu} T \right) \right]$$

Governments set their taxes to maximize tax revenues. The optimization program now under the destination principle gives the response functions

$$T_{ecD2} = \frac{\mu}{2} \left[\frac{\delta(1+b) + t}{\delta\theta(\theta-1) + \mu} \right]$$

$$t_{ecD2} = \frac{\mu}{2} \left[\frac{\delta(1-b) + T(1 - \frac{\delta\theta}{\mu})}{(\mu + \delta\theta^2)} \right]$$

In order to ease the interpretation, let's note $\Phi_1 = 4\delta^2(\theta-1)\theta^3 + \delta\mu(8\theta-3)\theta + 3\mu^2$ and $\Phi_2 = \delta\mu(\delta\theta[b(2\theta-1) - 2\theta + 3] + \mu(b-3))$, and $\Phi_3 = \delta\mu(2(b+1)\delta\theta^2 + \mu(3+b))$. The non-cooperative Nash equilibrium, for the destination principle case and e-commerce is hence given by the following equations.

$$T_{ecD2}^N = \frac{\mu}{2(\delta\theta(\theta-1) + \mu)} \frac{\Phi_3}{\Phi_1}$$

$$t_{ecD2}^N = \frac{\Phi_2}{\Phi_1}$$

4 Comparing cases

4.1 Taxes and Internet leakage

Taxes and taxes revenues at the equilibrium vary with the probability of not paying taxes when shopping on the Internet. Intuitively, two effects are expected: on one hand fiscal leakages, like fiscal competition, should lower taxes because the higher the probability of not paying taxes and the more willing are consumers to buy on the Internet; on the other hand, governments could raise taxes to compensate for those fiscal leakages.

4.1.1 Under the origin principle

Let's first consider the Nash equilibrium with taxation under the origin principle and determine how taxes vary when the probability to find a non-taxable seller increases.

The large country's taxes are not always decreasing with the probability of leakage. For small value of leakages, from 0 to a probability θ_1 , an increase in the probability of avoiding taxes on the Internet has the counter-intuitive impact of increasing taxes of the large country. This is because the large country may compensate the loss due to Internet by increasing the tax level and benefit from the large tax base. Note that the bigger b , *i.e.* larger the country, the smaller is θ_1 , and greater is the range where T is decreasing with θ .

Proof. For the large country, $\frac{\delta T}{\delta \theta}$ has the sign of $(11 - 3b)\theta^2 + (-18 + 10b)\theta + 3 - 3b$ which is negative between $\theta_1 = \frac{9-5b-4\sqrt{b^2-3b+3}}{11-3b}$ and $\theta_{11} = \frac{9-5b+4\sqrt{b^2-3b+3}}{11-3b}$, and positive outside this range. For all $b \in [0, 1]$, $\theta_{11} > 1$. But $\theta_1 > 0$. In other words, from 0 to θ_1 , $\frac{\delta T}{\delta \theta} > 0$ and T is increasing with θ , and between θ_1 and 1, $\frac{\delta T}{\delta \theta} < 0$ and T is decreasing with θ . \square

The situation is rather similar for the small country: taxes are not always decreasing with the probability of leakage. The small country's taxes are first increasing with θ , for $\theta \in [0, \theta_2]$, and then decreasing for $\theta \in [\theta_2, 1]$. One must note that θ_2 , is decreasing with the size of the large country b . Hence, the larger the large country, and the bigger is the range where taxes of the small country are decreasing with leakage. One can also note that $\theta_2 > \theta_1$, which means that the range where taxes are increasing is larger for the small country than for the large country.

Proof. $\frac{\delta t}{\delta \theta}$ has the sign of a 2 degree polynomial, is positive from 0 to $\theta_2 = \frac{-21-7b-4\sqrt{b^2-3b+3}}{11-3b}$ and is negative between θ_2 and 1. \square

Hence if $\theta \in [0, \theta_1]$, both taxes are increasing with the level of leakage; if $\theta \in [\theta_1, \theta_2]$, taxes are decreasing in the large country but increasing in the small country; and if $\theta \in [\theta_2, 1]$, both taxes are decreasing with the level of leakage

The large country's tax revenues are, like the tax levels, first increasing with the probability of leakage for small values of θ and then decreasing with θ for higher values of leakage. Hence for a small value of leakage (for $\theta < \theta_1$), the large country benefits from the Internet. The small country's revenues are always decreasing with θ . For the small country fiscal leakage is always harmful, whereas it can benefit the large country because it decreases the fiscal threat of cross-bording.

Proof. The small country's tax revenues evolution with θ is less straightforward, but one can check that $\frac{\delta r}{\delta \theta}$ is always negative on the range $[0, 1]$; this is because $\frac{\delta r}{\delta \theta}$ has the sign of a degree 5 polynomial in θ which is negative for $\theta \in [0, 1]$. \square

	T_{ecO}^N	t_{ecO}^N	R_{ecO}^N	r_{ecO}^N
θ	θ_1	θ_2	θ_1	

Figure 4: ECO case: Impact of leakage on taxes and revenues

4.1.2 Under the destination principle

- The first destination case

Let's consider the first destination case, where no cross-bordering remains. Since there are no cross-borderers, nor on brick-and-mortar shops nor on the Internet, countries are independent and there is no tax competition. The share of nontaxable sales decreases the optimal taxes and tax revenues. If there is no leakage and no tax competition, then taxes are maximum such as $t = v$ and $T = V$. If $\theta = 1$ and all transactions avoid taxes, then $T_{ecD1}^N = \frac{\mu}{2}(1 + b)$ and $t_{ecD1}^N = \frac{\mu}{2}(1 - b)$.

	T_{ecD1}^N	t_{ecD1}^N	R_{ecD1}^N	r_{ecD1}^N
θ				

Figure 5: ECD1 case: Impact of leakage on taxes and revenues

- The second destination case.

Let's consider now the second destination case, when cross-bordering remains in addition to on-line shopping. One can show that both taxes are first increasing then decreasing with θ .

Proof. Considering the taxes in the large country, $\frac{\delta T}{\delta \theta}$ has the sign of a 2 degree polynomial that is negative between 0 and $\theta_3 = 2\frac{\mu}{\delta}(b - 1)^2 + 2 \left((2\frac{\mu}{\delta}(b - 1))^2 + 8\frac{\mu}{\delta}(b + 3)(b + 1) \right)^{1/2}$, and positive between θ_3 and 1. Hence the taxes of the large country are first increasing with θ , for $\theta \in [0, \theta_3]$, and then decreasing for $\theta \in [\theta_3, 1]$. \square

4.2 The impact of e-commerce

4.2.1 Under the origin principle

How does on-line shopping affect the Nash equilibrium compared to the situation where no e-commerce was possible?

Let's consider first the ECO case. E-commerce has two impacts in this setting: under the origin principle, it lowers the travel costs ($\mu < \delta$) hence allows benefitting from a lower tax abroad. Moreover, it allows not paying taxes at all, thanks to the probability of finding a seller who doesn't have the obligation to apply VAT.

The comparison between the two equilibrium for all θ is not straightforward mainly because taxes depend on transport cost μ in the case of e-commerce and δ in the case of cross-bordering. It can be checked that the large country's taxes are lower with e-commerce than with cross-border transactions. However the small country's taxes can be lower if transaction costs on the internet are smaller "enough" than traveling costs.

If $\theta = 0$, *i.e.* with no leakage, then $T_{ecO}^N = \mu(1 + \frac{b}{3})$ and $t_{ecO}^N = \mu(1 - \frac{b}{3})$. With $\delta > \mu$, $T^N > T_{ecO}^N$ and $t^N > t_{ecO}^N$: e-commerce drives all taxes down because the transport cost is lower and shopping from foreign seller is easier. With full leakage, *i.e.* if $\theta = 1$, $T_{ECO}^N = \mu(\frac{1+b}{2})$ and $t_{ECO}^N = \mu(\frac{1-b}{2})$. Both taxes are lower with full leakage than with no leakage at all (this is because for all $0 < b < 1$, $\frac{1+b}{2} < 1 + \frac{b}{3}$ and $\frac{1-b}{2} < 1 - \frac{b}{3}$). Hence leakage is the second reason why taxes are lower: not paying taxes on the Internet drives all tax levels down.

Proof. We showed that T_{ECO}^N is increasing with θ from 0 to θ_1 , hence we compare for θ_1 , T_{ECO}^N and T^N . For θ_1 , $T_{ECO}^N < T^N$ if $\frac{\mu}{\delta} < F(b)$, F is an increasing function of b that is always higher than 0.96. Hence if the transport cost on Internet is lower than traveling cost ($\frac{\mu}{\delta} < 0.96$ which is a plausible assumption), T_{ECO}^N is always lower than T^N . We showed that t_{ECO}^N is increasing with θ from 0 to θ_2 , hence we compare t_{ECO}^N and t^N when $\theta = \theta_2$. For θ_2 , $t_{ECO}^N < t^N$ if $\frac{\mu}{\delta}$ is low enough. If the large country is very large and b is close to 1, $\frac{\mu}{\delta}$ needs to be lower than 0.85, but if the large country is smaller and b close to 0, than $\frac{\mu}{\delta}$ needs to be lower than 0.6 which can't be assumed easily. As a result, $t_{ECO}^N > t^N$ for a range of θ close to θ_2 , if $\frac{\mu}{\delta}$ is high enough. \square

The governments' tax revenues are always higher in the cross-border case than in the ECO case.

Proof. If $\theta = 0$, *i.e.* with no leakage, then $R_{ecO}^N = \mu(1 + \frac{b}{3})^2$ and $r_{ecO}^N = \mu(1 - \frac{b}{3})^2$; and with full leakage (if $\theta = 1$), then $R_{ECO}^N = \mu(\frac{1+b}{2})^2$ and $r_{ECO}^N = \mu(\frac{1-b}{2})^2$. One can check that for $\mu < \delta$, if $\theta = 0$, then $r_{ecO}^N < r^N$; and since r_{ecO}^N is always decreasing with θ , then for all $\theta \in [0, 1]$, $r_{ecO}^N < r^N$. Consider now the tax revenues of the large country. Like taxes, taxes revenues are increasing from 0 to θ_1 , but one can check that for $\theta = \theta_1$, $R_{ecO}^N < R^N$ if the transport cost on Internet is lower than traveling cost ($R_{ECO}^N < R^N$ if $\frac{\mu}{\delta} < G(b)$, and G is an increasing function of b that is always higher than 0.92). \square

4.2.2 Under the destination principle

In the ECD1 case, compared to the Nash equilibrium without on-line shopping, the levels of taxes are either higher or lower depending on the value of θ . If there is no leakage and no

tax competition, then taxes are maximum at levels higher than at the Nash equilibrium with cross bordering. Taxes are equal in the two cases (e-commerce under the destination principle and no e-commerce) in the large country for a level θ , such as $\frac{\mu}{2\theta^2}(1+b) = \delta(1+\frac{b}{3})$, and in the small country for a level θ , such as $\frac{\mu}{2\theta^2}(1-b) = \delta(1-\frac{b}{3})$. We note $\theta_4 = \frac{\mu}{2\delta} \frac{(1+b)}{(1+b/3)}$ and $\theta_5 = \frac{\mu}{2\delta} \frac{(1-b)}{(1-b/3)}$.

Compared with the cross-bordering case, tax revenues can be higher or lower depending on the value of θ , in the same way as taxes. Hence governments are better off with on-line shopping if they can tax at the destination of the consumer and if taxes are levied on Internet sales, that is if θ is small enough.

More precisely there is asymmetry between the small country and the large country: the large country is better off if $\theta^2 \leq \theta_4$ and the small country is better off for a smaller value of leakage, if $\theta^2 \leq \theta_5$ and $\theta_5 < \theta_4$. This is intuitive, for a relatively small value of leakage the large country is better off with taxed on-line shopping and no cross-borderers. On the contrary, the small country loses the tax revenue from cross-borderers hence gain from on-line shopping for only a smaller value of leakage.

Without With e- commerce	T^N	t^N	R^N	r^N
ECO	$T_{ecO}^N < T^N$	$t_{ecO}^N < t^N$ if $\mu \ll \delta$	$R_{ecO}^N < R^N$	$r_{ecO}^N < r^N$
ECD1	$T_{ecD1}^N > T^N$ if $\theta^2 < \theta_4$	$t_{ecD1}^N > t^N$ if $\theta^2 < \theta_5$	$R_{ecD1}^N >$ or $< R^N$	$r_{ecD1}^N >$ or $< r^N$

Figure 6: E-commerce vs cross-bordering

4.3 Destination or origin principle

If governments were to choose the taxation principle, which would they rather implement, a origin-based taxation or a destination-based taxation? Let's consider the case where e-commerce would supplant cross-border shopping (ECD1). The large country can always set a higher tax under the destination principle than under the origin principle. This result is intuitive: under the destination principle, with no cross-bordering, the large country face no fiscal competition hence can set a higher level of taxes.

Proof. One can check that for all $b \in [0, 1]$ and $\theta \in [0, 1]$, $T_{ecO} - T_{ecD1} < 0$ because the difference has a sign of a degree 4 polynomial which root is outside the range $[0, 1]$. \square

The situation is more complex for the small country because taxes can be higher under the origin principle than under the destination principle for large values of leakage. The threshold value for θ decreases with b , which means that the larger the large country, the

smaller is the range for θ , where the small country's taxes are higher under the destination principle than under the origin principle.

Proof. The difference $t_{ecO} - t_{ecD1}$ has a sign of a degree 3 polynomial in θ , and is first negative below a threshold value then positive when θ increases. \square

When one compare tax revenues under both principle, it is straightforward that the large country's tax revenues are always higher under the destination principle (and no cross-bording) than under the origin principle. Considering the small country, even if taxes may be higher or lower in the destination case than in the origin case, tax revenues are always lower in the origin case: this is because the small country's revenues are always decreasing with θ .

Origin vs Destination1	T^N	t^N	R^N	r^N
	$T^N_{ecD1} > T^N_{ecO}$	$t^N_{ecD1} > < t^N_{ecO}$	$R^N_{ecD1} > R^N_{ecO}$	$r^N_{ecD1} > r^N_{ecO}$

Figure 7: ECD1 vs ECO: destination or origin taxation

5 Tax cooperation and Various Harmonization schemes

Without Internet, in a similar setting, Nielsen (2001) shows that:

- (i) A small multilateral reform increasing both taxes would increase tax revenues in both countries.
- (ii) A minimum tax requirement (between taxes at the Nash equilibrium, $t^N < t_{min} < T^N$) increases tax revenues in both countries
- (iii) Harmonization always harms tax revenue in the small country but there exists a common tax between T^N and t^N that increases tax revenues of the large country

5.1 Under the origin principle

We resolve graphically the comparison to the situation without e-commerce. Without e-commerce the reaction functions can be represented in the diagram (t, T) (Figure 8). Reaction functions intersect at the Nash equilibrium point N .

$$T = \frac{\delta(1+b) + t}{2}$$

$$t = \frac{\delta(1-b) + T}{2}$$

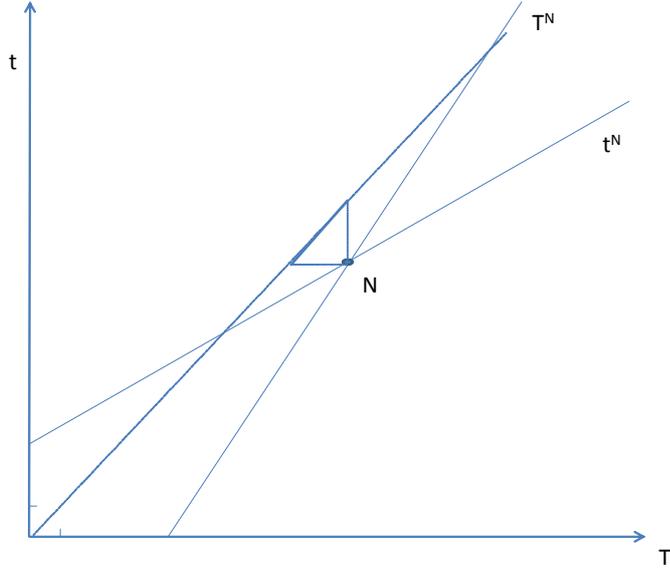


Figure 8: Tax coordination in the CB case

If taxation is origin based and e-commerce possible, the reaction functions are:

$$\begin{aligned}
 T_{ecO}^N &= \frac{\mu}{2}(1+b) + \frac{t}{2}(1-\theta) \\
 t_{ecO}^N &= \left(\frac{1}{(1-\theta)^2 + \theta^2} \right) \left[\frac{\mu}{2}(1-b) + \frac{T}{2}(1-\theta) \right]
 \end{aligned}$$

We represent the reaction functions and the Nash equilibrium in the ECO case in the following figure (Figure 9). The reaction function of the large country in the diagram (t, T) is always steeper in the ECO case than in the CB (cross-border) case (this is because for all $\theta < 1$, $\frac{2}{1-\theta} > 2$). However the intercept may be bigger or smaller: the reaction function in the ECO case is lower if $\frac{\mu}{\delta} > 1 - \theta$, which is the case represented in the next figure. The reaction function of the small country can be either steeper or less steep, higher or lower depending on the parameters. The reaction function is steeper if $\theta < \frac{1}{2}$ and is higher if $\frac{\mu}{\delta} \leq 1 - 2\theta + 2\theta^2$ (and lower otherwise). All cases are represented in the next figure. The dots indicate the Nash equilibria in each case.

A small multilateral reform that increases taxes in both countries has positive effects on both countries. This is comparable to what happens without e-commerce: cross effects of a increase in the neighbor's taxes are positive.

Harmonization would fix a common tax. On the figure it consists of choosing a tax value on the 45° line, between taxes set at the Nash equilibrium i.e. points (t^n, t^n) and (T^N, T^N) . As in the cross-border case, harmonization never benefits the small country,

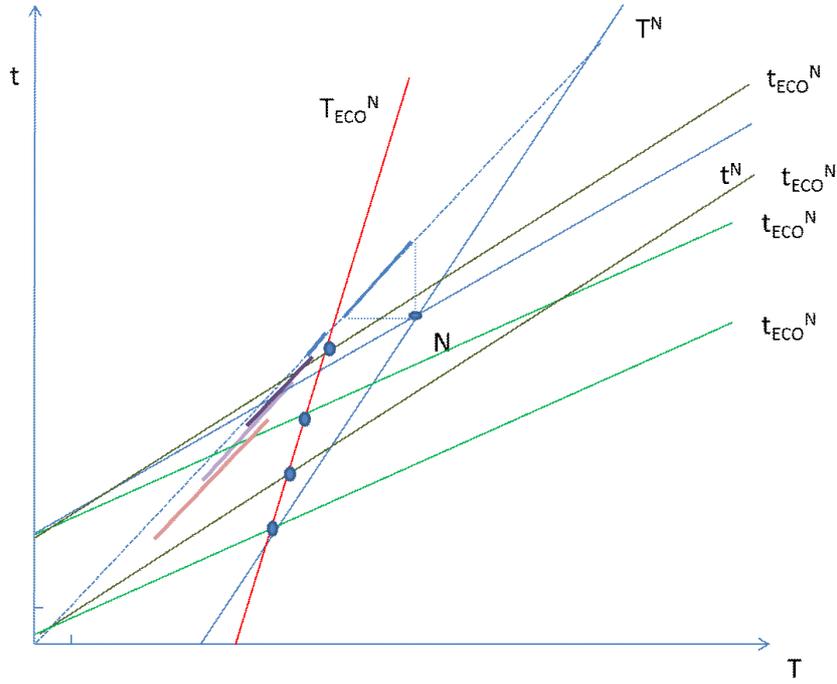


Figure 9: Tax coordination ECO case

since the tax set is always higher than the Nash equilibrium tax, and hence limits tax competition. A common tax can benefit the large country because it allows to tax those consumers who were buying on the Internet and paying the neighbor's tax and this gain could outweigh the loss of taxing less the local consumers. The range for a possible common tax are represented in solid colored lines in the figure.

Let's consider now the range of a possible minimum tax constraint. If a minimum tax is decided, the small country is constrained to set a tax t higher than this minimum tax. The large country is free to respond along its reaction curve. In this case, the differences in taxes will be lower after the minimum tax than before. Moreover, in this Internet economy, a minimum tax reduces more the difference in taxation compared to the effect of a minimum tax in a pre-Internet economy, this is because for an increase of the small economy's tax, the large country increases its tax by $\frac{1}{2}(1 - \theta)$, and this slope is lower than in the CB case. Hence convergence is larger in the ECO case than in the CB case.

5.2 Under the destination principle

If there is no cross-border shopping, there is no tax competition hence no coordination on taxes to be decided for in this game. However there is room for coordination on Internet leakages θ . In our setting we assumed that θ is the same across countries, but this doesn't need to be the case. VAT rules and liabilities are not the same across all countries, hence in a larger setting there is room for coordination on those leakages. If indirect taxation is destination-based, then the share of consumers on the internet is $\frac{\theta}{\mu}T$ in the

large country and $\frac{\theta}{\mu}t$ in the small country. Assume now that each country sets different thresholds for VAT liabilities. It is straightforward that all Internet consumers would buy from a producer localized in the country with the biggest θ . Despite the fact that VAT is destination-based, consumers could still avoid taxation by buying to a producer not liable to VAT in a country with the highest VAT threshold. This is in line with work on transparencies and exchange of information between countries. Under the destination principle, all countries gain at reducing θ .

Eventually, if we are in case ECD2, the reaction functions are:

$$T_{ecD2} = \frac{\mu}{2} \left[\frac{\delta(1+b) + t}{\delta\theta(\theta-1) + \mu} \right]$$

$$t_{ecD2} = \frac{\mu}{2} \left[\frac{\delta(1-b) + T(1 - \frac{\delta\theta}{\mu})}{(\mu + \delta\theta^2)} \right]$$

In this case $s^{ecD} < s^{CB} \iff t < (1 - \frac{\delta\theta}{\mu})T$. Hence $\delta\theta < \mu$ which implies $\delta\theta(1-\theta) < \mu$, hence both slopes of the reaction functions are positive. Now even when taxation is destination-based, because e-commerce doesn't supplant cross-border shopping, there is still tax competition between countries that drives taxes down. The reaction functions have positive slope hence tax harmonization and simultaneous tax increase have the same effects as in the ECO case. However the effects of a minimum tax are now ambiguous. If a minimum tax is decided for that constrain the small country, then the large country reacts along its reaction curve with a slope of $\frac{\mu}{2} \left[\frac{1}{\delta\theta(\theta-1) + \mu} \right]$. This slope is lower than 1 if $2\delta\theta(1-\theta) < \mu$, and higher otherwise. This means that depending on the transaction costs on the Internet, a minimum tax could imply divergence in taxes: if the small country is constrained by the minimum tax, the large country reacts along its reaction function by increasing its taxes by an even larger amount, hence the difference in taxes increases and so does competition. In this case, a minimum tax is harmful.

6 Conclusion

When taxation is origin-based, governments are always better off without than with Internet, this is because like cross-bording, e-commerce allows local consumers to avoid local taxation and moreover they benefit from Internet fiscal leakages. Taxes are expected to increase with the probability of avoiding taxes for a range of small probabilities, then are expected to decrease for large probability of leakage. When taxation is destination-based, e-commerce can coexist with cross-bording. When leakage probability is high enough, and differences in taxation are small enough, e-commerce supplants cross-border shopping. In this case governments may be better off with Internet because tax competition is avoided, or worse off if the leakage probability on internet is too high. Governments would always favor destination-based taxation over origin-based taxation on e-commerce if e-commerce

supplants cross-border shopping.

Tax coordination is altered by the importance of e-commerce and fiscal leakage. If taxation is origin-based, tax coordination is more efficient: this is because, a minimum tax that would constraint the small country could allow the large country to increase less its own taxes , resulting in a larger reduction in tax differences. If taxation is destination-based, and if e-commerce supplants cross-border shopping, then tax coordination is no longer on taxes but on taxes liabilities and leakage. For instance coordination on the minimum amount of sales liable to VAT is to be encouraged. Eventually, If taxation is destination-based, and if e-commerce doesn't supplant cross-border shopping, then coordination may be harmful: a minimum tax may end in a divergence in taxes and more tax competition.

Our results need to be confronted with the increase of e-commerce and tax variations. Europe switch to destination-based taxation on all e-services, could serve as a natural experiment to test the impact of taxation principle on both e-commerce and tax cooperation.

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Optimal Discrimination Ban

Stéphane Gauthier*

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Abstract

This note studies fiscal competition under the origin principle. It shows that any non cooperative symmetric Nash equilibrium arising under this regime implements the first-best optimum when (1) firms cannot use third-price discrimination based on consumer location, and (2) consumers display a home bias for the domestic products. These two conditions are plausibly satisfied in the context of electronic eBay-like commerce.

JEL codes: D4, H21, H77, L13.

Keywords: fiscal competition, origin principle, third-price discrimination, Internet taxes, electronic commerce.

1 Introduction

The issue of whether international and cross-border transactions should be taxed according to the origin or the destination principle is widely debated, both among academics and tax practitioners. Taxation within the boundaries of the US is ruled by the origin principle: a ‘use tax’ should be paid when completing purchases at merchants located in another tax jurisdiction. This principle is usually found dominated by the destination principle because the latter preserves production efficiency. Lockwood (2001) indeed discusses various reforms Pareto improving upon non cooperative Nash equilibria arising under the origin principle. Transactions within the EU that involve a final consumer were also ruled by the origin principle, but since the 1st of January 2015 all transactions are taxed according to the location of the buyer. This reform accords with OECD principles for consumption taxes that recommend taxation in the jurisdiction where consumption takes place.

This note provides a simple example where the outcome of fiscal competition under the origin principle maximizes the world social surplus, and so coincides with the destination principle. This example hinges on two features of Internet transactions and electronic commerce: the first one relies on the e-commerce technology and the second one relates to preferences of the consumers.

In the traditional commerce there is no technological constraints preventing firms to use third-price discrimination strategies by varying the price of its products according to the countries where it exports. On the contrary e-commerce involves platforms that render difficult discrimination

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based on the location of the consumers: a seller using eBay chooses a producer (net-of-tax) price that is simultaneously advertised in several countries with possibly different tax legislations. The product is available to each consumer in this large aggregate market at the net-of-tax price plus the local taxes. In this event, third-price discrimination based on location is not feasible.¹

In these large aggregate markets consumers can find many similar products sold by different firms. Anecdotal evidence suggest that in general they have some preference for the goods produced domestically (see, e.g., Oberecker et al., 2008). Such a home bias partly comes from shipping and transaction costs. It might also be due to perceived risks (potential losses of resources) associated with purchasing abroad: the transaction can be found as less secured because of possible Internet fraud, lack of information protection, or because differences in e-commerce legislations provide weak insurance against, say, random quality of the product. Ellison and Ellison (2009) provides recent empirical evidence from the pricewatch.com search engine that consumers pay attention to geography within US. They find that one extra day shipping time reduces demand by about 5% and that consumers also have an additional preference for buying from in-state firms equivalent to a two dollar price difference.

In contrast to the existing literature this note provides an equivalence result between origin and destination principles. From a global transnational viewpoint cross-border trade is suboptimal in the presence of a home bias: the first-best optimum involves no international trade. This note shows that, in the presence of a home bias, symmetric non cooperative Nash equilibria for consumption taxes obtained under the origin principle implement the first-best pattern of trade when firms cannot use third-price location based discrimination. If firms can post different prices in different countries, tax authorities have incentives to depart unilaterally from the first-best outcome: a lower tax at home implies that new foreign consumers buy domestic products, yields more profit to domestic firms and more collected taxes at home. If, on the contrary, firms cannot discriminate, then the home bias implies that firms find valuable to serve their own market in priority. Thus, by symmetry, they only serve their own domestic market. The first-best trade pattern obtains in symmetric Nash equilibria under the origin principle.

2 General setup

We consider an economy with two different countries indexed by i and $j \neq i$. Each country is populated by one single firm and a continuum of consumers with total unit mass. The two firms produce the same good at constant marginal cost c , $c \geq 0$. Each consumer buys at most one unit of the good. Consumers differ according to their preference θ for the domestic good. Consumer θ get a gross surplus v ($v > c$) from one unit of the foreign good, and $v + \theta$ from one unit of the domestic good. The parameter θ has log-concave cumulative distribution function F taking values in $[\theta^{\text{inf}}, +\infty)$. We assume that $\theta^{\text{inf}} \geq 0$, i.e., there is a home bias. The government of each country designs some income transfer T to the residents. This transfer is financed by commodity taxation.

¹In fact an eBay seller can use a blocking procedure preventing buyers from specific countries or regions from purchasing its product by setting suitable ‘buyer requirements’. In principle it cannot choose different prices for the same item in different eBay sites. The blocking procedure is therefore useless for discrimination purpose. In practice a fraudulent seller could masquerade its identity and create separate listings for each eBay site and then use the blocking procedure to implement discrimination. In order to avoid automatic detection by eBay bots sellers would then possibly introduce minor differences in their listings, e.g., in the item description or the abbreviation of the seller’s country.

In principle taxes are allowed to depend on the location of the consumer and the location of the firm. A resident of country i faces the excise tax t_i when she chooses the domestic variant, and t_j^* when she buys the foreign variant. Under the origin principle, $t_i = t_i^*$ and $t_j = t_j^*$.

Let p and p^* be the net-of-tax unit prices of a good purchased by the domestic and foreign consumers, respectively. The price paid by a consumer located in country i when purchasing the domestic variant is p_i while foreign consumers (from country j) pay p_j^* to consume this same good. A consumer from country i thus gets $v + \theta + T_i - p_i - t_i$ when purchasing the domestic variant, and $v + T_i - p_j^* - t_j$ when purchasing the foreign variant. Utility is 0 otherwise.

The social surplus from a consumer θ is $v + \theta - c$ when she consumes the domestic variant, and only $v - c$ when she consumes the foreign variant. The social optimum thus involves no trade across countries, all the domestic consumers being endowed with one unit of the domestic variant.

3 Competition under the origin principle

When third-price discrimination based on location is feasible, a firm can design different prices for domestic and foreign consumers. A consumer θ located in country i consumes the domestic variant if

$$v + \theta - p_i - t_i \geq \max \{0, v - p_j^* - t_j\}$$

and consumes the foreign variant if

$$v - p_j^* - t_j \geq \max \{0, v + \theta - p_i - t_i\}.$$

She does not consume otherwise. In the sequel we set v large enough so that every consumer always prefers to purchase some product.

It is assumed that first the two tax authorities simultaneously set their tax rates t_i and t_j and then firms compete in prices. Consumers from country i with

$$\theta \geq \bar{\theta}_i \equiv \sup \left\{ \theta^{\text{inf}}, (p_i + t_i) - (p_j^* + t_j) \right\} \quad (1)$$

choose the domestic variant, i.e., the variant produced by firm i . The remaining domestic consumers choose the foreign variant.

Given (t_i, t_j) and (p_j, p_j^*) firm i chooses a pair of prices (p_i, p_i^*) maximizing its profit

$$[1 - F(\bar{\theta}_i)] (p_i - c) + F(\bar{\theta}_j) (p_i^* - c).$$

The possibility given to the firms of using third-price discrimination implies that competition for attracting country i consumers can be made independently of competition for country j consumers. That is, Nash equilibrium prices p_i and p_j^* satisfy

$$p_i = \arg \max_{p_i} [1 - F(\bar{\theta}_i)] (p_i - c), \quad (2)$$

$$p_j^* = \arg \max_{p_j^*} F(\bar{\theta}_i) (p_j^* - c), \quad (3)$$

with $\bar{\theta}_i$ defined by (1). The equilibrium prices p_j and p_i^* satisfy similar programs, with index i (resp., j) replaced by j (resp., i).

Lemma 1. *Let (t_i, t_j) be given. There is a Nash equilibrium in prices where all the domestic consumers are served by the domestic firm in each country if and only if*

$$|t_j - t_i| \leq \theta^{\text{inf}} - \frac{1}{f(\theta^{\text{inf}})}.$$

This requires $\theta^{\text{inf}} f(\theta^{\text{inf}}) \geq 1$.

Proof. Let (t_i, t_j) be given. Consider first firm i in its own domestic market. The best price among $p_i \leq \theta^{\text{inf}} + p_j^* + t_j - t_i$ is the highest one, since all these prices yield the same level of demand. From this situation, concavity property of the profit function implies that there is no profitable (higher) price if and only if the profit $[1 - F(\bar{\theta}_i)](p_i - c)$ is nonincreasing at $p_i = \theta^{\text{inf}} + p_j^* + t_j - t_i$. This is the case if and only if $1 \leq f(\theta^{\text{inf}})(p_i - c)$ at this point.

A similar argument applies to firm j . Given (t_i, t_j) and p_i any price $p_j^* \geq p_i + t_i - t_j - \theta^{\text{inf}}$ yields zero demand to this firm, and so zero profit. By concavity of the profit function, it is not profitable to set a lower price if and only if a marginal decrease in p_j^* from $p_i + t_i - t_j - \theta^{\text{inf}}$ does not raise profit, i.e., $p_j^* - c \leq 0$ at this point.

Hence, given (t_i, t_j) , a Nash equilibrium in prices in country i involves all the consumers from this country purchasing the domestic product if and only if there exist (p_i, p_j^*) satisfying $p_i + t_i = \theta^{\text{inf}} + p_j^* + t_j$ such that both $1 \leq f(\theta^{\text{inf}})(p_i - c)$ and $p_j^* - c \leq 0$. This is the case if and only if

$$t_j - t_i \geq \frac{1}{f(\theta^{\text{inf}})} - \theta^{\text{inf}}.$$

By symmetry, permuting the indices i and j yields the condition for all the consumers in country j to choose the variant produced by firm j in a Nash equilibrium in prices. The result follows. \square

As expected, Nash equilibria involving no international trade obtain when there is a strong enough home bias, and provided that tax rate differences do not blur the home bias impact.

This configuration is of particular interest since an equilibrium satisfying the conditions given in Lemma 1 implements the first-best pattern of trade. In the case where the two tax rates t_i and t_j are close enough, there are Nash equilibria consistent with the first-best pattern of trade provided that the home bias is large enough $\theta^{\text{inf}} f(\theta^{\text{inf}}) \geq 1$. The social surplus is then

$$\int_{\theta^{\text{inf}}}^{+\infty} (v + \theta - c) dF(\theta).$$

The issue is whether governments might choose tax rates (t_i, t_j) that yield such an outcome. For arbitrary thresholds $\bar{\theta}_i$ and $\bar{\theta}_j$ the consumers from country i get a total surplus equal to

$$v + T_i - \int_{\theta^{\text{inf}}}^{\bar{\theta}_i} (p_j^* + t_j) dF(\theta) + \int_{\bar{\theta}_i}^{+\infty} (\theta - (p_i + t_i)) dF(\theta),$$

and the total profit of firm i is

$$[1 - F(\bar{\theta}_i)](p_i - c) + F(\bar{\theta}_j)(p_i^* - c).$$

Finally, for the transfer T_i to be financed by the total collected taxes, it must be that

$$t_i [1 - F(\bar{\theta}_i) + F(\bar{\theta}_j)] = T_i.$$

The social surplus is consequently

$$v + \int_{\bar{\theta}_i}^{+\infty} (\theta - c) dF(\theta) - (p_j^* + t_j) F(\bar{\theta}_i) + (p_i^* + t_i - c) F(\bar{\theta}_j). \quad (4)$$

The following result shows that the first-best pattern of trade cannot arise when the tax authorities choose t_i and t_j maximizing (4) by taking into account that prices are set in accordance to (2) and (3).

Proposition 1. *Consider a Nash equilibrium in prices such that each consumer buys one unit of the domestic product. Suppose that the domestic demand for the domestic good is then locally nonincreasing in the domestic tax rate for some country. This country always has a local incentive to reduce its own tax rate to attract the consumers of the remaining country.*

Proof. Suppose that the tax rates (t_i, t_j) satisfy the conditions given in Lemma 1 and suppose that the initial situation is a Nash equilibrium in prices where all the consumers purchase the domestic variant of the product. We have

$$(p_i + t_i) - (p_j^* + t_j) = (p_j + t_j) - (p_i^* + t_i) = \theta^{\text{inf}}.$$

Given t_j a small change dt_i yields a change in country i surplus equal to

$$-(\theta^{\text{inf}} - c + p_j^* + t_j) f(\theta^{\text{inf}}) \sup \left\{ 0, \frac{\partial \bar{\theta}_i}{\partial t_i} dt_i \right\} + (p_i^* + t_i - c) f(\theta^{\text{inf}}) \sup \left\{ 0, \frac{\partial \bar{\theta}_j}{\partial t_i} dt_i \right\},$$

with

$$\frac{\partial \bar{\theta}_i}{\partial t_i} = \frac{\partial p_i}{\partial t_i} - \frac{\partial p_j^*}{\partial t_i} + 1$$

and

$$\frac{\partial \bar{\theta}_j}{\partial t_i} = \frac{\partial p_j}{\partial t_i} - \frac{\partial p_i^*}{\partial t_i} - 1.$$

The profit functions make prices p_i and p_j^* dependent on the difference $t_i - t_j$. By symmetry, we have consequently

$$\frac{\partial p_i}{\partial t_i} = -\frac{\partial p_i}{\partial t_j} = \frac{\partial p_j}{\partial t_j} = -\frac{\partial p_j}{\partial t_i},$$

and

$$\frac{\partial p_j^*}{\partial t_i} = -\frac{\partial p_j^*}{\partial t_j} = \frac{\partial p_i^*}{\partial t_j} = -\frac{\partial p_i^*}{\partial t_i}.$$

It immediately follows

$$\frac{\partial \bar{\theta}_i}{\partial t_i} = -\frac{\partial \bar{\theta}_j}{\partial t_i} > 0,$$

where the last inequality follows from the assumption that domestic demand $1 - F(\bar{\theta}_i)$ is nonincreasing in t_i . Then, a marginal reduction in the domestic tax rate $dt_i < 0$ implies a change in domestic surplus equal to

$$-(p_i^* + t_i - c) f(\theta^{\text{inf}}) \frac{\partial \bar{\theta}_i}{\partial t_i} dt_i > 0.$$

This concludes the proof. \square

When country i reduces its tax rate t_i from the first-best pattern of trade, the domestic demand for the domestic good does not change, and so the domestic demand for the foreign good cannot change (it remains 0). The only consequence of a lower tax rate in country i is to attract foreign consumers with the lowest home bias. This yields more profit to firm i and more collected tax to country i , thus improving the surplus of this country. As a consequence, in line with the main stand of the literature (see, e.g., Lockwood, 2001) the social optimum cannot be the outcome of competition under the origin principle.

4 Competition through eBay

The eBay-like technology makes difficult for firms to use discrimination based on consumers' location. In the polar case where discrimination is not feasible at all, each firm must set the same price in both markets. Let p_i be the price chosen by firm i . Demand in country i is $1 - F(\bar{\theta}_i) + F(\bar{\theta}_j)$ where $\bar{\theta}_i = \sup\{\theta^{\text{inf}}, (p_i + t_i) - (p_j + t_j)\} = -\bar{\theta}_j$. Firm i must serve all the domestic consumers to be in a position to intervene in the foreign market. In any symmetric equilibrium, $p_i = p_j$ and $t_i = t_j$ so that $\bar{\theta}_i = \bar{\theta}_j = \sup\{\theta^{\text{inf}}, 0\} = \theta^{\text{inf}}$. This shows immediately that:

Proposition 2. *In the absence of discrimination any symmetric equilibrium coincides with the socially optimal outcome.*

REMARK. Unlike the conventional wisdom that the development of eBay-like commerce is associated with some form of globalization, Proposition 2 involves no international trade in equilibrium. Electronic commerce instead isolates countries.

As a result the outcome of competition under the origin and destination principle coincide. A prediction from Proposition 2 is therefore that the 1st of January, 2015 VAT reform from the origin to the destination principle implemented in the EU should have a low impact on strategies used by firms involved in e-commerce, compared to those involved in traditional retail commerce.

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