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Fusion et Groupage en Différenciation Verticale

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Résumé

Cette thèse est composée de trois essais portant sur la fusion et le groupage (*bundling*) de produits et de services verticalement différenciés.

Le premier essai étudie la fusion horizontale de firmes qui produisent un bien différencié par la qualité. Nous examinons d'abord le cas où seuls les coûts fixes dépendent de la qualité, puis celui où ce sont les coûts variables moyens qui dépendent de la qualité. Nous montrons: (i) que quand les coûts sont fixes, alors la firme fusionnée ne produit qu'une seule qualité; et (ii) que quand les coûts sont variables, alors la firme fusionnée produit deux qualités mais l'écart des qualités est plus faible que celui avant la fusion. Nous montrons que la firme fusionnée choisit les mêmes qualités qu'un planificateur social. Nous prouvons que la fusion diminue le bien-être total quelque soit la structure des coûts. Lorsque nous comparons l'effet sur le bien-être total des ajustements de prix seuls à l'effet conjoint sur le bien-être total des ajustements de prix et des qualités, nous trouvons que la réduction de bien-être due à l'effet conjoint est plus forte quand ce sont les coûts fixes plutôt que les coûts variables qui dépendent de la qualité. Nous discutons des implications de ce dernier résultat en termes de gain de bien-être pour les défenses d'efficiences de fusions.

Le second essai analyse l'incitation d'une firme de grouper deux biens quand elle fait face à une firme rivale qui produit l'un de ces biens. Nous montrons que la décision de groupage du monopoleur de l'une des composantes dépend de la qualité de la composante non monopolisée. Nous prouvons: (i) que le groupage n'est pas profitable pour le monopoleur de l'une des composantes si la composante complémentaire qu'il produit a une qualité supérieure à celle de son concurrent; et (ii) que le groupage est profitable pour le monopoleur si la composante complémentaire qu'il produit a une qualité inférieure à celle de son concurrent. La raison pour laquelle la vente séparée est plus profitable est due au fait qu'elle augmente les parts de marché de la composante monopolisée. Nous considérons aussi un jeu à deux étapes (qualité et prix) et nous déterminons l'équilibre de Nash parfait en sous jeux. Finalement, nous discutons les implications de ces résultats sur la politique de concurrence.

Le troisième essai considère le groupage dans un marché duopolistique où chaque firme offre deux composantes d'un même système de produits. Nous analysons un jeu à deux étapes. Dans la première étape, les firmes choisissent simultanément entre une stratégie de groupage et une stratégie de vente séparée. Ces décisions donnent quatre configurations possibles: (i) une configuration où les deux firmes vendent leurs services séparément ; (ii) une configuration où les deux firmes vendent leurs services en groupe ; et (iii) les deux configurations où une firme vend ses services séparément et l'autre firme vend ses services en groupe. Dans la seconde étape, les firmes choisissent simultanément les prix. Nous montrons que le groupage est une stratégie dominante pour chacune des firmes. En effet, il réduit l'intensité de la concurrence en augmentant la différenciation des services. Nous trouvons aussi que l'équilibre groupage-groupage laisse moins de surplus aux consommateurs et plus de surplus total que la vente séparée des deux composantes.

Mots-clés: antitrust, bien-être social, bundling, complémentarité, fusions, qualité, internet, monopolisation, téléphonie, télévision, politique de concurrence.

Classification JEL : L14, L15, L40, L41, L42

Abstract

This thesis is a collection of three essays on mergers and bundling in vertically differentiated markets.

The first essay studies horizontal mergers of firms producing vertically differentiated goods when the average costs of quality are convex and either fixed or variable in production. We show that in a duopoly: (i) the merged firm produces only one quality if production costs are fixed; and (ii) the merged firm produces the two qualities if production costs are variable. We demonstrate that the social planner chooses the same variety of qualities as the merged firm. In the case of variable production costs, both the social planner and the merged firm choose the same qualities. We find that social welfare is reduced in both cases. We show that this welfare reduction is higher when the production costs are fixed and lower when these costs are variables when compared to horizontal mergers where only prices adjustments are considered and not qualities'. We give implications for efficiencies defence.

The second essay analyzes bundling incentives in markets where products are composed of two complementary components. One of the components is monopolized and the other is sold by a duopoly. We assume quality differentiation between the components. We develop a model of quality competition à la Mussa and Rosen (1978). We demonstrate that the decision of the monopolist to bundle depends on the quality of the component where he faces a rival. We show that: (i) if the monopolist's component has a higher quality than the competitor's, then the monopolist prefers not to bundle (component selling); and (ii) if the quality of monopolist's component is lower than the competitor's, then the monopolist prefers bundling. Thus, the monopolist's incentive not to bundle is related to narrowing of market for its monopolized component. We also consider a dynamic game where firms

compete in two-stages (quality and price) and determine the subgame perfect Nash equilibrium. Finally, we discuss antitrust implications of these results.

The third essay looks at the competition and the welfare effects of bundling in the context of vertically differentiated products. We consider a two-stage game with two asymmetric firms. In the first stage firms simultaneously commit to adopt bundling or component pricing. These decisions give four possible configurations: (i) a configuration where both firms use component pricing; (ii) a configuration where both firms use bundling; and finally (iii) the two configurations where one firm use bundling and the other firm does not. In the second stage firms set simultaneously prices. We show that bundling is a dominant strategy equilibrium for both firms. The reason is that bundling increases the differentiation of services and reduces the intensity of price competition. We also find that although the bundling-bundling equilibrium reduces consumers' surplus, total economic welfare is higher than when both firms use component pricing.

Keywords: antitrust, bundling, complementarity, Internet, mergers, monopolization, quality, social welfare, telephone, television.

JEL Classification: L14, L15, L40, L41, L42

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À mon père Oury Diallo,
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à mes frères et sœurs.

Avant propos

Nous analysons dans cette thèse la fusion horizontale de firmes et le groupage de produits et de services différenciés par la qualité[1].

Le premier essai intitulé "Fusion horizontale, Choix de Qualité, et Bien-être", étudie la mise sous propriété commune de deux firmes qui offrent des produits différenciés verticalement. La question que nous posons et de savoir comment cette opération de fusion influence les choix des prix, des qualités et comment elle affecte le bien-être total. Dans un premier temps nous examinons le cas où la qualité du produit n'influence les coûts des firmes que par l'entremise des coûts fixes. Cette structure de coût est celle des industries ayant une importante activité de R&D comme les industries des logiciels, des biotechnologies et des télécommunications. Nous analysons ensuite la fusion dans le cas où ce sont les coûts variables qui dépendent de la qualité. Cette structure de coût est celle de la plupart des industries de service et de transport. Quand les coûts sont fixes, nous montrons que la firme créée par la fusion ne produit qu'une seule qualité. Alors que quand les coûts sont variables, la firme fusionnée continue de produire deux qualités mais l'écart des qualités est plus faible qu'avant la fusion. Nous montrons que la firme fusionnée choisit les mêmes qualités qu'un planificateur social.

Nous montrons que la fusion diminue le bien-être total quelque soit la structure des coûts. L'effet conjoint sur le bien-être total des ajustements de prix et des qualités est plus important que l'effet sur le bien-être total des ajustements de prix seuls quand ce sont les coûts fixes plutôt que les coûts variables qui dépendent de la qualité. Les effets de qualités ne sont pas généralement pris en compte quand on fait l'examen des effets de bien-être d'une fusion.

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[1] On parle de différenciation verticale ou de différenciation par la qualité lorsque pour des produits donnés, le classement de ces produits est identique pour tous les consommateurs, c'est-à-dire que les consommateurs préfèrent l'un des produits quand les prix sont les mêmes.

C’est une question importante puisqu’aux termes de la Loi canadienne tous les gains de bien-être peuvent constituer une défense au terme de l’article 96 de la Loi sur la concurrence.

Le deuxième essai intitulé "Bundling and Complementarity" analyse l’incitation au groupage de produits différenciés par la qualité. Le groupage est une stratégie de vente qui consiste à offrir plusieurs produits en seul paquet. Lorsque seul l'ensemble des produits est offert on dit que le groupage est pur. Par contre lorsque les composantes de l'ensemble des produits sont offertes aussi bien sous forme de paquet que de façon individuelle, on parle de groupage mixte. Les principales raisons données dans la littérature pour expliquer la pratique du groupage sont: l’impossibilité de pratiquer certaines formes de discrimination par les prix, l’exclusion de nouveaux entrants sur le marché et la réduction de coûts. Le groupage comme instrument de discrimination en prix est fondé sur l'hétérogénéité des choix des consommateurs en matière de disponibilité à payer. Cette stratégie est d'autant plus efficace quand les disponibilités à payer deux produits sont corrélées négativement. Le groupage peut empêcher l'entrée des concurrents sur un marché ou les contraindre à en sortir. En outre, il permet de consolider le pouvoir de marché ou d'adoucir le degré de concurrence. Finalement, le groupage peut permettre la réduction de coûts à l’aide d’économies d’échelles et d’économies de gammes dans la production et dans la distribution.

Notre analyse montre que dans le cas d’un système de deux produits verticalement différenciés, le groupage mixte est équivalent à la vente séparée. Lorsque l’une des composantes d’un système de deux produits verticalement différenciés est monopolisée et l’autre est vendue par deux firmes dont l’une est la firme qui monopolise l’autre composante, nous montrons que la firme qui détient une position de monopole pour l'une des composantes vend ses produits séparément quand la qualité de sa composante non-monopolisée est supérieure à celle de son rival. Dans ce cas, la vente séparée augmente la demande de la composante monopolisée. Quand la qualité de sa composante non-monopolisée est inférieure à celle de son rival, elle vend ses produits en groupe puisque la vente séparée réduit la demande de la composante vendue en concurrence. Nous montrons qu'il peut y avoir exclusion du rival et réduction du bien-être total lorsqu'il y'a groupage. Ces effets anticoncurrentiels ont des conséquences importantes en termes de politique de concurrence puisque la plupart des industries de logiciels ont une structure de marché identique à celle de notre analyse.

Comme la majorité des produits et services sont offerts dans un environnement non-monopolistique, nous élargissons notre analyse précédente dans un marché duopolistique où chaque firme offre deux composantes d'un même système de services. Dans ce troisième essai intitulé "Bundling in Communication Markets", la consommation d'un service est indépendante de celle de l'autre service. Par exemple une firme de télécommunication peut offrir un service de téléphonie seul ou un service de téléphonie combiné avec d'autres services comme l'internet et la télévision. Nous supposons que les services sont verticalement différenciés et nous analysons un jeu à deux étapes. Dans la première étape, les firmes choisissent simultanément entre une stratégie de groupage et une stratégie de vente séparée. Dans cette premier étape quatre configurations émergent: (i) une configuration où les deux firmes vendent leurs services séparément ; (ii) une configuration où les deux firmes vendent leurs services en groupe ; et (iii) les deux configurations où une firme vend ses services séparément et l’autre firme vend ses services en groupe. Dans la seconde étape, les firmes choisissent simultanément les prix. Nous montrons que la stratégie de groupage est un instrument de différenciation des services et qu’elle est une stratégie dominante pour chacune des firmes. Nous trouvons aussi que l’équilibre groupage-groupage laisse moins de surplus aux consommateurs et plus de surplus total que la vente séparée des deux composantes.

CHAPITRE 1

Fusion Horizontale, Choix de Qualité, et Bien-être

1.1 Introduction

La fusion est une opération par laquelle des firmes indépendantes se regroupent sous propriété commune. Il existe plusieurs types de fusions: la fusion de firmes d'une même industrie produisant des biens et services identiques ou similaires appelée *fusion horizontale;* la fusion d'une firme produisant un bien intermédiaire et d'une firme produisant un bien final qui utilise le bien intermédiaire comme intrant appelée *fusion verticale;* et enfin la fusion de firmes produisant des biens différents et indépendants appelée *fusion conglomérale.*

Les effets des fusions horizontales ont été étudiés pour des biens homogènes (Farrell et Shapiro, 1990) et des biens horizontalement différenciés (Deneckere et Davidson, 1985). Notre étude porte sur la fusion horizontale de firmes qui produisent des biens différenciés par la qualité, c'est à dire que tous les consommateurs préfèrent l'un des biens quand les prix des deux biens sont les mêmes. La question que nous posons et de savoir comment la fusion influence les choix des prix, des qualités, et comment elle affecte le bien-être.

Nous examinons dans un premier temps le cas où la qualité du produit n'influence les coûts des firmes que par l'entremise des coûts fixes. Cette structure de coût caractérise bon nombre d'industries à forte intensité de R&D pour lesquelles une amélioration de la qualité des produits provient d'investissements qui servent à développer de nouvelles techniques. Les coûts variables y sont souvent très faibles. On pense notamment à l'industrie des logiciels pour laquelle les coûts de fabrication sont très faibles par rapport aux coûts d'ingénierie pour développer de nouveaux programmes. On pense aussi aux industries de biotechnologie et aux télécommunications. Nous analysons ensuite le cas où ce sont les coûts variables qui dépendent de la qualité. Cette structure de coût caractérise les industries de service et de transport.

Nous montrons que la fusion horizontale entraîne la disparition d'une des qualités lorsque seuls les coûts fixes dépendent de la qualité et que les coûts variables sont nuls. La qualité proposée après fusion est comprise entre les qualités proposées avant fusion. Nous montrons aussi que lorsque les coûts variables sont nuls, un planificateur social choisit de produire une seule qualité à un niveau supérieur aux qualités choisies par les firmes avant et après fusion.

Quand ce sont les coûts variables moyens qui dépendent de la qualité, la firme fusionnée produit deux qualités. Ces qualités sont identiques à celles proposées par un planificateur social. Nous trouvons aussi que : (i) la qualité supérieure produite après fusion est plus faible que la qualité supérieure produite avant fusion; et (ii) la qualité inférieure produite après fusion est plus élevée que la qualité inférieure produite avant fusion. Donc l'écart des qualités est plus faible après fusion qu'avant fusion.

Pour les deux types de coûts, nous examinons les effets de la fusion sur le bien-être total. Nous montrons que la fusion diminue toujours le bien-être total. Nous comparons aussi l'effet sur le bien-être des ajustements de prix seuls à l'effet conjoint sur le bien-être des ajustements de prix et des qualités. Nous montrons que la réduction de bien-être due à l'effet conjoint est plus forte lorsque ce sont les coûts fixes plutôt que les coûts variables qui dépendent de la qualité.

Notre méthodologie est proche de celle d'Economides (1999) qui étudie l'intégration verticale de deux firmes qui produisent chacune une composante d'un système de deux biens complémentaires. Il suppose que les qualités des composantes sont les mêmes et que seuls les coûts fixes dépendent de la qualité. Il montre que l'intégration verticale conduit à des prix plus faibles, un profit total de la firme intégrée plus élevé et une qualité du système supérieure à celle qui prévaut en absence d'intégration. Notre étude est également proche de celle d'Amacher et al. (2003) qui comparent les choix d'un duopole à ceux d'un planificateur social mais uniquement pour une fonction de coûts quadratique en qualité. Ils ne parlent pas de fusion dans leur étude. Notre analyse est plus générale. En effet (i) nous examinons les cas où la qualité affecte soit les coûts fixes, soit les coûts variables moyens et nous faisons l'hypothèse que ces coûts sont des fonctions croissantes et convexes en qualité ; et (ii) nous examinons l'effet de la fusion d'un duopole sur le bien-être en tenant compte de l'effet conjoint sur le bien-être des ajustements de prix et des qualités.

Le texte se structure de la façon suivante : dans la section 1.2, nous présentons les préférences des consommateurs, les fonctions de demande qui en résultent, et les structures de coûts. Dans la section 1.3, nous comparons les équilibres de chaque structure de marché pour le cas où seuls les coûts fixes dépendent de la qualité. Nous analysons le cas où ce sont les coûts variables qui dépendent de la qualité dans la section 1.4. Dans la section 1.5, nous présentons des applications numériques et nous examinons l'effet conjoint des ajustements de prix et des qualités pour une fonction de coût spécifique. Nous concluons l'analyse dans la section 1.6.

1.2 Hypothèses et notations

Chaque consommateur achète soit une unité de bien, soit rien. Un consommateur de type θ qui achète une unité d'un produit de qualité s au prix p reçoit un surplus de:

$$U_\theta(s,p) = \theta s - p \text{, où } p \geq 0 .$$

Le paramètre θ est distribué sur $[0,1]$ selon une fonction de distribution $F(\theta)$. Si un consommateur choisit de ne pas acheter, il reçoit son utilité de référence que nous normalisons à zéro.

Nous supposons qu'il existe deux types de biens qui se différencient par leur qualité. Soient p_h et s_h, respectivement le prix et la qualité du bien de qualité supérieure et p_l et s_l, respectivement le prix et la qualité du bien de qualité inférieure ($s_h > s_l$). Le marché est servi par deux firmes indépendantes, firme *h* et firme *l* qui produisent respectivement les qualités s_h et s_l[1]. Le jeu se déroule en deux étapes. À la première étape les firmes choisissent simultanément leur qualité. À la seconde étape elles choisissent simultanément les prix.

La demande pour chaque bien dépend des prix et des qualités. Nous désignons par $\overline{\theta}$ le consommateur indifférent entre ne rien acheter et acheter le bien de qualité inférieure, et $\widetilde{\theta}$ le consommateur indifférent entre acheter le bien de qualité inférieure et le bien de qualité supérieure.

Pour obtenir la fonction de demande pour chaque bien, nous nous servons des contraintes de participation *(CP)* et des contraintes d'auto-sélection *(CA)* de chaque consommateur. Le consommateur du bien de qualité inférieure satisfait les contraintes suivantes :

$$\theta s_l - p_l \geq 0 \quad , \qquad (CP\ l)$$

$$\theta s_l - p_l \geq \theta s_h - p_h \quad . \qquad (CA\ l)$$

Quant au consommateur du bien de qualité supérieure, il satisfait les contraintes suivantes :

$$\theta s_h - p_h \geq 0 \quad , \qquad (CP\ h)$$

$$\theta s_h - p_h \geq \theta s_l - p_l \quad . \qquad (CA\ h)$$

---

[1] Quand $s_h = s_l$, alors les deux biens sont identiques pour les consommateurs et les deux firmes se font une concurrence à la Bertrand. Cette concurrence implique un prix égal au coût marginal et donc un profit nul, où négatif si les coûts fixes sont non nuls. Ainsi nous supposons que $s_h > s_l$ et que la firme *l* n'a pas d'incitation de passer par dessus de la firme h, c'est à dire de produire une qualité $s_l > s_h$.

De la contrainte *(CP l)* nous obtenons $\overline{\theta} = \frac{p_l}{s_l}$. Nous supposons que le bien de qualité inférieure n'est pas dominé par le bien de qualité supérieure, c'est à dire la *qualité par unité de prix* de *l* est supérieure à celle de *h*, $\frac{s_l}{p_l} \geq \frac{s_h}{p_h}$[2]. Puisque le consommateur $\widetilde{\theta}$ est indifférent entre les deux qualités, nous avons $\widetilde{\theta} = \frac{p_h - p_l}{s_h - s_l}$.

Les consommateurs dont $\theta \in [0, \overline{\theta}]$ n'achètent rien puisque *(CP l)* n'est pas satisfait, ceux dont $\theta \in [\overline{\theta}, \widetilde{\theta}]$ achètent le bien de qualité inférieure et ceux dont $\theta \in [\widetilde{\theta}, 1]$ achètent le bien de qualité supérieure. Si nous notons par $D_h(p_h, p_l, s_h, s_l)$ et $D_l(p_h, p_l, s_h, s_l)$ la demande respective des biens de qualité *h* et *l*, alors :

$$D_h(p_h, p_l, s_h, s_l) = 1 - F(\widetilde{\theta}),$$

$$D_l(p_h, p_l, s_h, s_l) = F(\widetilde{\theta}) - F(\overline{\theta}).$$

La forme générale de la fonction de coût total de production est $C(q,s)$, ou q représente le niveau de production et s le niveau de qualité du produit. Nous supposons dans un premier temps que :

$$C(q,s) = g(s) + q \text{, où } q = 0,\ g'(s) > 0,\ g''(s) > 0, \text{ et } g(0) = 0.$$

Dans un second temps nous supposons :

$$C(q,s) = qc(s) \text{, où } c'(s) > 0,\ c''(s) > 0, \text{ et } c(0) = 0.$$

---

[2] Le cas contraire, $\frac{s_l}{p_l} \leq \frac{s_h}{p_h}$ impliquera une demande nulle pour le bien de qualité inférieure, ce qui n'est pas très intéressant à étudier. Voir Tirole (1988).

1.3 Seuls les coûts fixes dépendent de la qualité

1.3.1 Duopole

Les profits de la firme *h* sont :

$$\pi_h^D(p_h^D, p_l^D, s_h^D, s_l^D) = p_h^D[1 - F(\tilde{\theta}^D)] - g(s_h^D) \ . \tag{1.1}$$

Les profits de la firme l sont :

$$\pi_l^D(p_h^D, p_l^D, s_h^D, s_l^D) = p_l^D[F(\tilde{\theta}^D) - F(\bar{\theta}^D)] - g(s_l^D) \ . \tag{1.2}$$

L'indexe *D* indique qu'il s'agit d'un duopole. p_h^D et p_l^D sont les prix et $\tilde{\theta}^D = \dfrac{p_h^D - p_l^D}{s_h^D - s_l^D}$ et $\bar{\theta}^D = \dfrac{p_l^D}{s_l^D}$ sont respectivement les paramètres de préférence des consommateurs marginaux de la qualité supérieure et inférieure. Les conditions de premier ordre sont :

$$1 - F(\tilde{\theta}^D) - \frac{p_h^D}{s_h^D - s_l^D} f(\tilde{\theta}^D) = 0, \tag{1.3}$$

$$F(\tilde{\theta}^D) - F(\bar{\theta}^D) - \frac{p_l^D}{s_h^D - s_l^D} f(\tilde{\theta}^D) - \frac{p_l^D}{s_l^D} f(\bar{\theta}^D) = 0. \tag{1.4}$$

Pour une distribution uniforme de θ sur $[0,1]$, cela donne :

$$p_h^D = \frac{2s_h^D(s_h^D - s_l^D)}{4s_h^D - s_l^D} \quad , \tag{1.5}$$

$$p_l^D = \frac{s_l^D(s_h^D - s_l^D)}{4s_h^D - s_l^D} \quad . \tag{1.6}$$

En substituant (1.5) et (1.6) dans (1.1) et (1.2), et en maximisant par rapport aux qualités, nous obtenons :

$$g'(s_h^D) = \frac{2s_h^D(2s_h^D - s_l^D)}{(4s_h^D - s_l^D)^2} + \frac{6s_h^D(s_l^D)^2}{(4s_h^D - s_l^D)^3} , \tag{1.7}$$

$$g'(s_l^D) = \frac{[s_h^D - s_l^D][4(s_h^D)^2 - 2(s_h^D)^2]}{(4s_h^D - s_l^D)^3}. \tag{1.8}$$

1.3.2 Firme Fusionnée

Les profits de la firme fusionnée que nous indexons par *m* sont :

$$\pi^m(p_h^m, p_l^m, s_h^m, s_l^m) = p_h^m[1 - F(\tilde{\theta}^m)] + p_l^m[F(\tilde{\theta}^m) - F(\bar{\theta}^m)] - g(s_h^m) - g(s_l^m), \tag{1.9}$$

où p_h^m, et p_l^m sont les prix, et $\tilde{\theta}^m = \dfrac{p_h^m - p_l^m}{s_h^m - s_l^m}$ et $\bar{\theta}^m = \dfrac{p_l^m}{s_l^m}$ sont respectivement les paramètres de préférence des consommateurs marginaux de la qualité supérieure et inférieure.

La maximisation du profit par rapport aux prix entraîne les conditions de premier ordre suivantes :

$$1 - F(\tilde{\theta}^m) - \frac{p_h^m}{s_h - s_l} f(\tilde{\theta}^m) + \frac{p_l^m}{s_h - s_l} f(\tilde{\theta}^m) = 0,$$

$$F(\tilde{\theta}^m) - F(\bar{\theta}^m) + \frac{p_h^m}{s_h - s_l} f(\tilde{\theta}^m) - \frac{p_l^m}{s_h - s_l} f(\tilde{\theta}^m) - \frac{p_l^m}{s_l} f(\bar{\theta}^m) = 0.$$

Nous pouvons les ré- écrire de la façon suivante :

$$\tilde{\theta}^m = \frac{1 - F(\tilde{\theta}^m)}{f(\tilde{\theta}^m)} \;, \tag{1.10}$$

$$\bar{\theta}^m = \frac{1 - F(\bar{\theta}^m)}{f(\bar{\theta}^m)}. \tag{1.11}$$

Si nous supposons que $\frac{f(\theta)}{1-F(\theta)}$ qui est le *taux de hasard* [3] de la distribution des θ est monotone, alors la fonction inverse du taux de hasard $\frac{1-F(\theta)}{f(\theta)}$ est aussi monotone en θ. Et dès lors nous pouvons utiliser (1.10) et (1.11) pour comparer $\tilde{\theta}^m$ à $\bar{\theta}^m$.

<u>Lemme 1.1</u>: *La fusion réduit le nombre de qualités à une seule.*

Preuve :

Les conditions (1.10) et (1.11) entraînent $\tilde{\theta}^m = \bar{\theta}^m$. Cela implique $F(\tilde{\theta}^m) = F(\bar{\theta}^m)$. Dès lors la demande pour la qualité inférieure $[F(\tilde{\theta}^m) - F(\bar{\theta}^m)]$ est égale à zéro.

Donc le profit après fusion s'écrit :

$$\pi^m(p^m, s^m) = p^m[1 - F(\bar{\theta}^m)] - g(s^m). \qquad (1.12)$$

Pour une distribution uniforme de θ sur $[0,1]$, le prix et la qualité qui maximisent (1.12) sont :

$$p^m = \frac{s^m}{2}, \qquad (1.13)$$

$$g'(s^m) = \frac{1}{4}. \qquad (1.14)$$

Nous allons maintenant comparer les qualités avant fusion à la qualité après fusion.

<u>Lemme 1.2</u> : *La qualité après fusion est comprise entre les qualités avant fusion.*

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[3] Pour comprendre pourquoi cette fonction s'appelle *taux de hasard*, supposons que l'on se déplace le long de l'axe des θs de 0 vers 1 et l'on élimine les θs qui sont dépassés. Un déplacement à partir d'un θ de $d\theta$ vers la droite donne que la probabilité conditionnelle que le type du consommateur soit à la fois inclus dans $[\theta, \theta + d\theta]$ et soit éliminé est $\frac{f(\theta)}{1 - F(\theta)} d\theta$. Le taux de hasard de la plupart des fonctions de distribution (Normale, Exponentielle, et Uniforme) est monotone.

Preuve :

Nous montrons d'abord que $s^m > s_l^D$ (I), puis ensuite que $s_h^D > s^m$ (II).

(I) - $s^m > s_l^D$ si et seulement si $g'(s^m) > g'(s_l^D)$. En vertu de (1.8) et (1.14), cette condition est satisfaite si:

$$\frac{1}{4} > \frac{[s_h^D - s_l^D][4(s_h^D)^2 - 2(s_h^D)^2]}{(4s_h^D - s_l^D)^3}$$

$$\Leftrightarrow [4s_h^D - s_l^D][16(s_h^D)^2 - 8s_h^D s_l^D + (s_l^D)^2] > [4(s_h^D - s_l^D)][4(s_h^D)^2 - 2(s_l^D)^2]$$

Or $4s_h^D - s_l^D > 4(s_h^D - s_l^D)$ et $[16(s_h^D)^2 - 8s_h^D s_l^D + (s_l^D)^2] > [4(s_h^D)^2 - 2(s_l^D)^2]$. Cela prouve :

$$s^m > s_l^D.$$

(II) - $s_h^D > s^m$ si et seulement si $g'(s_h^D) > g'(s^m)$. En vertu de (1.7) et (1.14), cette condition est satisfaite si :

$$\frac{2s_h^D(2s_h^D - s_l^D)}{(4s_h^D - s_l^D)^2} + \frac{6s_h^D(s_l^D)^2}{(4s_h^D - s_l^D)^3} > \frac{1}{4}$$

$$\Leftrightarrow 4s_h^D[16(s_h^D)^2 - 6s_h^D s_l^D + 8(s_l^D)^2] > [4s_h^D - s_l^D][16(s_h^D)^2 - 8s_h^D s_l^D + (s_l^D)^2]$$

Or $4s_h^D > 4s_h^D - s_l^D$, et $16(s_h^D)^2 - 6s_h^D s_l^D + 8(s_l^D)^2 > 16(s_h^D)^2 - 8s_h^D s_l^D + (s_l^D)^2$.Cela prouve : $s_h^D > s^m$.

<u>Lemme 1.3</u>: *Le paramètre de préférence du consommateur marginal qui achète après fusion est supérieur à celui du consommateur marginal qui achète la qualité supérieure avant fusion, c'est-à-dire* $\bar{\theta}^m > \tilde{\theta}^D$.

Preuve :

De (1.5) et (1.6), nous déduisons $\tilde{\theta}^D = \frac{2(s_h^D)^2 - 3s_h^D s_l^D + (s_l^D)^2}{(s_h^D - s_l^D)(4s_h^D - s_l^D)}$. De (1.13) nous déduisons $\bar{\theta}^m = \frac{1}{2}$.

$$\bar{\theta}^m > \tilde{\theta}^D \Leftrightarrow \frac{1}{2} > \frac{2(s_h^D)^2 - 3s_h^D s_l^D + (s_l^D)^2}{(s_h^D - s_l^D)(4s_h^D - s_l^D)} \Leftrightarrow (s_h^D - s_l^D)(4s_h^D - s_l^D) > 4(s_h^D)^2 - 6s_h^D s_l^D + 2(s_l^D)^2$$

$\Leftrightarrow 4(s_h^D)^2 - 5s_h^D s_l^D + (s_l^D)^2 > 4(s_h^D)^2 - 6s_h^D s_l^D + 2(s_l^D)^2 \Leftrightarrow s_l^D(s_h^D - s_l^D) > 0$ .Cela prouve :

$$\bar{\theta}^m > \tilde{\theta}^D.$$

1.3.3 Planificateur social

Puisque les seuls coûts sont des coûts fixes, le planificateur ne produira jamais deux qualités. Le remplacement de toute quantité de qualité inférieure par une même quantité de qualité supérieure réduit le coût total et augmente le bien-être des consommateurs.

Le bien-être total s’écrit :

$$BE_F = \int_{\bar{\theta}^{be}}^{1} (\theta s^{be} - p^{be})dF(\theta) + p^{be}[1 - F(\bar{\theta}^{be})] - g(s^{be}). \qquad (1.15)$$

où $\bar{\theta}^{be}$ est le paramètre de préférence du consommateur indifférent entre acheter et ne pas acheter, et p^{be} et s^{be} sont respectivement le prix et la qualité proposés par le planificateur social.

Pour une distribution uniforme de θ sur $[0,1]$, BE est égal à :

$$BE_F = \frac{1 - (\bar{\theta}^{be})^2}{2} s^{be} - g(s^{be}), \text{ où } \quad \bar{\theta}^{be} s^{be} - p^{be} = 0. \qquad (1.16)$$

Le planificateur social maximise BE_F sous la contrainte :

$$\pi(p^{be}, s^{be}) = p^{be}(1-\overline{\theta}^{be}) - g(s^{be}) = 0\,. \tag{1.17}$$

La condition (1.16) nous donne :

$$p^{be} = \overline{\theta}^{be} s^{be}\,. \tag{1.18}$$

En substituant (1.18) dans (1.17), nous obtenons :

$$\overline{\theta}^{be} s^{be}(1-\overline{\theta}^{be}) - g(s^{be}) = 0\ . \tag{1.19}$$

En remplaçant $g(s^{be})$ par $\overline{\theta}^{be} s^{be}(1-\overline{\theta}^{be})$ dans (1.16), nous avons :

$$BE_F = \frac{1-(\overline{\theta}^{be})^2}{2} s^{be} - \overline{\theta}^{be} s^{be}(1-\overline{\theta}^{be}) = s^{be}(1-\overline{\theta}^{be})(\frac{1+\overline{\theta}^{be}}{2} - \overline{\theta}^{be})\,,$$

$$BE_F = \frac{(1-\overline{\theta}^{be})^2}{2} s^{be}\,. \tag{1.20}$$

La condition de premier ordre de la maximisation du BE_F (1.20) par rapport à la qualité est :

$$\frac{\partial BE_F}{\partial s^{be}} = \frac{(1-\overline{\theta}^{be})^2}{2} - 2s^{be}\,\frac{(1-\overline{\theta}^{be})}{2}\frac{\partial \overline{\theta}^{be}}{\partial s^{be}} = 0\,. \tag{1.21}$$

À partir de la condition (1.19) le théorème des fonctions implicites nous permet d'écrire :

$$\frac{\partial \overline{\theta}^{be}}{\partial s^{be}} = \frac{g'(s^{be}) - \overline{\theta}^{be}(1-\overline{\theta}^{be})}{s^{be}(1-2\overline{\theta}^{be})}\ . \tag{1.22}$$

En remplaçant (1.22) dans (1.21), nous obtenons :

$$\frac{\partial BE_F}{\partial s^{be}} = \frac{(1-\overline{\theta}^{be})^2}{2} - 2s^{be}\,\frac{(1-\overline{\theta}^{be})}{2}\,\frac{g'(s^{be}) - \overline{\theta}^{be}(1-\overline{\theta}^{be})}{s^{be}(1-2\overline{\theta}^{be})} = 0,$$

$$\frac{\partial BE_F}{\partial s^{be}} = \frac{(1-\overline{\theta}^{be})}{2} - \frac{g'(s^{be}) - \overline{\theta}^{be}(1-\overline{\theta}^{be})}{(1-2\overline{\theta}^{be})} = 0.$$

Ce qui implique que :

$$g'(s^{be}) = \frac{1}{2}\left(1+\overline{\theta}^{be}\right). \tag{1.23}$$

La condition (1.23) donne que la qualité est optimale quand le coût marginal de qualité est égal à l'appréciation de qualité de l'acheteur moyen du produit.

Proposition 1.1 : *La qualité choisie par le planificateur social est supérieure à la qualité choisie après fusion.*

Preuve :

$$s^{be} > s^{m} \Leftrightarrow g'(s^{be}) = \frac{1}{2} + \frac{\overline{\theta}^{be}}{2} > \frac{1}{4} = g'(s^{m}).$$

1.3.4 Effets de bien-être lorsque les coûts sont fixes

Proposition 1.2: *La fusion diminue le bien-être de tous consommateurs.*

Preuve :

Nous savons que $p^{m} > p_{h}^{D} > p_{l}^{D}$, $s_{h}^{D} > s^{m} > s_{l}^{D}$ et $\overline{\theta}^{m} > \tilde{\theta}^{D} > \overline{\theta}^{D}$. La Figure 1.1 ci-dessous donne la répartition des consommateurs avant et après et fusion.

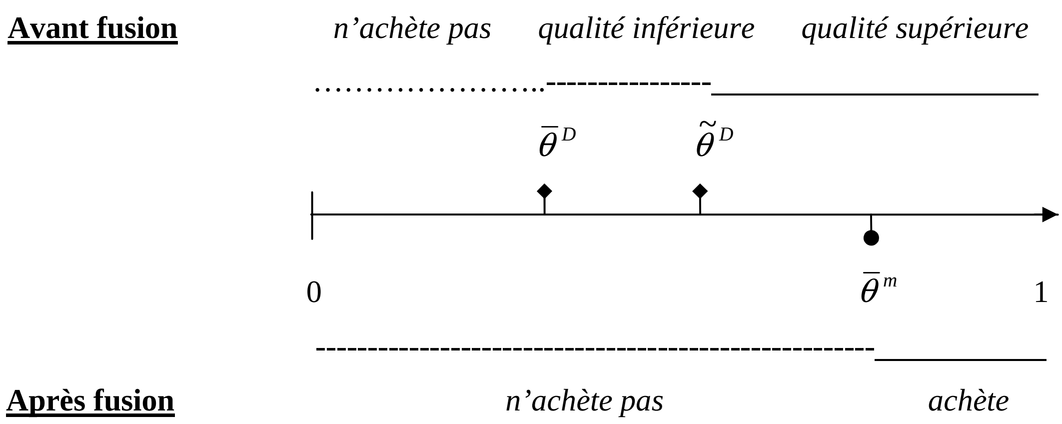

Figure 1.1. Répartition des consommateurs lorsque les coûts sont fixes**.**

Un consommateur avec un $\theta \leq \overline{\theta}^D$ est indifférent entre les deux régimes puisqu'il n'achète ni avant ni après fusion. Un consommateur avec $\theta \in (\overline{\theta}^D, \overline{\theta}^m)$ préfère acheter avant fusion car il réalise un surplus positif, alors qu'après fusion il n'achète pas. Un consommateur avec un $\theta \geq \overline{\theta}^m$ peut acheter avant et après fusion. Il préfère acheter avant fusion car il achète un produit de meilleure qualité à un prix plus faible.

1.4 Les coûts variables dépendent de la qualité

1.4.1 Duopole

Les profits sont :

$$\pi_h^D(p_h^D, p_l^D, s_h^D, s_l^D) = [p_h^D - c(s_h^D)][1 - F(\tilde{\theta}^D)], \tag{1.24}$$

$$\pi_l^D(p_h^D, p_l^D, s_h^D, s_l^D) = [p_l^D - c(s_l^D)][F(\tilde{\theta}^D) - F(\overline{\theta}^D)], \tag{1.25}$$

$\tilde{\theta}^D$ et $\overline{\theta}^D$ sont définis comme dans la section 1.1. Les valeurs optimales de $\tilde{\theta}^D$ et $\overline{\theta}^D$ satisfont les conditions :

$$1 - F(\tilde{\theta}^D) - \frac{p_h^D - c(s_h^D)}{s_h^D - s_l^D} f(\tilde{\theta}^D) = 0, \tag{1.26}$$

$$F(\tilde{\theta}^D) - F(\overline{\theta}^D) - \frac{p_l^D - c(s_l^D)}{s_h^D - s_l^D} f(\tilde{\theta}^D) - \frac{p_l^D - c(s_l^D)}{s_l^D} f(\overline{\theta}^D) = 0\,. \tag{1.27}$$

Les conditions de premier ordre de la maximisation des profits par rapport aux qualités sont :

$$c'(s_h^D)\left[1 - F(\tilde{\theta}^D)\right] = -[p_h^D - c(s_h^D)]\, f(\tilde{\theta}^D)\frac{\partial \tilde{\theta}^D}{\partial s_h^D}\,, \tag{1.28}$$

$$c'(s_l^D)\left[F(\tilde{\theta}^D) - F(\tilde{\theta}^D)\right] = -[p_l^D - c(s_l^D)]\left[f(\tilde{\theta}^D)\frac{\partial \tilde{\theta}^D}{\partial s_l^D} - f(\overline{\theta}^D)\frac{\partial \overline{\theta}^D}{\partial s_l^D}\right]. \tag{1.29}$$

Le membre de gauche de (1.28) représente le coût marginal de l'augmentation de la qualité supérieure. En effet c'est le produit entre le coût unitaire d'une augmentation de s_h^D représenté par $c'(s_h^D)$ et le nombre d'unité vendu de s_h^D représenté par $1-F(\tilde{\theta}^D)$. Le membre de droite de (1.28) est la recette marginale de l'augmentation de la qualité supérieure.

La condition (1.29) s'interprète de la même façon. Elle indique l'égalité entre le coût marginal et la recette marginale de l'augmentation de la qualité inférieure.

1.4.2 Firme Fusionnée

Le profit après fusion s'écrit :

$$\pi^m(p_h^m, p_l^m, s_h^m, s_l^m) = [p_h^m - c(s_h^m)][1-F(\tilde{\theta}^m)] + [p_l^m - c(s_l^m)][F(\tilde{\theta}^m) - F(\bar{\theta}^m)].$$

Les conditions de premier ordre de la maximisation du profit par rapport aux prix sont :

$$1-F(\tilde{\theta}^m) - \frac{p_h^m - c(s_h^m)}{s_h^m - s_l^m} f(\tilde{\theta}^m) + \frac{p_l^m - c(s_l^m)}{s_h^m - s_l^m} f(\tilde{\theta}^m) = 0, \tag{1.30}$$

$$F(\tilde{\theta}^m) - F(\bar{\theta}^m) + \frac{p_h^m - c(s_h^m)}{s_h^m - s_l^m} f(\tilde{\theta}^m) - \frac{p_l^m - c(s_l^m)}{s_h^m - s_l^m} f(\tilde{\theta}^m) - \frac{p_l^m - c(s_l^m)}{s_l^m} f(\bar{\theta}^m) = 0. \tag{1.31}$$

Les conditions de premier ordre de la maximisation du profit par rapport aux qualités sont :

$$c'(s_h^m)\left[1-F(\tilde{\theta}^m)\right] = -[p_h^m - c(s_h^m)] f(\tilde{\theta}^m) \frac{\partial \tilde{\theta}^m}{\partial s_h^m} + [p_l^m - c(s_l^m)] f(\tilde{\theta}^m) \frac{\partial \tilde{\theta}^m}{\partial s_h^m}, \tag{1.32}$$

$$c'(s_l^m)\left[F(\tilde{\theta}^m) - F(\tilde{\theta}^m)\right] = -[p_l^m - c(s_l^m)]\left[f(\tilde{\theta}^m) \frac{\partial \tilde{\theta}^m}{\partial s_l^m} - f(\bar{\theta}^m) \frac{\partial \bar{\theta}^m}{\partial s_l^m} \right]$$
$$-[p_h^m - c(s_h^m)] f(\tilde{\theta}^m) \frac{\partial \tilde{\theta}^m}{\partial s_l^m}. \tag{1.33}$$

Les conditions (1.32) et (1.33) donnent pour la qualité supérieure et la qualité inferieure respectivement, l'égalité entre le coût marginal et la recette marginale d'une augmentation de qualité. Lorsque nous comparons l'effet d'une augmentation de la qualité supérieure avant fusion donné par (1.28) à celui d'après fusion donné par (1.32) nous constatons que la recette marginale d'avant fusion et plus élevée que celle d'après fusion. Donc la qualité supérieure d'avant fusion est plus élevée que celle d'après fusion ($s_h^D > s_h^m$). Par contre lorsque nous comparons l'effet d'une augmentation de la qualité inférieure avant fusion donnée par (1.29) à celui d'après fusion donnée par (1.33) nous observons que la recette marginale de cette augmentation de la qualité inférieure d'avant fusion est moins élevée que celle d'après fusion. La qualité inférieure d'avant fusion est plus basse que celle d'après fusion ($s_l^D < s_l^m$). La dispersion des qualités avant fusion est donc plus élevée que celle d'après fusion.

Pour l'intuition de ce résultat notons qu'avant fusion, pour réduire l'intensité de la concurrence les firmes se différencient en augmentant leur différence de qualité. Tandis qu'après fusion, une faible dispersion des qualités n'implique pas une intensification de la concurrence en prix puisque la firme fusionnée prend en compte cette externalité dans ses choix de prix et de qualité. Nous illustrons ce résultat en annexes pour une fonction de coût spécifique (annexes 1.2 et 1.3).

Pour une distribution uniforme de θ sur $[0,1]$, les prix qui maximisent ce profit sont :

$$p_h^m = \frac{s_h^m + c(s_h^m)}{2}, \tag{1.34}$$

$$p_l^m = \frac{s_l^m + c(s_l^m)}{2}. \tag{1.35}$$

Par voie de conséquence:

$$\tilde{\theta}^m = \frac{1}{2}\left[1 + \frac{c(s_h^m) - c(s_l^m)}{s_h^m - s_l^m}\right], \text{ et } \bar{\theta}^m = \frac{1}{2}\left[1 + \frac{c(s_l^m)}{s_l^m}\right].$$

La maximisation du profit par rapport aux qualités donne:

$$c'(s_h^m) = \tilde{\theta}^m = \frac{1}{2}\left[1 + \frac{c(s_h^m) - c(s_l^m)}{s_h^m - s_l^m}\right], \tag{1.36}$$

$$c'(s_l^m) = \tilde{\theta}^m + \bar{\theta}^m - 1 = \frac{1}{2}\left[\frac{c(s_h^m) - c(s_l^m)}{s_h^m - s_l^m} + \frac{c(s_l^m)}{s_l^m}\right]. \tag{1.37}$$

La firme fusionnée s'intéresse aux consommateurs marginaux $\tilde{\theta}^m$ et $\bar{\theta}^m$. Elle propose s_h^m, telle que le coût marginal de production de cette qualité soit égal au prix de réserve des consommateurs marginaux de cette qualité: $c'(s_h^m) = \tilde{\theta}^m$. La condition (1.37) peut se réécrire comme $c'(s_l^m) = \bar{\theta}^m - (1 - \tilde{\theta}^m)$. La firme fusionnée propose s_l^m, telle que le coût marginal de production de cette qualité soit inférieur au prix de réserve : $c'(s_l^m) < \bar{\theta}^m$.

1.4.3 Planificateur social

Pour une distribution uniforme de θ sur $[0,1]$, la fonction de bien-être (BE_V) est:

$$\int_{\bar{\theta}^{be}}^{\tilde{\theta}^{be}} (\theta s_l^{be} - p_l^{be}) d\theta + \int_{\tilde{\theta}^{be}}^{1} (\theta s_h^{be} - p_h^{be}) d\theta + [p_l^{be} - c(s_l^{be})](\tilde{\theta}^{be} - \bar{\theta}^{be}) + [p_h^{be} - c(s_h^{be})](1 - \tilde{\theta}^{be}).$$

Nous pouvons la ré- écrire de la manière suivante :

$$BE_V = \frac{(\tilde{\theta}^2 - \bar{\theta}^2)}{2} s_l + \frac{(1 - \tilde{\theta}^2)}{2} s_h - (1 - \tilde{\theta}) c(s_h) - (\tilde{\theta} - \bar{\theta}) c(s_l).$$

Le bien-être est maximisé lorsque :

$$p_h^{be} = c(s_h), \tag{1.38}$$

$$p_l^{be} = c(s_l). \tag{1.39}$$

Les qualités maximisent le bien-être quand :

$$c'(s_h^{be}) = \frac{1+\tilde{\theta}^{be}}{2} = \frac{1+\dfrac{(p_h^{be}-p_l^{be})}{(s_h^{be}-s_l^{be})}}{2} = \frac{1}{2}\left[1+\frac{c(s_h^{be})-c(s_l^{be})}{s_h^{be}-s_l^{be}}\right], \qquad (1.40)$$

$$c'(s_l^{be}) = \frac{(\tilde{\theta}^{be}+\bar{\theta}^{be})}{2} = \frac{1}{2}\left[\frac{c(s_h^{be})-c(s_l^{be})}{s_h^{be}-s_l^{be}}+\frac{c(s_l^{be})}{s_l^{be}}\right]. \qquad (1.41)$$

Les conditions (1.40) et (1.41) montrent que les qualités sont optimales quand les coûts marginaux de qualité sont égaux à l'appréciation de qualité des acheteurs moyens des produits.

Remarquons que les conditions de premier ordre des choix de qualité (1.36) et (1.37) de la firme fusionnée et celles (1.40) et (1.41) du planificateur social sont similaires[4]. Nous déduisons donc la proposition 1.3.

Proposition 1.3: *Les qualités proposées par la firme fusionnée sont identiques à celles du planificateur social.*

Crampes et Hollander (1995) montrent que dans les marchés de biens verticalement différenciés sous l'hypothèse de couverture totale du marché, un duopole qui produit deux qualités d'un bien conduit à une forte dispersion entre ces qualités par rapport à l'optimum social. Nous montrons qu'un duopole qui produit deux qualités d'un bien conduit à une forte dispersion entre ces qualités par rapport à une firme fusionnée. Comme nous avons prouvé que la firme fusionnée et le planificateur social choisissent les mêmes qualités, nous

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[4] Comme dans la concurrence pure et parfaite le planificateur social demande pour chaque bien un prix égal au coût marginal de production. Mussa et Rosen (1978) montrent que dans le cas d'un continuum de qualités, le monopole élargit le spectre de qualité par rapport à une concurrence pure et parfaite. Nous montrons dans le cas de choix de qualités discrets que le monopole et le planificateur social font les même choix de qualité.

prouvons le résultat de Crampes et Hollander (1995) sous l'hypothèse de couverture partielle, c'est-à-dire lorsqu'il existe de consommateurs qui n'achètent pas[5].

1.4.4 Effets de bien-être lorsque les coûts sont variables

<u>Proposition 1.4</u>: *La fusion diminue le bien-être de tous les consommateurs.*

Preuve :

La Figure 1.2 donne la répartition des consommateurs avant et après fusion lorsque $\tilde{\theta}^m > \tilde{\theta}^D > \overline{\theta}^m$.

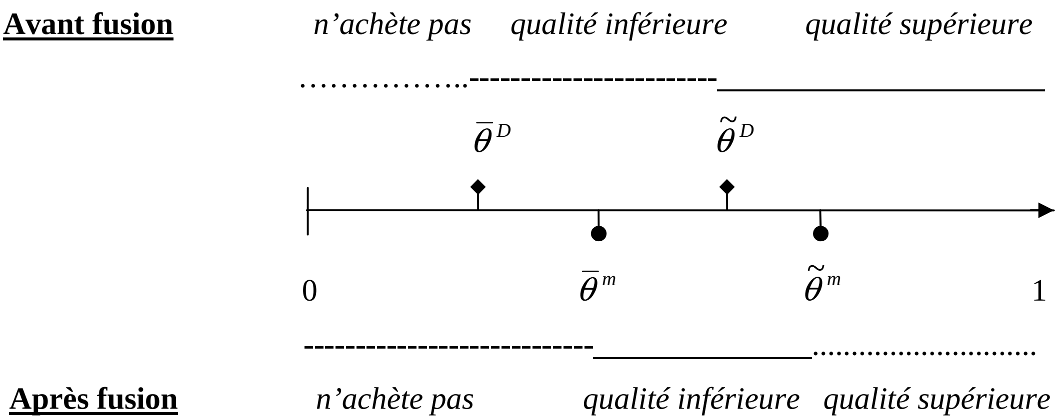

Figure 1.2. Répartition des consommateurs lorsque les coûts sont variables.

Un consommateur avec un $\theta \le \overline{\theta}^D$ est indifférent entre les deux structures de marché puisqu'il n'achète ni avant et ni après fusion. Un consommateur avec un $\theta \in [\overline{\theta}^D, \overline{\theta}^m]$ achète la qualité inférieure avant fusion et n'achète pas après fusion. Un consommateur

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[5] Crampes et Hollander (1995) suppose une couverture totale du marché.

avec un $\theta \in [\bar{\theta}^m, \tilde{\theta}^D]$ peut acheter la qualité inférieure avant et après fusion. Il préfère acheter la qualité inférieure avant fusion si et seulement si $\theta s_l^D - p_l^D \geq \theta s_l^m - p_l^m$ .Or $\theta s_l^D - p_l^D \geq \theta s_l^m - p_l^m$ si et seulement si $\theta \geq \frac{p_l^D - p_l^m}{s_l^D - s_l^m}$. Nous allons prouver que $\theta \geq \frac{(p_l^D - p_l^m)}{(s_l^D - s_l^m)}$. Nous savons déjà que $\bar{\theta}^m = \frac{p_l^m}{s_l^m} > \frac{p_l^D}{s_l^D} = \bar{\theta}^D$. Cela implique que $\frac{p_l^m}{s_l^m} > \frac{p_l^D - p_l^m}{s_l^D - s_l^m}$. Puisque nous sommes dans le cas $\theta \in (\bar{\theta}^m, \tilde{\theta}^D)$, alors :

$$\theta \geq \frac{p_l^m}{s_l^m} \geq \frac{(p_l^D - p_l^m)}{(s_l^D - s_l^m)} \ .$$

Un consommateur avec un $\theta \in [\tilde{\theta}^D, \tilde{\theta}^m]$ peut acheter aussi bien la qualité supérieure avant fusion que la qualité inférieure après fusion. Mais comme nous savons déjà que : (i) avant fusion, ce consommateur préfère la qualité supérieure à la qualité inférieure; et (ii) ce consommateur préfère la qualité inférieure après fusion à la qualité inférieure avant fusion. Nous déduisons donc que ce consommateur préfère la qualité supérieure avant fusion à la qualité inférieure après fusion. Un consommateur avec un $\theta \geq \tilde{\theta}^m$ préfère strictement la situation avant fusion à la situation après fusion car il achète la qualité supérieure avant fusion à un prix par unité de qualité qui est plus faible que le prix par unité de qualité après fusion$\left(\frac{p_h^D}{s_h^D} < \frac{p_h^m}{s_h^m}\right)$.

La même analyse s'applique lorsque $\tilde{\theta}^D > \tilde{\theta}^m > \bar{\theta}^m$ et facilement nous obtenons les mêmes conclusions que précédemment.

1.5 Applications numériques

1.5.1 Fonction de coûts fixes qui dépendent de la qualité

Nous supposons maintenant que la fonction de coûts à la forme suivante :

$$g(s_i) = \frac{s_i^k}{a} \text{ , avec } i = h,l \text{ , } k \in [2, k^*] \text{ .}$$

Pour les simulations numériques nous prendrons $a = 10$, $k^* = 5$ et θ uniforme sur $[0,1]$

Les prix, les qualités d'équilibres et les paramètres de préférences des consommateurs marginaux avant fusion et après fusion sont respectivement consignés dans les Tableaux 1.1 et 1.2 (voir annexe 1.5 et 1.6)[6].

Nous observons que le niveau du bien-être dépend de la prise en compte de l'effet conjoint des ajustements de prix et de qualité après fusion. Les effets des ajustements de prix sont connus et généralement pris en compte. Si la fusion ne conduit pas à des réductions de coûts considérables et à des gains d'efficience, alors la hausse des prix après fusion réduit le bien-être total. En effet, les dernières colonnes des Tableaux 1.1 et 1.2 montrent que la baisse du bien-être des consommateurs est plus élevée que les gains additionnels de la firme fusionnée.

Par contre les effets sur le bien-être total des ajustements de qualité sont moins prévisibles. Lorsque les coûts fixes sont supposés récupérables, le Tableau 1.4 indique que la baisse du bien-être avec les ajustements de qualité est plus élevée que celle sans les ajustements de

[6] Les résultats obtenus sont identiques à ceux de Motta (1993) où sont déterminés les prix et les qualités d'équilibres d'un duopole lorsque les coûts sont fixes où variables.

qualité (voir annexe 1.8). Ce résultat s'explique par le fait que la fusion réduit à la fois le niveau et le nombre de qualités lorsque seuls les coûts dépendent de la qualité. En ajustant la qualité, celle-ci diminue alors que le prix par unité de qualité ne change pas. En tenant compte de l'ajustement de qualité, nous observons une baisse du surplus des consommateurs et une hausse du profit des firmes. L'ajustement de qualité se fait au détriment du bien-être total puisque la baisse du surplus des consommateurs est plus considérable que la hausse de profit des firmes.

Donc l'ajustement conjoint des prix et des qualités lors d'une fusion horizontale lorsque seuls les coûts dépendent de la qualité augmente la perte de bien-être par rapport à l'ajustement des prix seuls. En tenant compte de l'ajustement conjoint après une fusion, le bien-être devrait baisser plus par rapport à la situation où les qualités sont supposées exogènes ou données.

1.5.2 Fonction de coûts variables en quantité

Nous supposons :

$$C(q_i, s_i) = q_i c(s_i) = q_i \frac{s_i^k}{a}, \text{ avec } i = h, l, k \in [2, k^*].$$

Pour les simulations numériques, nous prendrons encore $a = 10$, $k^* = 5$ et θ uniforme sur $[0,1]$.

Les prix, les qualités d'équilibres et les paramètres de préférences des consommateurs marginaux avant fusion et après fusion sont respectivement consignés dans les Tableaux 1.5 et 1.6 (voir annexe 1.9 et 1.10).

L'analyse du bien-être au Tableau 1.7 indique que la baisse de bien-être avec l'ajustement conjoint des prix et des qualités est plus faible que celle avec ajustement des prix seuls (annexe 1.11). La fusion conserve le nombre de variétés de produits et augmente le niveau de la qualité inférieure. Donc l'ajustement des qualités augmente la qualité inférieure et diminue par conséquent le prix par unité de qualité inférieure. Nous observons une hausse du surplus des consommateurs et une hausse du profit des firmes après ajustements. Les ajustements de qualité ne se font plus au détriment du bien-être total.

Donc l'ajustement conjoint des prix et des qualités lors d'une fusion horizontale lorsque les coûts variables dépendent de la qualité diminue donc la perte de bien-être par rapport à l'ajustement des prix seuls. Dans ce cas tenir compte des ajustements de qualité réduit moins le bien-être comparativement à une situation où les qualités sont supposées exogènes ou données. Notons que ce résultat est contraire au cas où seuls les coûts fixes dépendent de la qualité.

1.6 Conclusion

Nous avons analysé la fusion horizontale d'un duopole verticalement différencié sous deux hypothèses sur les fonctions de coûts. Dans un premier temps, nous avons supposé que seuls les coûts fixes dépendent de la qualité ; dans un second temps nous avons supposé que ce sont les coûts variables qui dépendent de la qualité. Dans le premier cas la fusion entraîne l'élimination d'une des qualités, la réduction de la couverture des marchés, l'augmentation des prix et la diminution du bien-être. Dans le second cas, après fusion le nombre de qualité est conservé et les qualités choisies sont identiques aux qualités d'un planificateur social. Nous avons montré aussi que la fusion conduit à une réduction de la dispersion entre les deux niveaux de qualité. Cependant après fusion, la firme maintient des prix beaucoup plus élevés que ceux du duopole. Ce qui à pour effet de réduire le bien-être total.

L’évaluation des effets de bien-être d’une fusion ne prend généralement pas en compte les ajustements de qualité qui font suite à la fusion. Nos résultats indiquent que ne pas tenir compte des ajustements de qualité surestime ou sous-estime les effets de bien-être selon la structure de coûts de l’industrie. Si la fusion a lieu dans une industrie dont les coûts sont essentiellement fixes comme les industries à forte intensité de R&D (télécoms, biotechnologies), ne pas tenir compte des ajustements de qualité sous-estime la perte de bien-être après une fusion. Par contre si la fusion à lieu dans une industrie où ce sont les coûts variables qui dépendent de la qualité (services et transport) ne pas tenir compte des ajustements de qualité surestime la perte de bien-être.

Cela suggère que les fusions sont trop souvent acceptées dans le premier cas et sont trop souvent rejetées dans le second. Dans la pratique les effets de qualités sont négligés quand on fait l’examen des effets de bien-être d’une fusion. Aux termes de certaines lois de la concurrence comme la Loi canadienne, tous les gains de bien-être peuvent constituer une défense au terme de l’article 96 de la Loi sur la concurrence. Nos résultats montrent qu’il est aussi important de tenir compte des ajustements de qualités dans l’analyse d’une fusion pour avoir tous les gains d’efficiences.

CHAPITRE 2

Bundling and Complementarity

2.1 Introduction

Many products are consumed in combination with other products to form a complete system. For example a computer system contains a basic unit and a monitor, a stereo system includes an amplifier and speakers. Components of the system, when produced by different firms can be made compatible or incompatible. A component is incompatible with components sold by another firm, if it cannot be assembled with them to form a usable system. Firms' strategies in regard to compatibility are closely related to strategies in regard to bundling. Bundling is a practice under which a firm offers to sells a unit of one product on condition that the buyer commit to purchase from him a fixed quantity of a another product, or all his requirements of another product. The difference between bundling and incompatibility is that under the former a buyer of bundle may still be able to combine components produced by different firms to create a system with characteristics that match his preferences more closely than any bundle offered by producer. [1]

The early literature sees bundling as a tool to achieve price discrimination [Burstein (1960), Stigler (1968), Adams and Yellen (1976), Schmalensee (1984), and McAfee, McMillan and Whinston (1989)]. Heterogeneity in consumers' valuations frustrates the seller's ability to capture the entire consumer surplus. Bundling reduces the heterogeneity in reservation prices. This allows the seller to capture more consumer surplus. Burstein (1960) shows how the results of perfect discrimination can be approximated by bundling. Stigler (1968) and Adams and Yellen (1976) show how bundling enhances profits when the reservation values of the components are negatively correlated. Schmalensee (1984) considers the entire class of Gaussian demands and shows that bundling makes it possible for the seller to extract a greater portion of potential surplus when demands are uncorrelated, even positively correlated. McAfee, McMillan and Whinston (1989) provide general characterization of the

[1] This may require that the buyer discard one or more components contained in a bundle that he purchased.

circumstances in which bundling is an optimal strategy for a multiproduct monopolist. They show that mixed bundling, i.e. the individual goods as well as the package are sold, is always an optimal strategy when reservation values for the various goods are independently distributed in the population of consumers.

A second reason for bundling is leveraging of market power that exists in one market into another market [Blair (1978), Schmalensee (1982)]. The idea is to prevent firm to compete in the market for the component that can be supplied competitively. This theory has come under heavy attack from the Chicago School economists [Director and Levi (1956), Posner (1976), Bork (1978)], who have argued that a monopolist will not bundle to foreclose a competitive industry. The reason is that bundling lowers profits by reducing the demand for the monopolized component.

Whinston (1990) and Nalebuff (2004) examine the role of bundling as an entry deterrent. Whinston (1990) shows that the Chicago School's criticism of leveraging monopoly power from one market (say market A) to another (say market B) applies only if market B is perfectly competitive, or when neither A nor B can be consumed alone. He proves this result for the particular case of a firm that is the sole producer of a component A, of a system which would also include a component B. He shows that the monopolist in A does better by not bundling than by committing to a bundling strategy that evicts its rival firm in B from the market[2]. This happens because if the competitor is inactive, sales of A are lower. However when B is supplied by an imperfectly competitive industry or when one component yields utility even when not consumed in conjunction with the other component, bundling to exclude can be profitable. Nalebuff (2004) re-examines the role of bundling as an entry deterrent. He shows that pure bundling is more profitable for an incumbent even if commitment to bundle is impossible. This is the case if the entrant can

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[2] The proposition 3 of Whinston (1990)

enters only in one market. The intuition is that the entrant must compete for consumers in the other market as well since the incumbent only offers a bundle. This greatly reduces the profits of the entrant. Nalebuff (2004) shows that the gain from entry deterrence (whether the entrant effectively enters or not) largely exceeds those from price discrimination.

Matutes and Regibeau (1992) and Economides (1993) extend the basic framework to the case of duopoly where both components are produced by two firms. They assume that competition takes place between firms. They show that bundling is dominated by component selling. This result is due to two effects: market size effect and a softening of price competition. Component selling increases the number of systems that can be assembled.[3] This enables consumers to obtain a system closer to their ideal specification and yields larger demand. Component selling also weakens price competition because a decrease in the price of a component by one firm increases the demand for the own system where all components come from that firm, and for the mixed system where one of the components is from the rival firm.

Bundling may also enhance profits by enabling economies of scope in production and distribution. Salinger (1995) introduces the role of cost savings to interact with demand effects. He offers a graphical representation of the advantages of bundling when there are such economies. By comparing graphically the demand for the bundle and the vertical sum of the demands for its components, he proves that when bundling does not lower costs, bundling tends to be profitable when reservation values are negatively correlated and high relative to costs. But, if bundling lowers costs, it tends to be more profitable when demands for the components are highly positively correlated and component costs are high.

The choice of compatibility in imperfectly competitive settings have been investigates by Chou and Shy (1989), Matutes and Regibeau (1989) for the case where each firm sells a different component. Matutes and Regibeau (1988), Economides (1989, 1991), and Einhorn (1992) have looked at the case where each firm can supply all the components. In most models, compatibility increases industry demand and profits. Economides (1991) is an exception. He shows that for firms supplying all components, compatibility is more profitable when the demand for the system increases. He considers a model where the market for one component (say market *A*) is a duopoly, and the other (say market *B*) is monopolistically competitive. He argues that when the addition of a new variety of *B* leads to little or no increase in the demand for the system *AB*, the profits of the two producers of *A* are higher under incompatibility. By contrast, when the addition of a new variety of *B* increases the demand for the system *AB*, the profits of a firm of the duopolist are higher under compatibility.

This paper analyzes bundling in markets where consumers demand a system and each system is composed of two components (e.g. hardware and software). There are two firms. One firm called firm 1 is the sole producer of component called *A*. It also produces a component called *B*. The second firm called firm 2 produces only *B*. The quality of *B* produced by the two firms need not to be necessarily the same. We ask first whether or not firm 1 is better off bundling the two components that it produces. We also look at welfare.

Our model differs from those of the aforementioned authors in the following ways: (i) it examines the case of bundling where consumers can separate the components and use them in conjunction with rival' component; (ii) we consider components differentiated in quality; and (iii) we endogenize the quality of the component produced by both firms and we ask how firms choose quality when one of the firms may opt for bundling rather than component selling.

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[3] From *AA* and *BB* to *AA*, *AB*, *BA* and *BB*

We show that firm 1's bundling decision depends on the relative quality of the component produced by both firms. We prove that firm 1 earns higher profits by selling A and B separately than selling the system as bundle when its product B is of higher quality than that of its rival. On the other hand if firm 1's component B has the lower quality, then the bundling strategy yields more profits than component selling. The intuition is simple. The profitability of component selling depends on the relative increase in the demand for A compared to the losses incurred due to competition in B. Component selling leads to an increase in the demand for A through sales with rival's component in B when the monopolist produces the higher quality of B. Conversely, component selling yields no increase in the demand for A when the monopolist produces the lower quality of B. These results are in line with Whinston (1990) and Matutes and Regibeau (1992), who examined the case where components are not vertically differentiated. In contrast to these studies, we examine the case where buyers can combine one component of a bundle with another component purchase from another firm. We also show that bundling always reduces social welfare.

The plan of the paper is as follows. In section 2.2, we introduce the notation and formalize the basic assumptions. In section 2.3, we determine the range of possible selling strategies. In section 2.4 and 2.5, we compare the component selling strategy to the bundling strategy under different assumptions about qualities. In section 2.6, we perform a welfare analysis. In section 2.7, we investigate the endogenous case of quality choices with a quadratic cost function. In section 2.8, we give antirust implications and we conclude.

2.2 The Model

There are two firms, denoted 1 and 2 and two products denoted A and B. Firm 1 sells the products A and B, whereas firm 2 sells only B. The quality of B need not to be the same for both firms. Quality means reliability, i.e. the probability that the component will not break down. Component A has zero probability of breaking down, component B has positive probability of breaking down. Let α_L denote the probability of breakdown the B component with the lower reliability, and let α_H denote the probability of breakdown the B component with the higher reliability ($\alpha_H > \alpha_L$).

We assume that A is produced at zero marginal cost and zero fixed cost. Component B is produced at a constant unit cost that depends on its reliability. We assume the cost of B to be:

$$C(q,\alpha) = qc(\alpha),$$

where q and α denote respectively the quantity and the reliability. Also, we assume that $c(\alpha) \geq 0, c'(\alpha) \geq 0, c''(\alpha) \geq 0$ for all α. Convexity of the unit cost function implies:

$$\alpha_L c(\alpha_H) - \alpha_H c(\alpha_L) > 0. \qquad (2.1)$$

We note by P_{AB_I}, the price of the complete system AB_I, $I \in \{H, L\}$. If the components of the complete system are purchased individually, then the price of the complete system is the sum of the prices of the individual components, that is $P_A + P_I$, $I \in \{H, L\}$. Else, the price of the complete system is the bundle price P_{GI}, where GI represents the bundle AB_I, $I \in \{H, L\}$.

Consumers who have Mussa and Rosen (1978) preferences derive utility only from the system; i.e. they derive utility only when they use one unit of A in combination with one unit of B. They can, however, combine A with a unit of B of any quality. Consumers are indexed θ, where θ is uniformly distributed on $[0,1]$. When none of the components breaks down, consumer θ obtains utility θ; if one component or both components break down his utility is zero.

When components are sold separately consumers can choose between two systems: AB_H and AB_L, where AB_H contains one unit of A and one unit of B of reliability α_H and AB_L contains one unit of A and one unit of B_L of reliability α_L. We assume that the reliabilities of B, α_H and α_L, are common knowledge.

Consumers are risk neutral. They maximize expected surplus. Therefore, when firm 1 sells the components separately the following individual- rationality constraints (I) and the self-selection constraints (S) must be satisfied for the consumer who purchases the B components with the higher reliability:

$$\alpha_H \theta - P_{AB_H} \geq 0, \qquad (I_H)$$

$$\alpha_H \theta - P_{AB_H} \geq \alpha_L \theta - P_{AB_L}. \qquad (S_H)$$

For the consumer who purchases the B component with lower reliability, the following constraints are met:

$$\alpha_L \theta - P_{AB_L} \geq 0, \qquad (I_L)$$

$$\alpha_H \theta - P_{AB_H} < \alpha_L \theta - P_{AB_L}. \qquad (S_L)$$

This means that when firm 1 sells the components separately, consumer θ chooses the component B that maximizes his expected surplus:

$$\alpha_I \theta - P_{AB_I},\ I \in \{H, L\}.$$

We indicate by $\tilde{\theta}$ the preference parameter of the consumer who is indifferent between purchasing the higher quality system (AB_H) and the lower quality system (AB_L). The consumer indexed $\overline{\theta}$ is indifferent between purchasing the lower quality system (AB_L) and not purchasing at all. Therefore we have $\tilde{\theta} = \frac{P_{AB_H} - P_{AB_L}}{\alpha_H - \alpha_L}$ and $\bar{\theta} = \frac{P_{AB_L}}{\alpha_L}$. Figure 2.1 below displays market areas of each system:

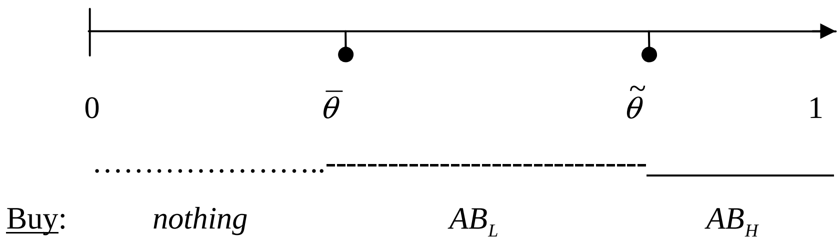

Figure 2.1. Market shares under component selling

The demands for AB_H and AB_L are respectively:

$$D_H^S = 1 - \tilde{\theta}\,, \tag{2.2}$$

and

$$D_L^S = \tilde{\theta} - \bar{\theta}\,. \tag{2.3}$$

2.3 Selling Strategies

We consider in turn two cases. Case 1 is where firm 1 produces A and B_H and firm 2 produces B_L ; Case 2 is where firm 1 produces A and B_L and firm 2 produces B_H .

In case 1 firm 1 can choose among five strategies:

(i) sell A and B_H separately;

(ii) sell the bundle AB_H only;

(iii) sell A and B_H separately and sell the bundle AB_H at a price lower than the sum of individual prices (mixed bundling);[4]

(iv) sell B_H and the bundle AB_H;

(v) sell A and the bundle AB_H.

We note the following: strategy (ii) is equivalent to strategy (iv) because no one buys B_H alone, that is both strategies yield only a demand for AB_H. The same applies to strategy (iii), which is equivalent to strategy (v), because consumers who want AB_L need only to purchase A from firm 1. Strategies (iii) and (v) yield only demands for A and AB_H.

Thus, it is sufficient that we compare strategies (i), (ii), and (iii).

Similarly we can show that under case 2 the only strategies to consider are: (i) selling A and B_L separately; (ii) selling the bundle AB_L only; and (iii) selling A and B_L separately and selling the bundle AB_L.

We now show the following lemma:

Lemma 2.1: *Component selling (strategy i) yields the same profits as mixed bundling (strategy iii).*

Proof:

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[4] According to Adam and Yellen (1976) the first three marketing strategies refer respectively to pure components strategy or separate selling strategy (*S*), pure bundling strategy (*PB*) and mixed bundling strategy (*MB*).

Case 1:

The profits of firm 1 under component selling are:

$$\pi_1^S = [P_A^S + P_H^S - c(\alpha_H)](1-\tilde{\theta}) + P_A^S(\tilde{\theta} - \bar{\theta}) \ , \qquad (2.4)$$

The profits of firm 1 under mixed bundling are:

$$\pi_1^{MB} = [P_{GH}^{MB} - c(\alpha_H)]D_{GH}^{MB} + [P_A^{MB} + P_H^{MB} - c(\alpha_H)]D_H^{MB} + P_A^{MB}D_L^{MB} . \qquad (2.5)$$

where D_{GH}^{MB} and P_{GH}^{MB} respectively denote the demand and the price for the bundle AB_H .

If $P_{GH}^{MB} \geq P_A^S + P_H^S$ then $D_{GH}^{MB} = 0$. That is, nobody buys the bundle. Therefore:

$$\pi_1^{MB} = [P_A^{MB} + P_H^{MB} - c(\alpha_H)]D_H^{MB} + P_A^{MB}D_L^{MB} \ . \qquad (2.6)$$

Thus strategy (i) is equivalent to strategy (iii).

If $P_{GH}^{MB} \leq P_A^S + P_H^S$, we have $D_H^{MB} = 0$. That is, nobody buys components A and B_H separately. Those who want AB_H buy the bundle, those who want AB_L buy A from firm 1 and B_L from firm 2. Therefore:

$$\pi_1^{MB} = [P_{GH}^{MB} - c(\alpha_H)]D_{GH}^{MB} + P_A^{MB}D_L^{MB} \ . \qquad (2.7)$$

If we define the implicit price of B_H as: $\tilde{P}_H^{MB} = P_{GH}^{MB} - P_A^{MB}$, (2.7) can be written as:

$$\pi_1^{MB} = [\tilde{P}_H^{MB} + P_A^{MB} - c(\alpha_H)]D_{GH}^{MB} + P_A^{MB}D_L^{MB} .$$

This shows that component selling (2.4) yields the same profits as mixed bundling (2.7), when P_{GH}^{MB} is defined as the sum of individual component prices ($P_A^S + \tilde{P}_H^S$). This proves that mixed bundling strategy cannot be more profitable than component selling.

Case 2:

Firm 1's profits under component selling are:

$$\pi_1^S = [P_A^S + P_L^S - c(\alpha_L)]D_L^S + P_A^S D_H^S \ , \tag{2.8}$$

where D_H^S and D_L^S are defined by (2.2) and (2.3).

With mixed bundling profits are:

$$\pi_1^{MB} = [P_{GL}^{MB} - c(\alpha_L)]D_{GL}^{MB} + [P_A^{MB} + P_L^{MB} - c(\alpha_L)]D_L^{MB} + P_A^{MB} D_H^{MB} . \tag{2.9}$$

If $P_{GL}^{MB} \geq P_A^{MB} + P_L^{MB}$, clearly $D_{GL}^{MB} = 0$. That is nobody buys bundle. Therefore:

$$\pi_1^{MB} = [P_A^{MB} + P_L^{MB} - c(\alpha_L)]D_L^{MB} + P_A^{MB} D_H^{MB} . \tag{2.10}$$

Thus, strategy (i) is equivalent to strategy (iii).

If $P_{GL}^{MB} \leq P_A^{MB} + P_L^{MB}$, then $D_L^{MB} = 0$. Therefore:

$$\pi_1^{MB} = [P_{GL}^{MB} - c(\alpha_L)]D_{GL}^{MB} + P_A^{MB} D_H^{MB} . \tag{2.11}$$

It is obvious that $\pi_1^{MB} = \pi_1^S$ when P_{GL}^{MB} is the sum of prices of individual components' prices ($P_A^S + \tilde{P}_L^S$).

From Lemma 2.1, it follows that a complete discussion of strategies only requires a discussion of the choice between component selling and pure bundling. All forms of mixed bundling are irrelevant because of the complementarity of components. For example consider case 1, where firm 1 produces A and B_H and firm 2 produces B_L. Under component selling (strategy i), consumers who want AB_H buy both A and B_H , and those who want AB_L buy A only from firm 1. Under mixed bundling, consumers who want AB_H can either buy both A and B_H separately or the bundle AB_H, and those who want AB_L buys A only from firm 1. Both strategies yield a similar demand for the system AB_H .

We now compare the profits from component selling and bundling first for case 1 and second for case 2.[5]

2.4 Case 1: the producer of A also produces B_H

2.4.1 Component selling

The profits of firm 2 under component selling are

$$\pi_2^S = [P_L^S - c(\alpha_L)](\tilde{\theta} - \bar{\theta}). \qquad (2.12)$$

The profits of firm 1 are given by (2.4).

When both firms choose prices simultaneously, they satisfy conditions (2.13), (2.14) and (2.15) below:

$$P_A^S = \frac{\alpha_L}{6}\left[2\left(1 - \frac{c(\alpha_L)}{\alpha_L}\right) + \left(1 - \frac{c(\alpha_H)}{\alpha_H}\right)\right], \qquad (2.13)$$

$$P_H^S = \frac{\alpha_H - \alpha_L}{2} + \frac{c(\alpha_L)}{3} + \frac{(3\alpha_H + \alpha_L)c(\alpha_H)}{6\alpha_H}, \qquad (2.14)$$

$$P_{B_L}^S = \frac{\alpha_L}{3}\left[\frac{c(\alpha_H)}{\alpha_H} + 2\frac{c(\alpha_L)}{\alpha_L}\right]. \qquad (2.15)$$

Firm 1 sells A to all consumers and sells B_H only to those with high reservation prices. Firm 2 sells B_L only to consumers with low reservation prices. We note that P_A^S is decreasing in α_H and increasing in α_L. We also note that P_H^S is increasing in α_H and

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[5] When the quality of B is the same for both firms, firms' profits are the same under component selling and bundling. Indeed under component selling, Bertrand competition leads to a unique equilibrium where prices equal unit cost for product B and component A is priced as if firm 1 was selling a bundle AB. Since nobody buys B alone when firm 1 bundles, firm 2 makes zero profit under both strategies.

decreasing in α_L, and that P_L^S is increasing in both α_H and α_L. In contrast to the standard model of vertically differentiated duopoly, firm 1 raises the price of A and lowers the price of B_H to induce firm 2 to lower the price of B_L. Since B has no value without A, firm 1 uses A to extract consumers' surplus from the system AB.

Conditions (2.13), (2.14) and (2.15) imply

$$\tilde{\theta} = \frac{1}{6}\left[3 + \frac{c(\alpha_H)}{\alpha_H} + \frac{2c(\alpha_H) - c(\alpha_L)}{\alpha_H - \alpha_L}\right], \tag{2.16}$$

and

$$\bar{\theta} = \frac{1}{3}\left[\frac{c(\alpha_H)}{\alpha_H} + 2\alpha_H \frac{c(\alpha_L)}{\alpha_L}\right]. \tag{2.17}$$

Therefore,

$$1 - \tilde{\theta} = \frac{1}{2}\left[1 - \frac{c(\alpha_H)}{\alpha_H} - \frac{c(\alpha_H) - c(\alpha_L)}{\alpha_H - \alpha_L} - \frac{c(\alpha_H)}{\alpha_H - \alpha_L}\right],$$

and

$$\tilde{\theta} - \bar{\theta} = \frac{1}{6}\left[3 + \frac{2c(\alpha_H) - c(\alpha_L)}{\alpha_H - \alpha_L} - \frac{c(\alpha_H)}{\alpha_H} - 4\alpha_H \frac{c(\alpha_L)}{\alpha_L}\right].$$

2.4.2 Pure bundling

When firm 1 bundles, A and B_H, no one purchases B_L. Firm 1's profits are

$$\pi_1^{PB} = [P_{GH} - c(\alpha_H)](1 - \bar{\theta}_{GH}), \tag{2.18}$$

where $\bar{\theta}_{GH} = \dfrac{P_{GH}}{\alpha_H}$. $\bar{\theta}_{GH}$ is the preference parameter of the consumer who is indifferent between purchasing the bundle AB_H and not purchasing at all.

The profit maximization price satisfies:

$$P_{GH} = \frac{\alpha_H + c(\alpha_H)}{2} \ , \tag{2.19}$$

Observe that the price of the bundle (2.19) is the sum of the component prices given by (2.13) and (2.14). This means for given qualities, the decision to bundle does not affect the price of the system. The intuition is that both A and B_H are required to put together to form the system AB_H and firm1 has a monopoly over the system AB_H. Therefore firm 1 offers both A and B_H separately or as a bundle for the same price. Condition (2.18) implies:

$$\overline{\theta}_{GH} = \frac{1}{2}\left[1 + \frac{c(\alpha_H)}{\alpha_H}\right] \ . \tag{2.20}$$

<u>Proposition 2.1</u>: *When firm 1 produces the higher quality version of B, (i) the bundle price equal the sum of component prices it would set under component selling; and (ii) under bundling its profits are smaller than under component selling.*

Proof:

By virtue of $c''(\alpha) > 0$ (see condition 1.1), we have $\tilde{\theta} > \overline{\theta}_{GH} > \overline{\theta}$. Thus, we can rewrite (2.18) as:

$$\pi_1^{PB} = [P_{GH} - c(\alpha_H)](1 - \overline{\theta}_{GH}) = [P_{GH} - c(\alpha_H)](1 - \tilde{\theta}) + [P_{GH} - c(\alpha_H)](\tilde{\theta} - \overline{\theta}_{GH}) \ . \tag{2.21}$$

Since $P_A^S + P_H^S = P_{GH}$, the first term of (2.4) is the same as the first term of (2.21). By virtue of (2.16) and (2.20) the second term of (2.4) can be written

$P_A^S(\tilde{\theta} - \overline{\theta}) = P_A^S[\frac{\alpha_L c(\alpha_H) - \alpha_H c(\alpha_L)}{3\alpha_L(\alpha_H - \alpha_L)}]$, and

$$[P_{GH} - c(\alpha_H)](\tilde{\theta} - \bar{\theta}_{GH}) = [P_{GH}^{PB} - c(\alpha_H)][\frac{\alpha_L c(\alpha_H) - \alpha_H c(\alpha_L)}{3\alpha_H(\alpha_H - \alpha_L)}].$$

Therefore component selling is better than bundling if and only if $P_A^S > [P_{GH} - c(\alpha_H)]\frac{\alpha_L}{\alpha_H}$.

Which requires $\frac{\alpha_L c(\alpha_H) - \alpha_H c(\alpha_L)}{3\alpha_L} > 0$. The latter holds by virtue of $c''(\alpha) > 0$. This proves the proposition.

Figure 2.2 displays market shares under component selling and bundling.

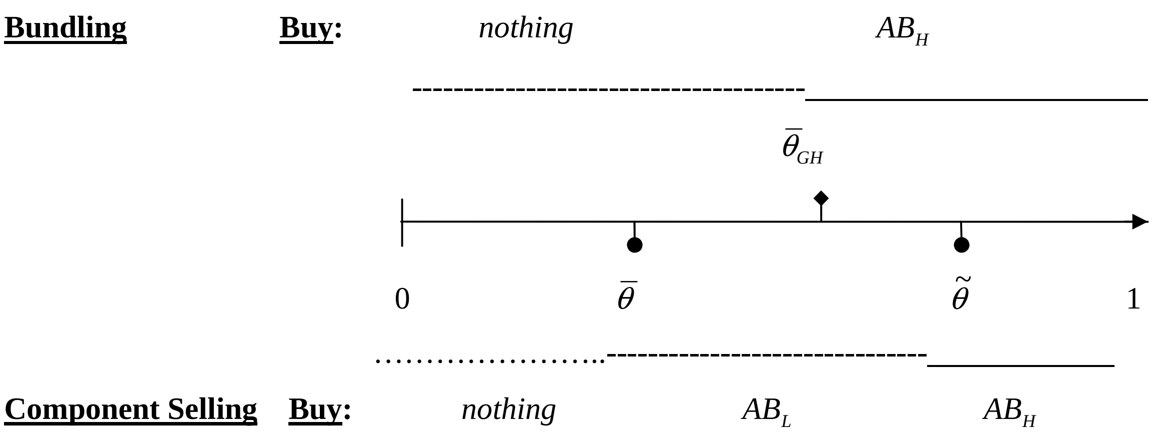

Figure 2.2. Market shares under the two regimes when firm 1 produces B_H

Figure 2.2 shows that when firm 1 sells its components separately, it sells A and B_H to consumers with $\theta \in (1 - \tilde{\theta})$ and A alone to consumers with $\theta \in (\tilde{\theta} - \bar{\theta})$. By contrast when it bundles, it sells AB_H to consumers with $\theta \in (1 - \bar{\theta}_{GH})$. To find which strategy dominates, we must compare the extra profits from bundling that result from selling both A and B_H to consumers with $\theta \in (\tilde{\theta} - \bar{\theta}_{GH})$, to the losses from not selling A to consumers with

$\theta \in (\tilde{\theta} - \bar{\theta})$. The extra profits from bundling are: $[P_{GH} - c(\alpha_H)](\tilde{\theta} - \bar{\theta}_{GH})$, while the losses from bundling are: $P_A^S(\tilde{\theta} - \bar{\theta})$. Therefore separate selling is better than bundling if and only if:

$$P_A^S(\tilde{\theta} - \bar{\theta}) > [P_{GH} - c(\alpha_H)](\tilde{\theta} - \bar{\theta}_{GH}).$$

This condition is met when the production cost is convex in reliability.

The intuition behind proposition 2.2 is straightforward. A switch to bundling from component selling narrows the demand for component A which costs nothing to produce, at the same time it increases the demand for component B_H which cost $c(\alpha_H)$ to produce. Also it reduces the number of systems that can be put together. But to increase the demand for B_H, firm 1 needs to increase the reliability of B_H, in order to decrease the *price per unit of reliability*. Firm 1 can then capture the former consumers of AB_L that have a higher valuation of the system. But when the unit cost is convex in quality, it is not profitable to do so because B_H becomes very costly compared to B_L.

2.5 Case 2: the producer of A also produces B_L

2.5.1 Component selling

The profits of firm 1 and firm 2 are now:

$$\pi_1^S = [P_A^S + P_L^S - c(\alpha_L)](\tilde{\theta} - \bar{\theta}) + P_A^S(1 - \tilde{\theta}), \qquad (2.22)$$

$$\pi_2^S = [P_H^S - c(\alpha_H)](1 - \tilde{\theta}). \qquad (2.23)$$

When both choose prices simultaneously we obtain:

$$P_A^S = \frac{1}{6}[2\alpha_H + \alpha_L - 2c(\alpha_H) - c(\alpha_L)], \qquad (2.24)$$

$$P_H^S = \frac{1}{3}[2c(\alpha_H) + c(\alpha_L) - \alpha_L + \alpha_H], \tag{2.25}$$

$$P_L^S = \frac{1}{3}[c(\alpha_H) + 2c(\alpha_L) - \alpha_H + \alpha_L]. \tag{2.26}$$

In comparison to the case when firm 1 sold B_H (see 2.13, 2.14, and 2.15), we find that the price of A is higher and the prices of B_H and B_L are lower. This comes from the fact that firm 1 sets a higher price for A to capture surplus from consumers with high reservation prices for the system AB_H. Then both firms lower the price of their component B to avoid an excessive increase in the price of systems AB_H and AB_L. [6]

2.5.2 Pure bundling

If firm 1 bundles its profits are:

$$\pi_1^{PB} = [P_{GL} - c(\alpha_L)](1 - \overline{\theta}_{GL}), \tag{2.27}$$

where $\overline{\theta}_{GL} = \frac{P_{GL}}{\alpha_L}.\overline{\theta}_{GL}$ is the preference parameter of a consumer indifferent between purchasing the bundle AB_L and not purchasing at all.

Consumers, who desire to purchase the higher quality system AB_H, must purchase B_H in addition to the bundle AB_L and then discard B_L. Those who do so must have θ such that:

$$\alpha_H\theta - P_{GL} - P_H \geq \alpha_L\theta - P_{GL}. \tag{2.28}$$

The preference parameter of a consumer indifferent between purchasing B_H in addition to AB_L and purchasing AB_L alone is:

---

[6] We assume $c(\alpha)$ to be sufficiently low to justify the existence of a duopoly in market B.

$$\overline{\theta}_H = \frac{P_H}{\alpha_H - \alpha_L}. \tag{2.29}$$

If there exist consumers who purchase B_H in addition to AB_L , their demand is: $1-\overline{\theta}_H$. Therefore firm 2's profits are:

$$\pi_2^{PB} = [P_H^{PB} - c(\alpha_H)](1-\overline{\theta}_H). \tag{2.30}$$

Maximization of (2.27) and (2.30) with respect to prices yields:

$$P_{GL} = \frac{\alpha_{B_L} + c(\alpha_L)}{2}, \tag{2.31}$$

$$P_H^{PB} = \frac{\alpha_H - \alpha_L + c(\alpha_L)}{2}. \tag{2.32}$$

Therefore, $\overline{\theta}_H = \dfrac{P_H^{PB}}{\alpha_H - \alpha_L} = \dfrac{1}{2} + \dfrac{c(\alpha_H)}{2(\alpha_H - \alpha_L)}.$ (2.33)

The latter is smaller than one when:

$$\alpha_H - \alpha_L \geq c(\alpha_H). \tag{2.34}$$

Condition (2.34) must be satisfied for firm 2 to remain in the market. The l.h.s. of (2.34), $(\alpha_H - \alpha_L)$ is the difference in values of systems AB_H and AB_L for the consumer for whom $\theta = 1$. If the consumer with $\theta = 1$ does not purchase B_H, then no other consumer purchases B_H. The demand for B_H is positive only when condition (2.34) holds.

Equilibrium profits for firm 1 and firm 2 are respectively:

$$\pi_1^{PB} = \frac{[\alpha_L - c(\alpha_L)]^2}{4\alpha_L},$$

$$\pi_2^{PB} = \begin{cases} \frac{[\alpha_H - \alpha_L - c(\alpha_H)]^2}{4(\alpha_H - \alpha_L)} & if \quad \alpha_H - \alpha_L \geq c(\alpha_H) \\ 0 & else \end{cases} \tag{2.35}$$

We now show the following:

<u>Proposition 2.2</u>: *When firm 1 produces the lower quality version of B, (i) the bundle price equal the sum of component prices it would set under component selling; and (ii) under bundling its profits are higher than under component selling.*

Proof:

We already know that the price of the system AB_L is the same whether or not firm 1 bundles. The consumer who is indifferent between purchasing AB_L and not purchasing at all is the same under both regimes $(\overline{\theta} = \hat{\theta}_L)$. Indeed from (2.24) and (2.26), we find $\overline{\theta} = \frac{P_A^S + P_L^S}{\alpha_L} = \frac{1}{2}\left[1 + \frac{c(\alpha_L)}{\alpha_L}\right]$, and from (2.31) we find $\overline{\theta}_{GL} = \frac{P_{GL}}{\alpha_L} = \frac{1}{2}\left[1 + \frac{c(\alpha_L)}{\alpha_L}\right]$.

Therefore the demand for A under component selling equals the demand for A under bundling. The demand for B_L under component selling is smaller than the demand for B_L under bundling as: $\tilde{\theta} - \overline{\theta} < 1 - \overline{\theta}_{GL}$. Consequently, the demand of bundle AB_L is higher under pure bundling. Thus, firm 1's profits are higher under bundling than under component selling. This proves the proposition.

Figure 2.3 illustrates the point.

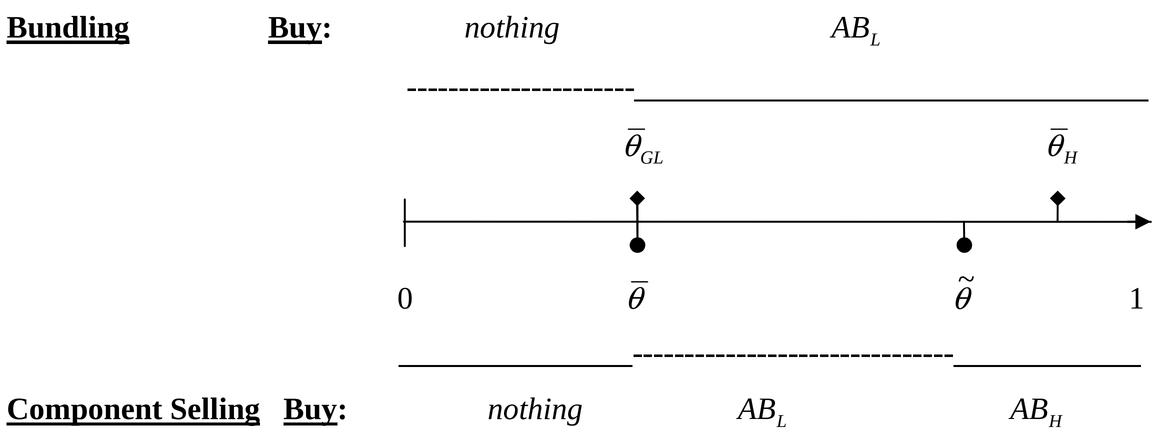

Figure 2.3. Market shares under the two regimes when firm 1 produces B_L

The intuition is as follow. We already know that component A is mandatory for all consumers. By bundling A and B_L firm 1 makes component B_L mandatory as well for all consumers. This increases the demand for B_L because consumers who like AB_H must purchase AB_L to get A. Those who like AB_L demand the same quantity of that system since the price is the same under component selling and bundling. Therefore, the profits of firm 1 are higher under component selling than under and bundling.

The findings for cases 1 and 2 can be summarized as follows. Firm 1 never finds it worthwhile to bundle in order to reduce the level of competition in market for B, when doing so narrows the market for A. The reason is that since A is essential for all systems (AB_H and AB_L), firm 1 benefits from competition in B by way of its sales of A when it produces B_H. On the other hand when it produces B_L, component selling brings no increase in the demand for A. It may in fact reduce the demand for B_L. Therefore component selling is dominated by bundling, which may lead to exclusion of the rival. [7,8]

2.6 Welfare Analysis

Now let us see how consumers' surplus and total welfare are affected by the selling strategies. In all cases (case 1 and case 2), we find the following:

Proposition 2.3: *Consumers' surplus and social welfare are higher under component selling than under bundling*.

Proof :

Case 1: firm 1 produces A and B_H.

When firm 1 sells the components separately, consumers' surplus, denoted CS^S is:

$$CS^S = \int_{\tilde{\theta}}^{1} (\alpha_H \theta - P_A^S - P_H^S) d\theta + \int_{\underline{\theta}}^{\tilde{\theta}} (\alpha_L \theta - P_A^S - P_L^S) d\theta ,$$

Total welfare SW^S is:

$$SW^S = CS^S + \pi_1^S + \pi_2^S .$$

When firm 1 bundles consumers' surplus CS^{PB} is:

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[7] Our results are also in contrast to Choi (2003) who showed in an asymmetric information setting that a monopolist will choose to bundle a product of established quality to one of unknown quality by consumers only if for the latter the monopolist produces a quality higher than rivals'.

[8] Remark that when costs of quality improvement are fixed, the result is straightforward. The monopolist chooses bundling to foreclose its competitor in B. Indeed, as proved by Diallo (2004), for symmetrical distribution of consumers' taste for quality, the monopolist prefers to produce only one variety of a system when costs of quality improvement are fixed. So he would like to eliminate the others varieties from the market.

$$CS^{PB} = \int_{\bar{\theta}_{GH}}^{1} (\alpha_H \theta - P_{GH}) d\theta \,.$$

Total welfare SW^{PB} is:

$$SW^{PB} = CS^{PB} + \pi_1^{PB} + \pi_2^{PB} \;.$$

Figure 2.2 shows that a switch to bundling from component selling makes consumers with $\theta \in [0, \bar{\theta}]$ indifferent because they don't buy under both regimes. Consumers with $\theta \in [\bar{\theta}, \bar{\theta}_{GH}]$ prefer component selling because they have positive surplus under component selling, while they don't buy under bundling. Consumers with $\theta \in [\bar{\theta}_{GH}, \tilde{\theta}]$ prefer component selling because their surplus under component selling is higher than their surplus under bundling (see appendix 2.1). Finally consumers with $\theta \in [\tilde{\theta}, 1]$ are indifferent because they buy AB_H at the same price under both strategies. Therefore, consumers' surplus is higher under component selling than under bundling. As firms' profits are higher under component selling, we conclude that total welfare is higher under component selling than under bundling.

Case 2: firm 1 produces A and B_L.

The price of the system AB_L is the same under both regimes. Thus those who acquire the system AB_L are indifferent. Those who acquire the system AB_H under bundling must purchase both AB_L and B_H. By virtue of revealed preferences we know that those who acquire AB_H under component selling must be better off. Since firms' profits are also higher under component selling, we conclude that total welfare is higher under component selling than under bundling.

2.7 Endogenous Quality

We now consider the two-stage game where in the first stage firms simultaneously choose qualities, and in the second, one firm determines the selling regime and both firms set prices. A solution of this game is a set of equilibrium qualities and prices. We assume that unit cost of quality is:

$$c(\alpha) = \frac{\alpha^2}{2}.$$

If both firms choose the same quality and firm 1 does not bundle, Bertrand competition leads to a unique equilibrium where prices equal unit cost for product B. Therefore firm 2 will want to weaken Bertrand competition by setting a different reliability for B than firm1.

We already know that a certain equilibrium with two active firms requires firm 1 to produce the higher quality of B. Otherwise firm 1 bundles and firm 2 may be excluded. We also know that when firm 1 produces the higher quality of B, component selling dominates bundling.

When the cost of quality is quadratic, the equilibrium prices (2.13), (2.14) and (2.15) in section 2.4 (components selling) are given by:

$$P_A^S = \frac{\alpha_L}{6}\left[2\left(1-\frac{\alpha_L}{2}\right)+\left(1-\frac{\alpha_H}{2}\right)\right], \tag{2.36}$$

$$P_H^S = \frac{\alpha_H - \alpha_L}{2} + \frac{(\alpha_L)^2}{6} + \frac{(3\alpha_H + \alpha_L)\alpha_H}{12}, \tag{2.37}$$

$$P_{B_L}^S = \frac{\alpha_L}{3}\left[\alpha_L + \frac{\alpha_H}{2}\right]. \tag{2.38}$$

Firm 1 wants to choose α_H as close as possible to α_L to induce firm 2 to lower the price of B_L, so it can use A to maximize its profits in markets for A and B. Thus, the gap in qualities must be smaller than in the conventional duopoly model where each firm produces a vertically differentiated non system good.

By substituting these prices into profit functions, and maximizing with respect to qualities, we get a nonlinear system of equations of (α_H, α_L) which is complicated to solve analytically. When solving numerically, the first order conditions with respect to α_H and α_L assuming (2.38-2.38), we obtain[9]:

$$\alpha_H^S = 0.710102, \tag{2.39}$$

$$\alpha_L^S = 0.35505. \tag{2.40}$$

The corresponding prices and profits are[10]:

$$P_A^S = 0.1355;\ P_H^S = 0.3456;\ P_L^S = 0.08404$$

$$\pi_1^S = 0.076329;\ \pi_2^S = 0.002486.$$

To show that these price-reliability combinations constitute a Nash equilibrium, we establish that firm 2 has no incentive to "leapfrog" firm 1 and produce the higher quality of *B*. If firm 2 "leapfrogs" firm 1, it may only sell B_H to consumers who buy AB_L, discard B_L and then buy B_H.

If firm 2 "leapfrogs" firm 1, and firm 2 and chooses a reliability α_H^* greater than $\alpha_H^S = 0.710102$, its profits given by (2.28) become:

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[9] Expressions (2.39) and (2.40) give the pair of candidate equilibrium qualities. The second derivatives with respect to qualities are negative:

$$\frac{\partial^2 \pi_1^S}{(\partial \alpha_H)^2}\Big|_{\alpha_L = 0.71010} = -0.2139 \le 0 \text{ and } \frac{\partial^2 \pi_2^S}{(\partial \alpha_{B_L})^2}\Big|_{\alpha_L = 0.35505} = -0.0394 \le 0.$$

[10] When we compute consumers' surplus and social welfare under both marketing strategies, we find that:

$$CS^S = 0.038165 \quad ; \quad CS^{PB} = 0.03703 \quad ; \quad SW^S = 0.117 \quad ; \quad SW^{PB} = 0.111$$

$$\pi_2 = \begin{cases} \dfrac{[\alpha_H^* - \alpha_H^S - \dfrac{(\alpha_H^*)^2}{2}]^2}{4(\alpha_H^* - \alpha_H^S)} & \text{if} \quad \alpha_H^* - \alpha_H^S \geq \dfrac{(\alpha_H^*)^2}{2}, \\ 0 & \text{else}. \end{cases} \qquad (2.44)$$

When $1 \geq \alpha_H^S \geq \alpha_H^*$ and $\alpha_H^S = 0.710102$, there is no positive value of α_H^* for which $\alpha_H^* - \alpha_H^S \geq \dfrac{(\alpha_H^*)^2}{2}$. Therefore $\pi_2 = 0$. We can now state the following result:

<u>Proposition 2.4</u>: *The producer of component A produces the higher quality of component B.*

We observe that $\alpha_H^S = 2\alpha_L^S$ and $\alpha_H^S - \alpha_L^S = 0.35505$. In the conventional duopoly model where each firm produces a vertically differentiated non system goods we obtain $\alpha_H^D = 0.8195$, $\alpha_L^D = 0.3987$ and $\alpha_H^D - \alpha_L^D = 0.4208$. We see that $\alpha_H^S - \alpha_L^S$ is smaller than $\alpha_H^D - \alpha_L^D$.

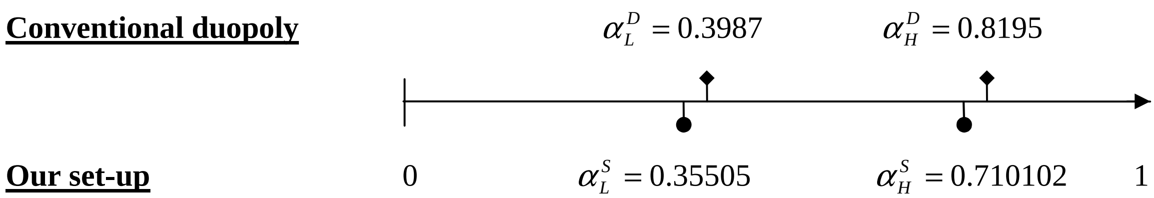

Figure 2.4. Endogenous quality choice

The gap in qualities is lower than the standard profit maximization duopoly outcome. The

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As proved in the previous section, consumers' surplus and social welfare are higher under separate selling than under bundling.

reason is that in our set-up, firm 1 achieves a better extraction of consumers' surplus from the system *AB* by intensifying price competition in market *B.* Consequently, quality differentiation in this market is tighter. Figure 2.4 illustrates the point.

2.8 Final Remarks

We developed a model of quality competition and we showed that a sole producer of an essential component of systems that combine two components chooses bundling, when his produces the higher quality of components where he faces competition. The decision whether or not to bundle is related to market extension for the monopolized component versus the narrowing of the market of the component that is offered competitively. The monopolist chooses the selling strategy which produces the largest demand for all its components. However, in the two-stage game where in the first stage firms simultaneously choose qualities and in the second, the monopolist determines the selling regime and firms set prices, we show that the sole producer offer the higher quality of the component that is supply competitively.

The results of this paper show that bundling can be anticompetitive by exclusion of rivals. Then, this paper can be used to asses a proper legal rule regarding bundling in market for systems that combine vertically differentiated complementary components. For example in the Microsoft litigation, courts had to determine whether it was lawful for Microsoft to bundle Internet Explorer with Windows. Microsoft is dominant in the personal computer operating system market and faces competition in the browser market. Since operating systems and browsers are complementary, this case fits appropriately our model if we assume that the browsers are vertically differentiated. Our results suggest the following[11]:

[11] Absent the possibility that the rivals' browsers might later in the future become a substitute to the operating system, the presence of network externality, and predatory pricing which otherwise lead to others Antitrust issues

(i) the bundling strategy adopted by Microsoft implies that the quality of its browser (Internet Explorer) is lower than the others browsers (e.g. Netscape Navigator); and (ii) Microsoft leverages its market power from the market for operating system to the market for web browser[12].

In most of the studies on bundling there is no clear result about welfare effects. We found that the welfare effects of bundling are clearly negative under the assumption of complementarily. This establishes that an efficiency presumption for bundling in markets of complementary products where one product is produced by a monopoly is unwarranted. In an imperfect and asymmetric information world, bundling may also be a signal for the quality of the monopolist's component that is supply competitively. Because we already know that under some assumptions bundling takes place only when the monopolist produces the lowest quality of the component that is offered competitively.

It is worthwhile to note that the results of this paper must be interpreted under the following simplifications: we ignored positive demand externalities (or network externalities) and we assumed no cost savings result from bundling. Network externalities will increase the profitability of component selling, while cost savings that result from economy of scope in distribution will increase the profitability of bundling. Finally, for future research, it will be interesting to look at the case where each firm supplies all the components necessary to form the complete system.

[12] The same conclusions apply to the Microsoft litigation in media players.

CHAPITRE 3

Bundling in Communication Markets

3.1 Introduction

Today consumers are offered telephone, high speed Internet and television services by cable operators and telecom companies. Cable operators supply broadband Internet access and voice telephony in addition to their "traditional" video services. Similarly, telecom companies supply telephone, video images and high speed Internet[1]. Typically cable operators and telecoms require subscribers to take their traditional service and they offer add-on services for an extra payment that is lower than the stand alone price of these services.

The purchase of all services from a single supplier is said to be convenient for buyers. It is also said to be a deterrent to churn [2] because disappointment with one service can be compensated by satisfaction with another service[3].

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[1] In Quebec the dominant cable operator, Videotron provides digital television, telephone and high-speed Internet services with the coaxial cable technology while the dominant telecommunication company, Bell Canada provides the same services with satellite transmission and twisted pair. Coaxial cable is the kind of cable used by cable TV companies between the community antenna and the user homes and businesses. It carries broadband services for a great distance. To offer high speed Internet services, a cable operator creates a data network that operates over its hybrid fiber/ coax (HFC) plant. A twisted pair is an ordinary copper wire that connects home and business computers to the telephone company. DSL (Digital Subscriber line) Internet access provided by the local telephone company convert existing twisted-pair telephone lines into access paths for multimedia and high-speed data communications. So with satellite and twisted pair technologies, a local telecommunication company can also supply same kind of services as a local cable operator.

[2] The rate at which customer discontinues service (in order to shift to competitor) - among high usage customers, at the expense of profit margins: Keith Damsell "Telecom bundling seem luring customers. Grouping services together for lower prices builds loyalty, turn "churn" low. Study says "The Globe and Mail, 29 September 2003, at p.138, citing Convergence Consulting Group ltd study: The Battle for the North American Couch Potatoes, and referring to Cox Communications, extremely low churn rate with the triple play services of digital television, high speed internet access, and local telephone services.

[3] On the other hand consumers can drop all services when they are disappointed with one of them.

It is believed that the traditional telephone operator provides better telephone service than the cable operator, whereas the latter provides better television. Both offer a similar quality of high speed Internet[4]. Consumers therefore have to choose, between lower quality telephone combined with high quality television offered by the cable operator, and higher quality telephone with lower quality television offered by the telephone company.

This paper addresses the following questions: (i) under what conditions do suppliers bundle? that is under what conditions does it sell two or more services as a package only? ; (ii) how does bundling compare to component selling in terms of welfare? ; and (iii) what attitude should competition authorities adopt toward such bundling?

There are no clear-cut results pertaining to the profitability and welfare effect of bundling as opposed to separate selling of components. Adams and Yellen (1976), Schmalensee (1982, 1984), Mc Afee et al (1989), and Whinston (1990) show that under monopoly bundling raises profits when variable costs are zero. However, the vast majority of consumer services are supplied in non-monopolistic environments. Only few papers [(Matutes and Regibeau, 1992; Economides, 1993; Anderson and Leruth, 1993; Kopalle and al, 1999)] examine the non-monopolistic case where firms have the option of bundling. Theses papers assume horizontal differentiation of services and their conclusions are numerical.

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[4] Indeed cable telephony has some limitations: e.g. it doesn’t work when there is power failure and drop out when broadband demand (the ability of the user to view content across the internet that includes large files, such as video, audio and 3D) is high. Also not all areas are served by the POC since hybrid fiber/ coax (HFC) plants are expensive to install. Consequently additional costs of providing services to additional customers are higher for co-ax (HFC) technology than twisted pair technology. On the other hand the television service of telecoms has also severe limitations in competing with cable TV. It encounters some constraints due to broadband transmission, to cities’ architectures, to weather conditions and it needs an installation of a non esthetical device, the dish.

Economides (1993) considers a two-stage game and shows that the Nash equilibrium is mixed bundling[5] rather than component selling. Because competition is more intense under mixed bundling, a prisoner's dilemma arises, that is firms would be better off if they could commit not to bundle. Anderson and Leruth (1993) show in a two-stage model that the Nash equilibrium is both firms offer components selling. The reason is that firms fear the extra degree of competition intrinsic to mixed bundling. Kopalle and al (1999) reconcile the result of Economides (1993) and Anderson and Leruth (1993) by incorporating the role of market expansion on equilibrium bundling strategies. They show that for complementary components mixed bundling dominates component selling only when it creates a new market for the bundle.

Matutes and Regibeau (1992) consider a game where in the first stage there is a choice between compatibility versus incompatibility[6]. In the second and the third stage of the game firms choose the selling strategy and prices respectively. Matutes and Regibeau ask whether firms would choose to make their products compatible and whether they would sell their products as a bundle. For compatible components, they find that, depending on consumer's reservation price there can be two kinds of equilibria. In the first, one firm bundles and one firm does not. In the second, both firms bundle[7].

None of the aforementioned papers is concerned with: (i) vertically differentiated services; and (ii) they do not give clear results about the welfare effect of bundling. The underlying motivation of this paper is to analyze the competition and the welfare effect of bundling in

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[5] Mixed bundling means that the packages as well as the individual components of the package are available.

[6] A component is incompatible with components sold by other firms', if it cannot be assembled with them to form a usable system. The economic consequence of compatibility versus incompatibility have been examined by Matutes and Regibeau (1988), Economides (1989, 1991), and Einhorn (1992). They have looked at the case where each firm supplied all the necessary goods.

[7] The first equilibrium occurs when consumer's reservation price is low, while the second one occurs when it is high.

the communication market within the context of vertically differentiated services. We consider a two-stage game with two asymmetric firms. In the first stage firms simultaneously commit to use bundling or component pricing. These decisions give four possible configurations: (i) a configuration where both firms use component pricing; (ii) a configuration where both firms use bundling; and finally (iii) the two configurations where one firm use bundling and the other firm does not. In the second stage firms set prices simultaneously.

We show that bundling is a dominant strategy equilibrium for both firms. The reason is that bundling increases the differentiation of services and reduces the intensity of price competition[8]. We also find that although the bundling-bundling equilibrium reduces consumers' surplus, the total economic welfare is higher than when both firms use component pricing.

The paper is structured as follows. In section 3.2, we present a duopoly model, where each firm has the choice to sell its services either separately or as a bundle. In section 3.3, we analyze the game. In section 3.4, we derive the equilibrium selling strategy of each firm. In section 3.5, we analyze the welfare consequences of bundling. In section 3.6, we provide an application of the model to the communication market and we conclude.

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[8] Chen (1997) also analyzes bundling as differentiation tool. He studies the case where two sellers compete in a first market, and both also sell another product in a second competitive market. Absent bundling, Bertrand competition drives both sellers' profits in the first market to zero. If one seller uses bundling and the other does not, however, both can earn positive profits since the bundle and the individual first-market product are effectively differentiated products.

3.2 The Model

There are two firms, denoted *h* and *l*. E.g. firm *h* is a telecom company and firm *l* is a cable operator. Each firm sells two services, denoted *A* and *B*. E.g. service *A* is a telephone service and service *B* is an Internet service. The service *A* comes in two qualities, a_h and a_l supplied respectively by firm *h* and firm *l*, $a_h > a_l > 0$. The quality b of service *B* is the same for both firms. Both the variable cost and the fixed cost are zero for each service. Every consumer demands one or zero unit of service of *A* and/or *B*.

A consumer with a parameter θ derives a utility θa_i from quality a_i of service *A*, $i = h, l$. Similarly, a consumer with a parameter γ derives a utility γb from quality *b* of service *B*. If the consumer chooses not to buy a service, she receives her reference utility which is normalized to zero. A consumer with preference indices (θ, γ) who buys one unit of *A* of quality a_i at price p_i and one unit of B at price p_B receives a net surplus:

$$U = (\theta a_i - p_i) + (\gamma b - p_B), i = h, l$$

Each consumer makes her purchase decision to maximize her consumer surplus. Consumer preference indices θ and γ are independently and uniformly distributed on $[0,1] \times [0,1]$.

We model the competition as a two-stage game. In the first stage, firms decide whether to bundle, or not to bundle; in the second stage[9] they set prices. There are four possible subgames at stage 2: (i) (C_h, C_l) denotes the game where both firms sell components separately; (ii) (B_h, B_l) denotes the game where both firms bundle; (iii) (B_h, C_l) denotes the game where firm *h* bundles, and firm *l* sells its components separately; and

[9] Firms observe the choices made in the first stage.

(iv) (C_h, B_l) denotes the game where firm *h* sells its components separately, and firm *l* bundles. We will examine under what conditions each of the subgame is an equilibrium.

3.3 Price determination

3.3.1 Case (i): (C_h, C_l), Pure Components by both Firms

Since both firms produce the same quality of service *B*, Bertrand competition insures that its price is driven down to marginal cost, which is zero. With regard to service *A*, we know[10] that an equilibrium with two active firms requires[11]: $\frac{p_h}{a_h} \geq \frac{p_l}{a_l}$. We designate by $\bar{\theta}$ the consumer indifferent between not purchasing and purchasing one unit of A_l, and by $\tilde{\theta}$ the consumer who is indifferent between purchasing A_l and A_h. Figure 3.1 displays market shares as $(1-\tilde{\theta})$ for firm *h* and $(\tilde{\theta}-\bar{\theta})$ for firm *l* when firms compete in prices.

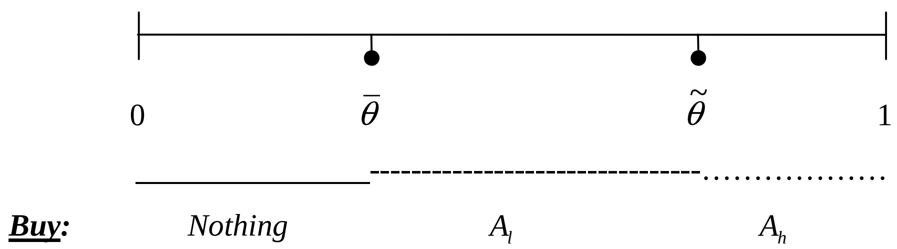

Figure 3.1. Market areas under the regime (C_h, C_l)

[10] See Tirole (1988)

[11] The condition states that the *price per unit of quality* is higher for a_h than for a_l. This means that low quality is not dominated by high quality. If low quality is dominated by high quality then the firm with the low quality exits the market.

The firms' profits are:

$$\pi_h^{C_h,C_l} = p_h(1-\tilde{\theta}) \quad \text{for firm } h,$$

$$\pi_l^{C_h,C_l} = p_l(\tilde{\theta}-\bar{\theta}) \quad \text{for firm } l,$$

where $\bar{\theta} = \frac{p_l}{a_l}$ and $\tilde{\theta} = \frac{p_h - p_l}{a_h - a_l}$. Prices are chosen optimally when they satisfy the conditions below

$$p_h = \frac{2(a_h^2 - a_h a_l)}{4a_h - a_l}, \text{ and } p_l = \frac{(a_h - a_l)a_l}{4a_h - a_l}.$$

Then:

$$\pi_h^C = \frac{4a_h^2(a_h - a_l)}{(4a_h - a_l)^2}, \text{ and } \pi_l^C = \frac{a_h a_l(a_h - a_l)}{(4a_h - a_l)^2}.$$

3.3.2 Case (ii): (B_h, B_l), Bundling by both Firms:

Denote by p_{Gh} and p_{Gl} the prices of bundles $A_h B$ and $A_l B$ respectively. The individual-rationality constraints are

for consumers of $A_h B$: $\theta a_h + \gamma b - p_{Gh} \geq 0$, (R_h)

for consumers of $A_l B$: $\theta a_l + \gamma b - p_{Gl} \geq 0$. (R_l)

Self-selection constraints are

for consumers of $A_h B$: $\theta a_h + \gamma b - p_{Gh} \geq \theta a_l + \gamma b - p_{Gl}$, (S_h)

for consumers of $A_l B$: $\theta a_l + \gamma b - p_{Gl} \geq \theta a_h + \gamma b - p_{Gh}$. (S_l)

The condition $\theta a_h + \gamma b - p_{Gh} \geq Max(0, \theta a_l + \gamma b - p_{Gl})$ must be satisfied by buyers of $A_h B$.
The condition $\theta a_l + \gamma b - p_{Gl} \geq Max(0, \theta a_h + \gamma b - p_{Gh})$ must be satisfied by buyers of $A_l B$.

We find again that market areas depend on the ranking of *price per unit of quality* of service *A*. To see how, we define the preference parameter of the consumer indifferent between the bundles $A_h B$ and $A_l B$ by $\theta^* \equiv \frac{p_{Gh} - p_{Gl}}{a_h - a_l}$. We distinguish three cases.

Case 1: $\frac{p_{Gh}}{a_h} \leq \frac{p_{Gl}}{a_l}$.

Case 2: $\frac{p_{Gh}}{a_h} \geq \frac{p_{Gl}}{a_l}$ and $\theta^* < 1$.

Case 3: $\frac{p_{Gh}}{a_h} \geq \frac{p_{Gl}}{a_l}$ and $\theta^* > 1$

In case 1 the *price per unit of quality* of $A_h B$ is lower than *price per unit of quality* of $A_l B$. In case 2 and case 3 *the price per unit of quality* of $A_h B$ is higher than the *price per unit of quality* of $A_l B$. The difference between case 2 and case 3 is that in the latter there is no consumer indifferent between $A_h B$ and $A_l B$.

Case 1: $\frac{p_{Gh}}{a_h} \leq \frac{p_{Gl}}{a_l}$.

The price of bundle $A_h B$ per unit of quality of service *A* is lower than the price of bundle $A_l B$ per unit of quality of service *A*. The lines labelled R_h and R_l in Figure 3.2 are the individual-rationality constraints of high and low quality buyers.

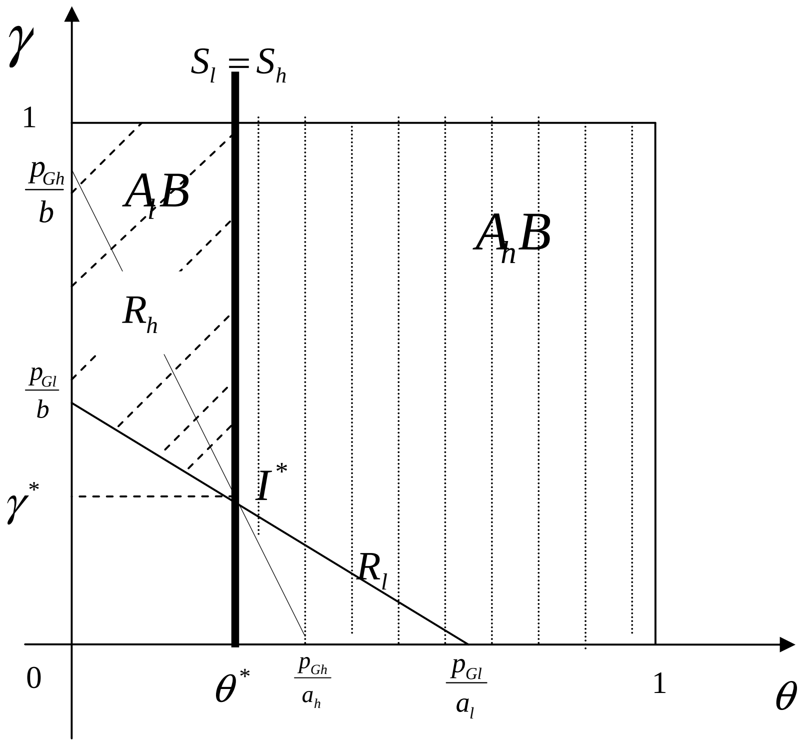

Figure 3.2: Market areas under the regime (B_h, B_l) when $\frac{p_{Gh}}{a_h} \leq \frac{p_{Gl}}{a_l}$

The lines S_h and S_l represent[12] the self-selection constraint faced by consumers. Consumers with preference parameters above R_h derive positive utility from $A_h B$.

[12] The constraints S_h and S_l yield the same line.

Consumers with preference parameters above R_l derive positive utility from $A_l B$. We note that S_h, S_l, R_h and R_l intersect at $I^* \equiv \left(\theta^* \equiv \frac{p_{Gh} - p_{Gl}}{a_h - a_l}; \gamma^* \equiv \frac{a_h p_{Gl} - a_l p_{Gh}}{a_h - a_l} \right)$.

The high quality firm serves consumers with preference parameters $\theta \in [\theta^*, 1]$ and above R_h ; the low quality firm serves consumers with preference parameters $\theta \in [0, \theta^*]$ and above R_l. The size of market served by the firm *h* is $D_{Gh} = 1 - \theta^* - \frac{(\gamma^*)^2}{2a_h}$ and the size of market served by the firm *l is* $D_{Gl} = \theta^*(1 - \frac{p_{Gl}}{2b} - \frac{\gamma^*}{2})$. Firm *h* and firm *l* profits' function are respectively:

$$\pi_h^{PB} = p_{Gh} D_{Gh} \text{ and } \pi_l^{PB} = p_{Gl} D_{Gl} .$$

In contrast to the standard model of single differentiated good, we find that there can be two active firms even when $\frac{p_{Gh}}{a_h} \leq \frac{p_{Gl}}{a_l}$[13]. The difference is as follows: in standard models of a single differentiated good, consumers make the comparison on a service by service basis. If A_l is dominated by A_h, all consumers obtain more surplus from A_h than from A_l. Nobody purchases A_l. We also know that for service *B*, Bertrand competition and zero marginal cost imply that consumers obtain *B* for free from both firms. Thus firm *l* is excluded from market *A*, but remains in market *B*. In the regime of (B_h, B_l) there is a competition for vertically differentiated system goods. Therefore, the best available alternative for consumers who wish to purchase only service *B* is to purchase the low quality bundle $A_l B$. In that case, if A_l is dominated by A_h the low quality firm can survive

[13] That is the low quality system is dominated by the high quality system.

in both markets because it serves the bundle $A_l B$ to consumers who care very little about service *A*, while the high quality firm serves the bundle $A_h B$ to consumers who care for service *A* and for service *B*.

Case 2: $\frac{p_{Gh}}{a_h} \geq \frac{p_{Gl}}{a_l}$ and $\theta^* < 1$.

The price of bundle $A_h B$ per unit of quality of service *A* is higher than the price of bundle $A_l B$ per unit of quality of service *A* and there exist a consumer who is indifferent between the bundles. Market areas are shown in Figure 3.3.

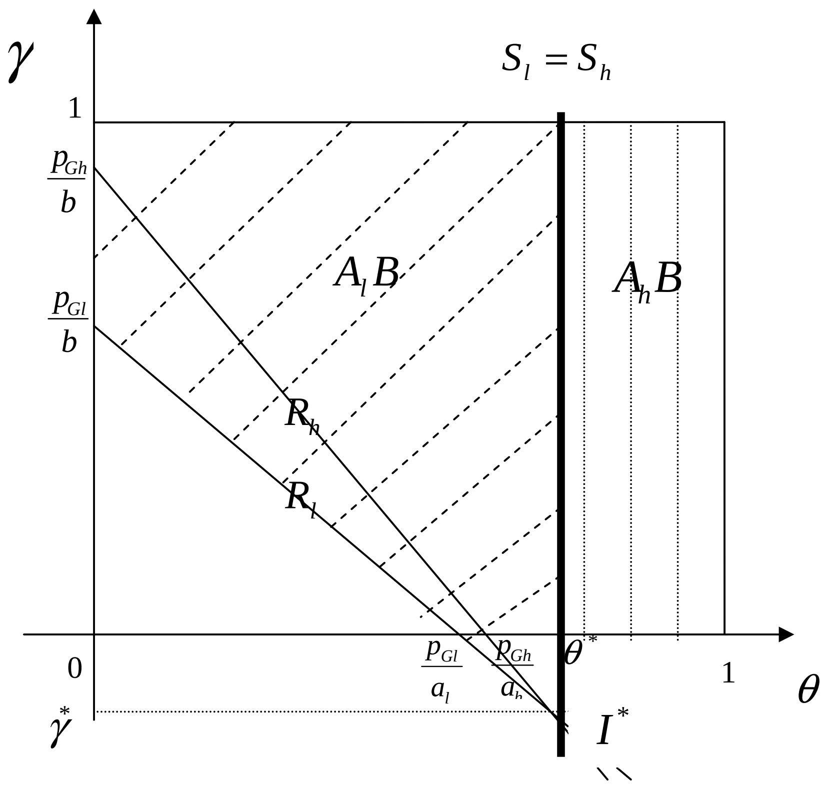

Figure 3.3: Market areas under the regime (B_h, B_l) when $\frac{p_{Gh}}{a_h} \geq \frac{p_{Gl}}{a_l}$ and $\theta^* < 1$.

The high quality firm serves consumers with preference parameters $\theta \in [\theta^*, 1]$ and above R_h. The low quality firm serves consumers with preference parameters $\theta \in [0, \theta^*]$

and above R_l. Consumers with preference parameters below R_l do not purchase at all. The market areas for A_hB and A_lB are respectively: $D_{Gh} = 1 - \theta^*$ and $D_{Gl} = \theta^*\left[1 - \frac{(p_{Gl})^2}{2ba_l}\right]$.

Case 3: $\frac{p_{Gh}}{a_h} \geq \frac{p_{Gl}}{a_l}$ and $\theta^* \geq 1$.

The price of bundle A_hB per unit of quality of service A is higher than the price of bundle A_lB per unit of quality of service A and nobody is indifferent between the bundles. Market areas are displayed in Figure 3.4.

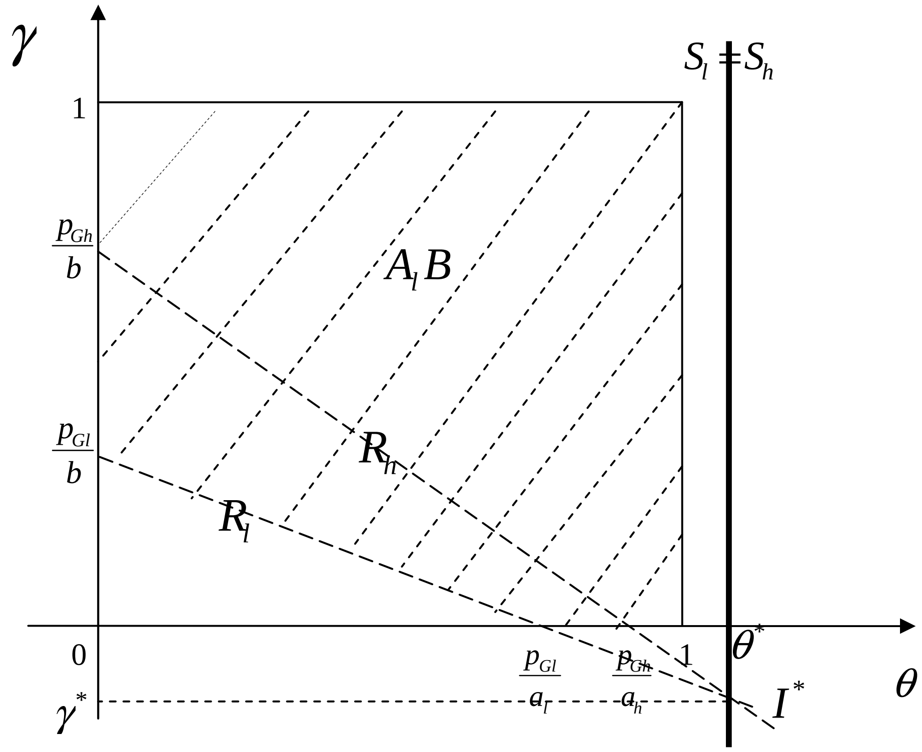

Figure 3.4: Market areas under the regime (B_h, B_l) when $\frac{p_{Gh}}{a_h} \geq \frac{p_{Gl}}{a_l}$ and $\theta^* \geq 1$.

Because $\theta^* \geq 1$, the demand for the bundle $A_h B$ is zero. The low quality firm serves consumers with preference parameters $\theta \in [0,1]$ and above R_l [14]. Consumers with preference parameters below R_l do not purchase at all. The market areas for $A_h B$ and $A_l B$ are respectively: $D_{Gh} = 0$ and $D_{Gl} = 1 - \frac{(p_{Gl})^2}{2ba_l}$

3.3.2.1 Determination of the equilibrium prices in (B_h, B_l)

In case 1 the first order conditions are:

$$\frac{\partial \pi_h^B}{\partial p_{Gh}} = 1 - \frac{2p_{Gh}}{a_h - a_l} - \frac{3}{2a_h}\left(\frac{a_l p_{Gh}}{a_h - a_l}\right)^2 + \left(\frac{a_l}{a_h - a_l} + \frac{2a_l p_{Gh}}{(a_h - a_l)^2}\right)p_{Gl} - \frac{a_h}{2}\left(\frac{p_{Gl}}{a_h - a_l}\right)^2 = 0$$

$$\frac{\partial \pi_l^B}{\partial p_{Gl}} = p_{Gh} + \frac{a_l (p_{Gh})^2}{2(a_h - a_l)} - 2p_{Gl} - \left(\frac{1}{b} + \frac{a_h + a_l}{a_h - a_l}\right)(p_{Gh} p_{Gl}) + \left(\frac{3}{2b} + \frac{3a_h}{2(a_h - a_l)}\right)(p_{Gl})^2 = 0$$

We can see that the first order conditions are quite complex. We obtain similar complicated first order conditions for all others cases. For this reason, we search the price equilibria numerically for a range of values of a_h and a_l.

In case 1, the equilibrium prices that we obtain always satisfy $\frac{p_{Gh}}{a_h} \leq \frac{p_{Gl}}{a_l}$. Figure 3.5 shows the equilibrium values of $\frac{p_{Gh}}{a_h}$ and $\frac{p_{Gl}}{a_l}$ for different values of a_h.

[14] In that case , firm *h* makes zero profit and it easy to see that this is not an equilibrium because firm *h* is always better off (makes positive profits) by choosing its price such that $\theta^* \leq 1$.

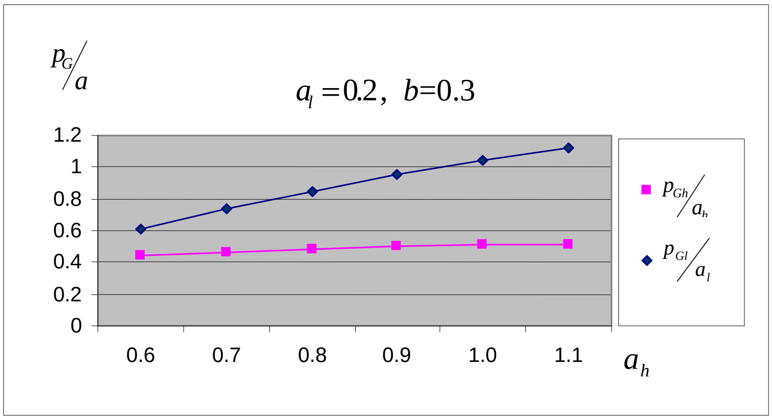

Figure 3.5: Comparison of prices per unit of quality under regime (B_h, B_l)

In case 2 and 3, the equilibrium prices that we obtain do not satisfy $\frac{p_{Gh}}{a_h} > \frac{p_{Gl}}{a_l}$. Therefore, we will only look at case 1.

It is interesting to compare profits in (B_h, B_l) to profits in (C_h, C_l). The profits under the regime (C_h, C_l) and the regime (B_h, B_l) for different values of a_h are shown in Figure 3.6. $\pi_h^{B_h,B_l}$ is always higher than $\pi_h^{C_h,C_l}$. Similarly, $\pi_l^{B_h,B_l}$ is always higher than $\pi_l^{C_h,C_l}$. We obtain similar results for various values of a_l.

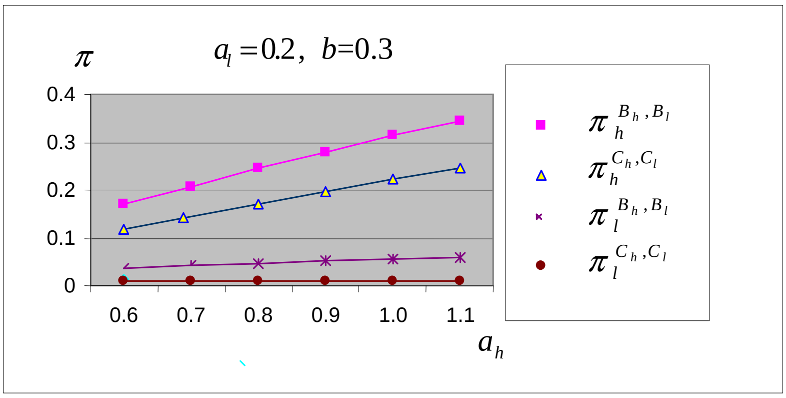

Figure 3.6: Comparison of firms' profits under the regimes (C_h, C_l) and (B_h, B_l).

We see that both firms are better when they bundle. The reason is that bundling affects the intensity of competition via two channels: (i) it reduces the intensity of the competition for service *B* by increasing differentiation; and (ii) it increases the intensity of the competition for service *A* by reducing differentiation. The net effect of bundling is a decrease of competition between the two firms because the competition for *B* under component pricing is extreme (Bertrand competition). Therefore each makes more profits in the subgame (B_h, B_l) than in the subgame (C_h, C_l).

3.3.3 Case (iii): (B_h, C_l), Bundling by firm *h*, Pure Component Selling by firm *l*

The individual-rationality constraints are now

for consumers of $A_h B$: $\theta a_h + \gamma b - p_{Gh} \geq 0$, (R_h)

for consumers of A_l : $\theta a_l - p_l \geq 0$, (R_l)

for consumers of B : $\gamma b - p_B \geq 0$, (R_b)

for consumers of $A_l + B$ [15] : $\theta a_l + \gamma b - p_l - p_B \geq 0$. (R_m)

The self-selection constraints are

for consumers of $A_h B$: $\theta a_h + \gamma b - p_{Gh} \geq Max(\theta a_l + \gamma b - p_l - p_B, \theta a_l - p_l, \gamma b - p_B)$, (S_h)

for consumers of A_l : $\theta a_l - p_l \geq Max(\theta a_h + \gamma b - p_{Gh}; \theta a_l + \gamma b - p_l - p_B; \gamma b - p_B)$, (S_l)

for consumers of B : $\gamma b - p_B \geq Max(\theta a_h + \gamma b - p_{Gh}; \theta a_l + \gamma b - p_l - p_B; \theta a_l - p_l)$, (S_b)

for consumers of $A_l + B$: $\theta a_l + \gamma b - p_l - p_B \geq Max(\theta a_h + \gamma b - p_{Gh}; \gamma b - p_B; \theta a_l - p_l)$. (S_m)

The condition $\theta a_h + \gamma b - p_{Gh} \geq Max(0, \theta a_l + \gamma b - p_l - p_B, \theta a_l - p_l, \gamma b - p_B)$ must be satisfied by buyers of $A_h B$.

The condition $\theta a_l - p_l \geq Max(0, \theta a_h + \gamma b - p_{Gh}; \theta a_l + \gamma b - p_l - p_B; \gamma b - p_B)$ must be satisfied by buyers of A_l alone.

The condition $\gamma b - p_B \geq Max(0, \theta a_h + \gamma b - p_{Gh}; \theta a_l + \gamma b - p_l - p_B; \theta a_l - p_l)$ must be satisfied by buyers of B alone.

And finally the condition $\theta a_l + \gamma b - p_l - p_B \geq Max(0, \theta a_h + \gamma b - p_{Gh})$ must be satisfied by buyers of both A_l and B.

From S_h, we derive that the preference index of the consumer indifferent between purchasing $A_h B$ and purchasing A_l and B separately is $\hat{\theta} \equiv \frac{p_{Gh} - p_l - p_B}{a_h - a_l}$. Note that S_l, R_h, and R_l intersect at $\hat{I} \equiv \left(\frac{p_l}{a_l}; \hat{\gamma} \equiv \frac{1}{b}(p_{Gh} - \frac{a_h}{a_l} p_l) \right)$. $\hat{\gamma}$ can be understood as the implicit *price per unit of quality of B*, when the quality of *A* is valued at the price set by firm *l*. Note also that R_h , R_b, and S_b intersect at $\left(\frac{p_{Gh} - p_B}{a_h}; \frac{p_B}{b} \right)$[16]. The market areas depend on

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[15] Consumers of $A_l + B$ means consumers of both A_l and B but each component is purchased separately.

[16] Service *B* is sold as part of the bundle $A_h B$. Remark that $\frac{p_B}{b} < \frac{1}{b}(p_{Gh} - \frac{a_h}{a_l} p_l) \equiv \hat{\gamma}$ can be written as: $\frac{p_{Gh} - p_B}{a_h} > \frac{p_l}{a_l}$. The ratio $\frac{p_{Gh} - p_B}{a_h}$ represents the *implicit price per unit of quality* of A_h when it is sold as part of the bundle $A_h B$. Thus market areas depends on whether this *implicit price per unit of quality* is greater, lower or equal to the explicit *price per unit of quality* of A_l .

whether $\hat{\gamma}$, the *implicit price per unit of quality* of B is greater, lower or equal to $\frac{p_B}{b}$, the *explicit price per unit of quality* of *B* set by firm *l*. We now distinguish three cases.

Case 1: $p_{Gh} > p_l + p_B$ and $\hat{\gamma} > \frac{p_B}{b}$.

Case 2: $p_{Gh} > p_l + p_B$ and $\hat{\gamma} \leq \frac{p_B}{b}$.

Case 3: $p_{Gh} \leq p_l + p_B$.

In case 1 and case 2 the price of the bundle $A_h B$ is higher than the price of both A_l and B. The difference between the two cases is that in case 1 the *implicit price per unit of quality* of *B is* greater than the *explicit price per unit of quality* of *B* set by firm *l*. While in case 2 the *implicit price per unit of quality* of *B is* lower than the *explicit price per unit of quality* of *B* set by firm *l*. In case 3 the price of the bundle $A_h B$ is lower than the price of both A_l and B.

Case 1: $p_{Gh} > p_l + p_b$ and $\hat{\gamma} > \frac{p_B}{b}$

It is the case where the implicit *price per unit of quality of B* is larger than the *explicit price per unit of quality* of *B*. Figure 3.7 shows that parameter space divides into five segments[17]

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[17] We recall that $\hat{\theta} \equiv \frac{p_{Gh} - p_l - p_B}{a_h - a_l}$ and $\hat{\gamma} \equiv \frac{1}{b}(p_{Gh} - \frac{a_h}{a_l} p_l)$.

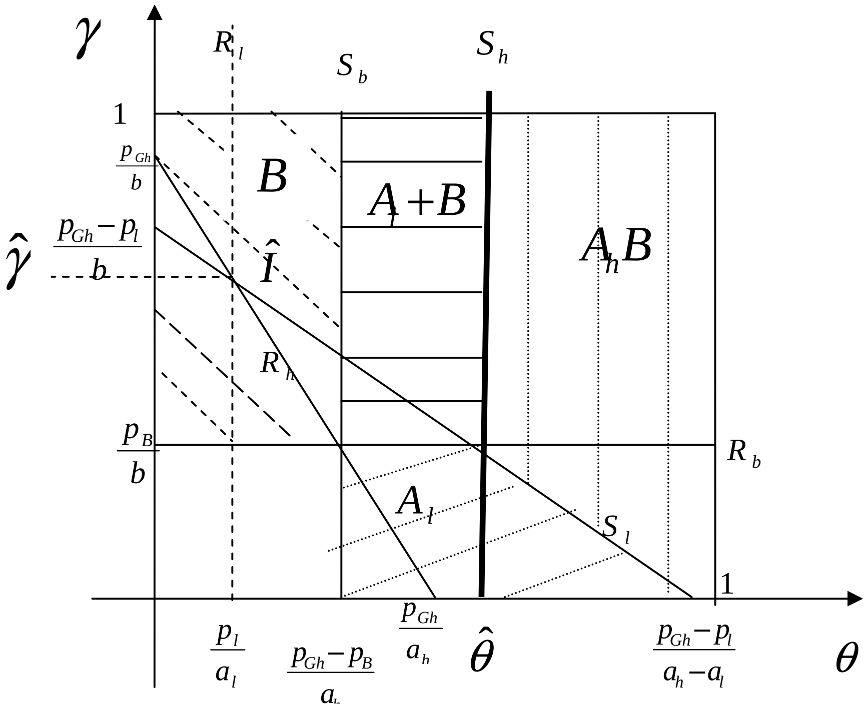

Figure 3.7: Market areas under the regime (B_h, C_l) when $p_{Gh} > p_l + p_b$ and $\hat{\gamma} > \frac{p_B}{b}$

Consumers with preference parameters to the right of S_h and above S_l purchase the bundle $A_h B$. The market area of those consumers is $D_{Gh} = 1 - \hat{\theta} - \frac{(p_B)^2}{2b(a_h - a_l)}$. Consumers with preference parameters between S_b and S_l and below R_b purchase A_l alone. The market area of those consumers is $D_{A_l} = \frac{p_B}{b}\left[\hat{\theta} - \frac{p_{Gh} - p_B}{a_h} + \frac{p_B}{2(a_h - a_l)}\right]$. Consumers with preference parameters to the left of S_h, to the right of S_b, and above R_b purchase A_l and B. The market area of those consumers is $D_{A_l+B} = \left(\hat{\theta} - \frac{p_{Gh} - p_B}{a_h}\right)\left(1 - \frac{p_B}{b}\right)$. Finally consumers with preference parameter to the left of S_b and above R_b purchase B alone. The market area of those consumers is $D_B = \left(\frac{p_{Gh} - p_B}{a_h}\right)\left(1 - \frac{p_B}{b}\right)$. Others don't purchase.

Case 2: $p_{Gh} > p_l + p_b$ and $\hat{\gamma} \leq \dfrac{p_B}{b}$

It is the case where the implicit *price per unit of quality of B* is lower than the explicit *price per unit of quality* of *B*. Figure 3.8 shows that parameter space divides into four segments.

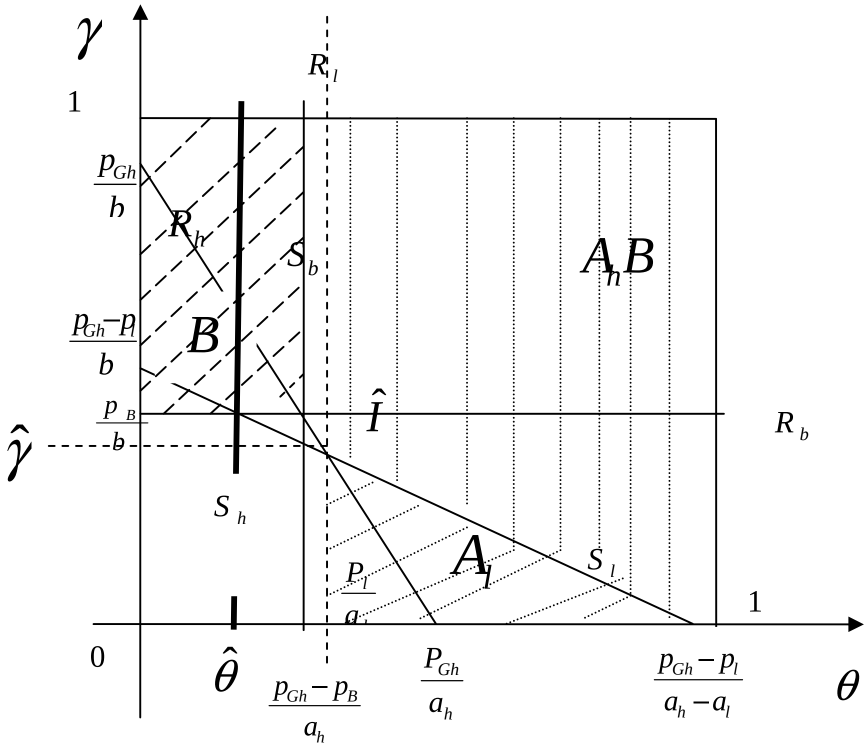

Figure 3.8: Market areas under the regime (B_h, C_l) when $p_{Gh} > p_l + p_B$ and $\hat{\gamma} \leq \dfrac{p_B}{b}$

The allocation of consumers is as follows: consumers with preference parameters to the right of S_b, above R_h and above S_l purchase $A_h B$. Those with preference parameters to the left of S_b and above R_b purchase *B* alone. Finally consumers with preference parameter to the right of R_l and below S_l purchase A_l alone. Others don't purchase.

We see in Figure 3.8 that $\hat{\theta} < \frac{p_{Gh} - p_B}{a_h}$ and S_b is to the right of S_h. Therefore nobody buys $A_l + B$, that is no consumer purchases B separately when she also purchases A_l [18]. The reason is that the explicit price of B is higher than the implicit price of B when purchased as part in the bundle $A_h B$.

For the particular case where $\hat{\gamma} \equiv \frac{p_B}{b}$, we have $S_h \equiv S_l \equiv R_l$ and the allocation of consumers in the parameter space is the same as above.

Case 3: $p_{Gh} \leq p_l + p_B$

It is the case where the consumers who purchase B separately, also purchase A_l and pay for both services a price higher than the price of the bundle $A_h B$. In this case the demand for both A_l and B is zero since consumers can purchase $A_h B$, that is they can get a better bundle at a lower price. But consumers purchase A_l alone and B alone. Market areas are shown in Figure 3.9.

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[18] Recall that buy $A_l + B$ means buy both A_l and B.

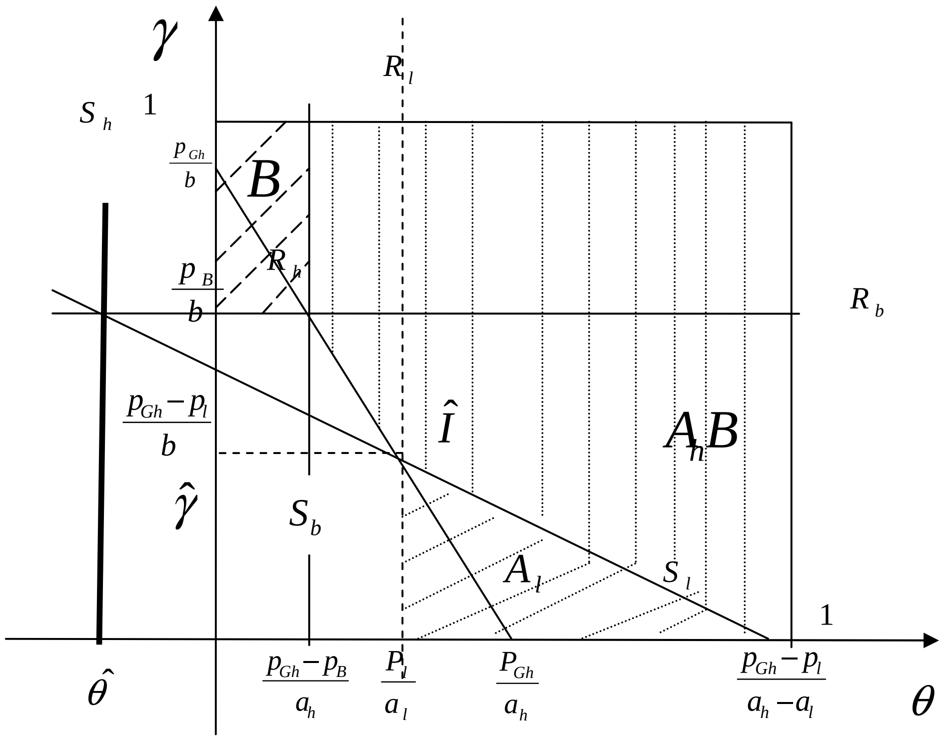

Figure 3.9: Market areas under the regime (B_h, C_l) when $p_{Gh} \leq p_l + p_B$

Figure 3.9 depicts a similar pattern as for Figure 3.8. Therefore case 2 and case 3 give the same allocation of consumers in the parameter space.

3.3.3.1 Determination of the equilibrium prices in (B_h, C_l)

Here also the first order conditions are quite complex. We search the price equilibria numerically for a range of values of a_h and a_l. Figure 3.10 shows the equilibrium values of $\hat{\gamma}$ and $\frac{p_B}{b}$ for a range of values of a_h[19] in case 1. The equilibrium prices that we obtain always satisfy $\hat{\gamma} > \frac{p_B}{b}$. In case 2 and 3, the equilibrium prices that we obtain do not satisfy $\hat{\gamma} \le \frac{p_B}{b}$. Therefore, we will only look at case 1.

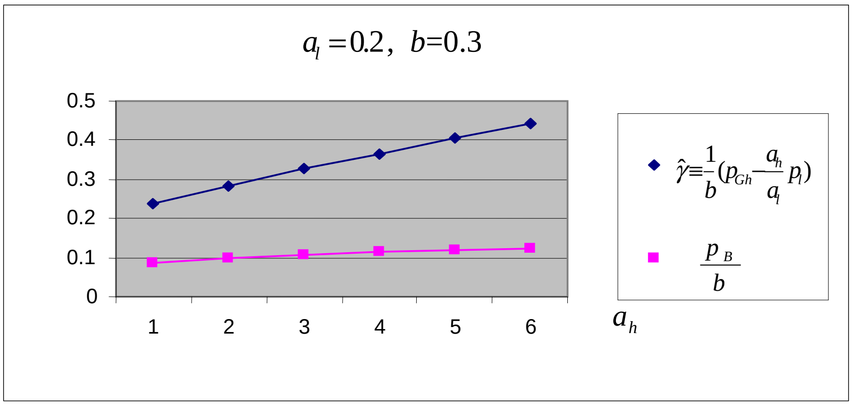

Figure 3.10: Comparison of prices per unit of quality under the regime of (B_h, C_l)

Note that gap between the explicit price of service *B* and the implicit price of service *B* becomes larger when a_h becomes larger.

---

[19] The equilibrium condition $\frac{p_B}{b} \ge \hat{\gamma}$ is not satisfied for the parameter values that we have chooses for simulation.

3.3.4 Case (iv): (C_h, B_l), Pure Components by Firm *h*, Bundling by Firm *l*

The participation constraints are

for consumers of $A_l B$: $\theta a_l + \gamma b - p_{Gl} \geq 0$, (R_l)

for consumers of A_h : $\theta a_h - p_h \geq 0$, (R_h)

for consumers of B : $\gamma b - p_B \geq 0$, (R_b)

for consumers of $A_h + B$[20] : $\theta a_h + \gamma b - p_h - p_B \geq 0$. (R_m)

The self-selection constraints are

for consumers of $A_l B$: $\theta a_l + \gamma b - p_{Gl} \geq Max(0, \theta a_h + \gamma b - p_h - p_B, \theta a_h - p_h, \gamma b - p_B)$, (S_h)

for consumers of A_h : $\theta a_h - p_h \geq Max(\theta a_l + \gamma b - p_{Gl}; \theta a_h + \gamma b - p_h - p_B; \gamma b - p_B)$, (S_l)

for consumers of B : $\gamma b - p_B \geq Max(\theta a_l + \gamma b - p_{Gl}; \theta a_h + \gamma b - p_h - p_B; \theta a_h - p_h)$, (S_b)

for consumers of $A_h + B$: $\theta a_h + \gamma b - p_h - p_B \geq Max(\theta a_l + \gamma b - p_{Gl}; \gamma b - p_B; \theta a_h - p_h)$. (S_m)

The condition $\theta a_l + \gamma b - p_{Gl} \geq Max(0; \theta a_h + \gamma b - p_h - p_B; \theta a_h - p_h; \gamma b - p_B)$ must be satisfied by buyers of $A_l B$.

The condition $\theta a_h - p_h \geq Max(0; \theta a_l + \gamma b - p_{Gl}; \theta a_h + \gamma b - p_h - p_B; \gamma b - p_B)$ must be satisfied by buyers of A_h alone.

The condition $\gamma b - p_B \geq Max(0; \theta a_l + \gamma b - p_{Gl}; \theta a_h + \gamma b - p_h - p_B; \theta a_h - p_h)$ must be satisfied by buyers of B alone.

---

[20] Consumers of $A_h + B$ means consumers of both A_h and B but each component is purchased separately.

And finally $\theta a_h + \gamma b - p_h - p_B \geq Max(0; \theta a_l + \gamma b - p_{Gl}; \theta a_h - p_h; \gamma b - p_B)$ must be satisfied by buyers of both A_h and B.

From S_h and R_b, we derive that the preference index of the consumer indifferent between purchasing $A_l B$ and purchasing A_h and B separately is $\overset{\leftrightarrow}{\theta} \equiv \frac{p_{Gl} - p_h - p_B}{a_h - a_l}$. Now S_l, R_h, and R_l intersect at $\vec{I} = \left(\frac{p_h}{a_h}; \overset{\leftrightarrow}{\gamma} \equiv \frac{1}{b}(p_{Gl} - \frac{a_l}{a_h} p_h) \right)$. $\overset{\leftrightarrow}{\gamma}$ can be understood as the implicit *price per unit of quality of B*, when the quality of *A* is valued at the price set by firm *h*. Note also that R_l, R_b, and S_b intersect at $\left(\frac{p_{Gl} - p_B}{a_l}; \frac{p_B}{b} \right)$[21]. The market areas depend on whether this *implicit price* is greater, lower or equal to the explicit *price per unit of quality* of *B* set by firm *h*. There are now four cases to consider that correspond to number of cells in Table3.1.[22]

Table 3.1: Different cases under the regime of (C_h, B_l)

	$\overset{\leftrightarrow}{\gamma} < \frac{p_B}{b}$	$\overset{\leftrightarrow}{\gamma} \geq \frac{p_B}{b}$
$p_h \leq p_{Gl} < p_h + p_B$	Case 1	Case 2
$p_{Gl} < p_h$	Case 3	Case 4

[21] Also remark that $\frac{p_B}{b} < \frac{1}{b}(p_{Gl} - \frac{a_l}{a_h} p_h) \equiv \overset{\leftrightarrow}{\gamma}$ can be written as: $\frac{p_{Gl} - p_B}{a_l} > \frac{p_h}{a_h}$. The ratio $\frac{p_{Gl} - p_B}{a_l}$ represents the *implicit price per unit of quality* of A_l when it is sold as part of the bundle $A_l B$. Thus market areas depends on whether this *implicit price per unit of quality* is greater, lower or equal to the explicit *price per unit of quality* of A_h.

[22] There is no equilibrium with $p_{Gl} > p_h + p_B$ because nobody buys $A_l B$.

In all cells except cell 3 we have $\overleftrightarrow{\theta} < 1$, i.e. the preference parameter of the consumer indifferent between $A_l B$ and both A_h and B is lower than one. For cell 3, we consider separately the case where $\overleftrightarrow{\theta} < 1$ and the case where $\overleftrightarrow{\theta} \geq 1$.

Case 1: $p_h \leq p_{Gl} < p_h + p_B$ and $\overleftrightarrow{\gamma} < \frac{p_B}{b}$

Figure 3.11 shows a segmentation of the space of preference parameters into five segments. $\overleftrightarrow{\theta} = \frac{p_h + p_B - p_{Gl}}{a_h - a_l}$ is derived from S_h.

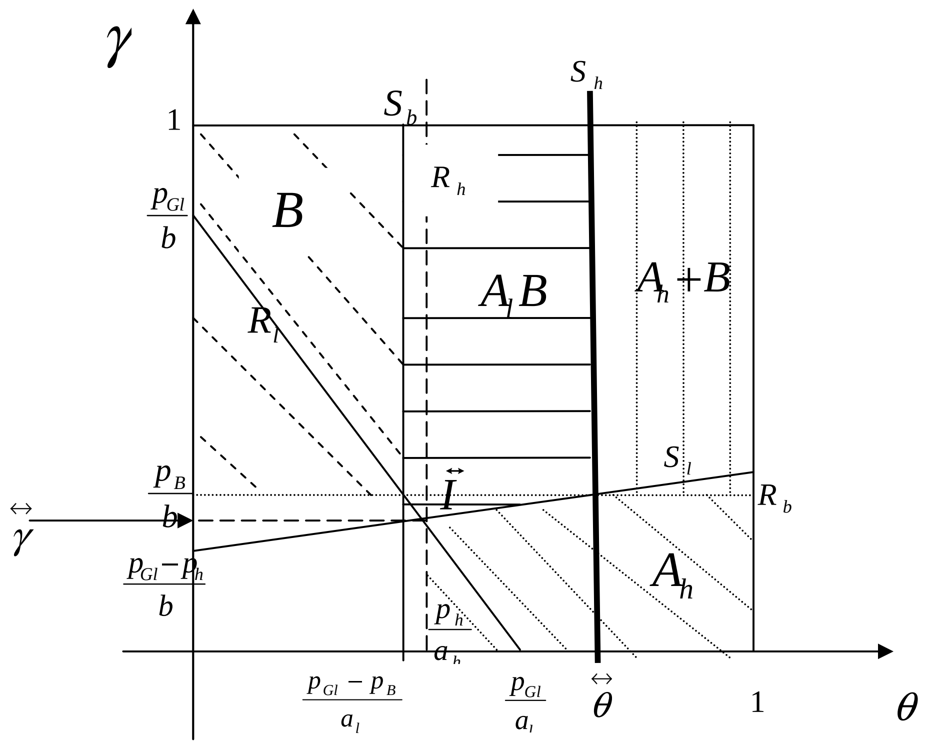

Figure 3.11: Market areas under the regime (C_h, B_l) when $p_h \leq p_{Gl} < p_h + p_B$ and

$$\overleftrightarrow{\gamma} < \frac{p_B}{b}$$

Consumers with preference parameters to the left of S_h, to the right S_b and above S_l and R_l purchase $A_l B$. The market area of those consumers is:

$$D_{Gl} = (1 - \frac{p_B}{b})(\overset{\leftrightarrow}{\theta} - \frac{p_{Gl} - p_B}{a_l}) + \frac{1}{2}(\frac{p_B}{b} - \overset{\leftrightarrow}{\gamma})(\overset{\leftrightarrow}{\theta} - \frac{p_{Gl} - p_B}{a_l}),$$

$$D_{Gl} = (\overset{\leftrightarrow}{\theta} - \frac{p_{Gl} - p_B}{a_l})(1 - \frac{p_B}{2b} - \frac{\overset{\leftrightarrow}{\gamma}}{2}).$$

Consumers with preference parameters to the right of S_h and above S_b purchase both A_h and B. Consumers with preference parameters to the left of S_b and above R_b, purchase B alone. Finally consumers with preference parameters to the right of R_h and below S_l purchase A_h only. Demands D_{A_h} for A_h and D_B for B are respectively:

$$D_{A_h} = 1 - \overset{\leftrightarrow}{\theta} + \frac{1}{2}(\overset{\leftrightarrow}{\theta} - \frac{p_h}{a_h})(\frac{p_B}{b} + \overset{\leftrightarrow}{\gamma}), \text{ and } D_B = (1 - \frac{p_B}{b})(1 - \overset{\leftrightarrow}{\theta} + \frac{p_{Gh} - p_B}{a_l}).$$

The others consumers do not purchase.

Case 2: $p_{Gl} < p_h$ and $\overset{\leftrightarrow}{\gamma} < \frac{p_B}{b}$

When $\overset{\leftrightarrow}{\theta} < 1$

Figure 3.12 displays also a segmentation of the space of preference parameters into five segments. We obtain the same segmentation of preference parameters space than in case 1. Therefore demands in case 2 when $\overset{\leftrightarrow}{\theta} < 1$ are similar to demands in case 1.

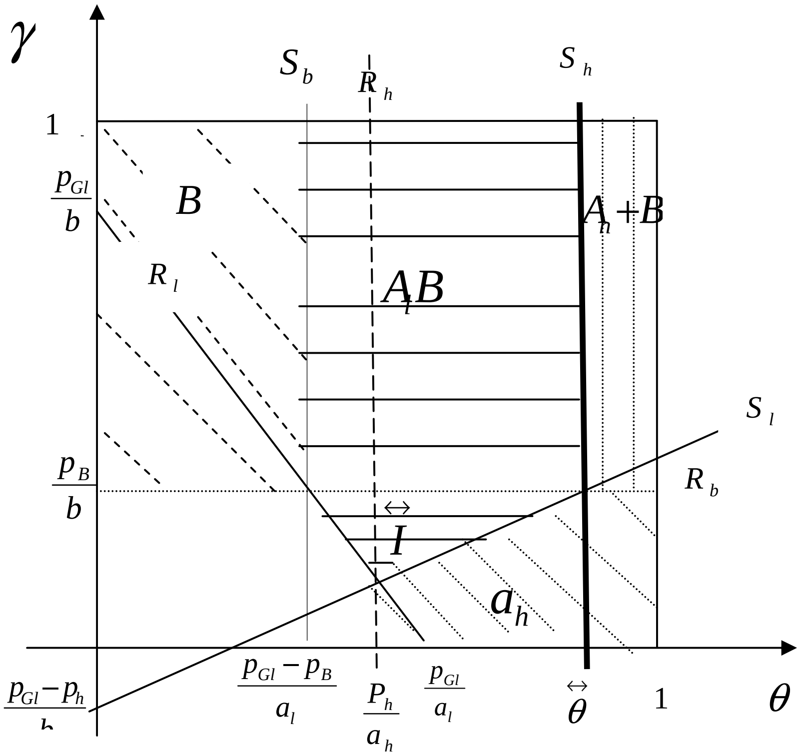

Figure 3.12: Market areas under the regime (C_h, B_l) when $p_{Gl} < p_h$, $\overset{\leftrightarrow}{\gamma} < \frac{p_B}{b}$ and $\overset{\leftrightarrow}{\theta} < 1$.

When $\overleftrightarrow{\theta} \geq 1$

Figure 3.13 shows a segmentation of the space of preference parameters into three segments.

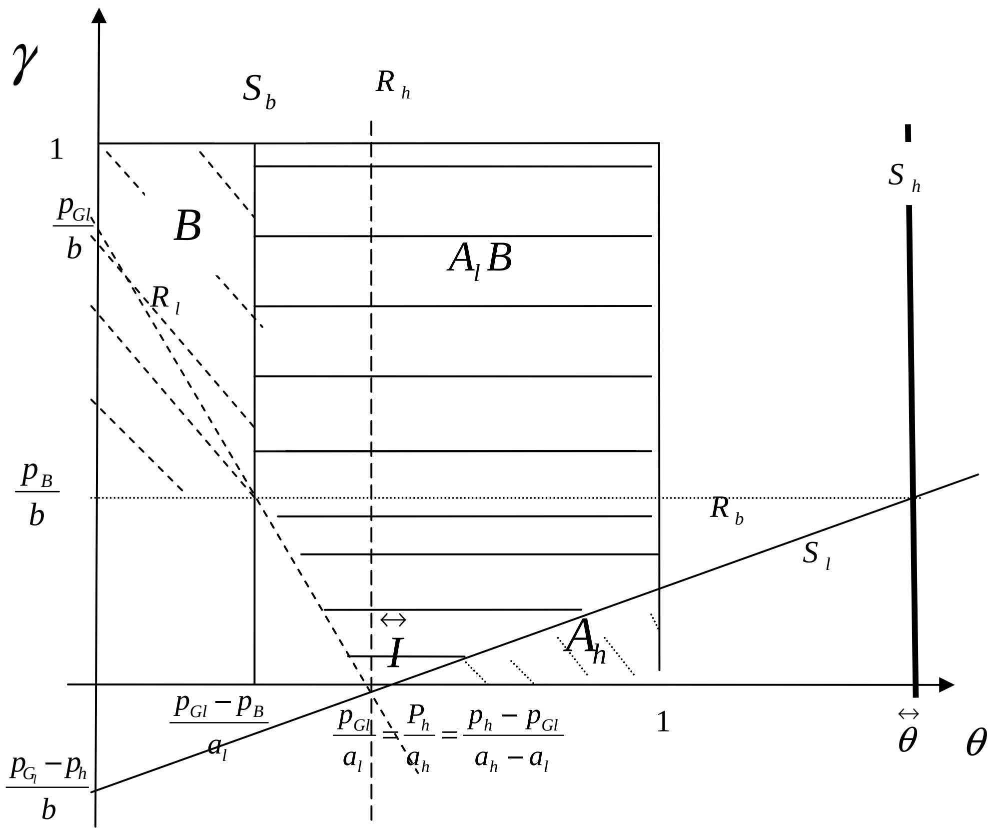

Figure 3.13: Market areas under the regime (C_h, B_l) when $p_{Gl} < p_h$, $\overleftrightarrow{\gamma} < \frac{p_B}{b}$ and $\overleftrightarrow{\theta} \geq 1$

Consumers with preference parameters to the right of S_b, above R_l and above S_l purchase $A_l B$. Those with preference parameters to the left of S_b and above R_b , purchase B alone. Consumers with preference parameters below S_l purchase A_h only, to the right S_b and above S_l and R_l purchase $A_l B$. Others don't purchase. No one purchases both A_h and B.

Case 3: $p_h \le p_{Gl} < p_h + p_B$ and $\overleftrightarrow{\gamma} \ge \frac{p_B}{b}$

Figure 3.14 shows segmentation of the space of preference parameters into four segments.

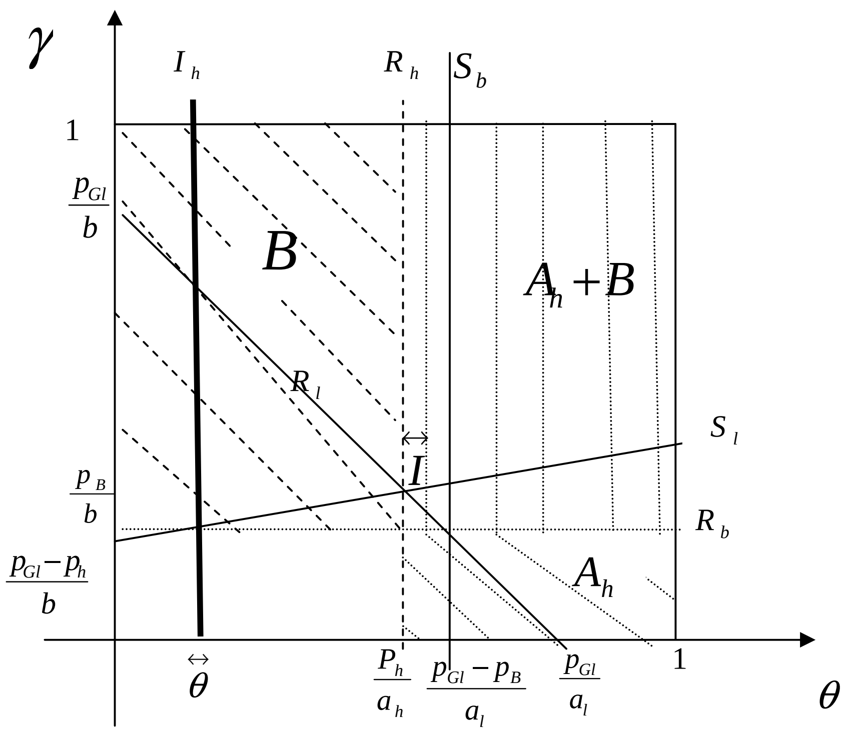

Figure 3.14: Market areas under the regime (C_h, B_l) when $p_{Gl} < p_h + p_B$, $\overleftrightarrow{\gamma} \ge \frac{p_B}{b}$ and

$$p_{Gl} > p_h$$

Consumers with preference parameters to the right R_h and above R_b purchase both A_h and B. Those with preference parameters to the left of R_h and above R_b , purchase B

alone. Consumers with preference parameters to the right R_h and below R_b purchase A_h only. Others don't purchase. Demand for $A_l B$ is zero.

Case 4: $p_{Gl} < p_h$ and $\overleftrightarrow{\gamma} \geq \frac{p_B}{b}$

Figure 3.15 depicts the same segmentation of preference parameters space than in case 3. Therefore demands in cases 4 are similar to demands in case 3.

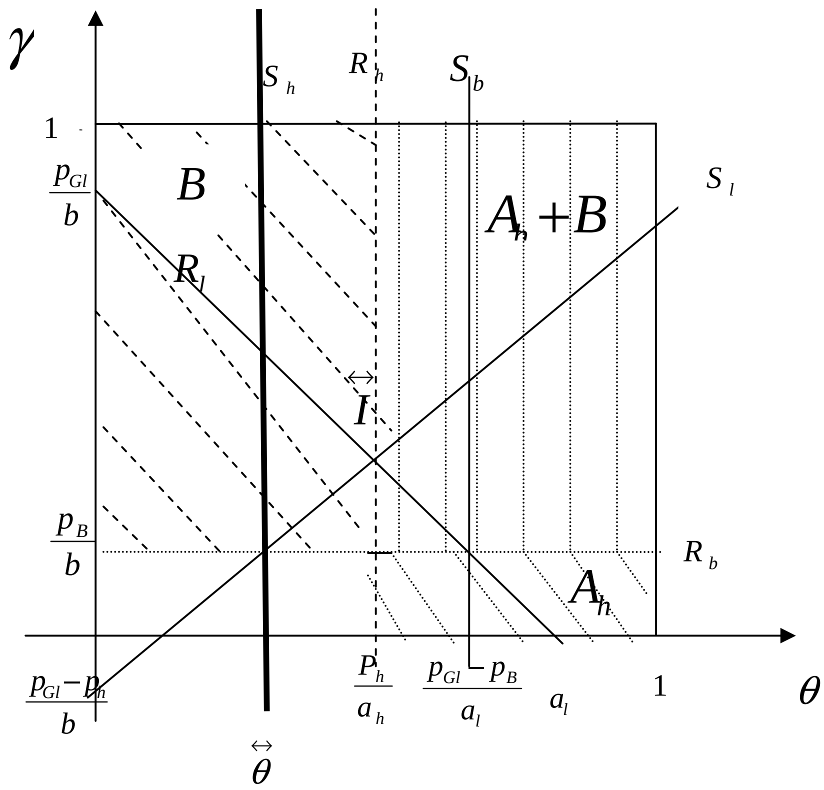

Figure 3.15: Market areas under the regime (C_h, B_l) when $p_{Gl} < p_h$ and $\overleftrightarrow{\gamma} \geq \frac{p_B}{b}$

3.3.4.1 Determination of the equilibrium prices in (C_h, B_l)

We note that there is no duopoly equilibrium with $\overleftrightarrow{\gamma} \geq \frac{p_B}{b}$ because this condition entails zero sales by the low quality firm. Therefore, the remaining case to analyze is the case where $\overleftrightarrow{\gamma} < \frac{p_B}{b}$ and $\overleftrightarrow{\theta} < 1$ or $\overleftrightarrow{\theta} \geq 1$. So the question is what subcase constitutes a Nash equilibrium in prices?

As in the previous sections, analytical difficulties lead us to search the price equilibria numerically for a range of values of a_h and a_l. Figure 3.16 displays the value of $\overleftrightarrow{\gamma}$ and $\frac{p_B}{b}$ for a range of values of a_h[23]. We find that the only equilibrium prices that we ever get always are consistent with $\overleftrightarrow{\gamma} < \frac{p_B}{b}$. Also at equilibrium $\overleftrightarrow{\theta} < 1$. Therefore we look only at case 1 when $\overleftrightarrow{\theta} < 1$.

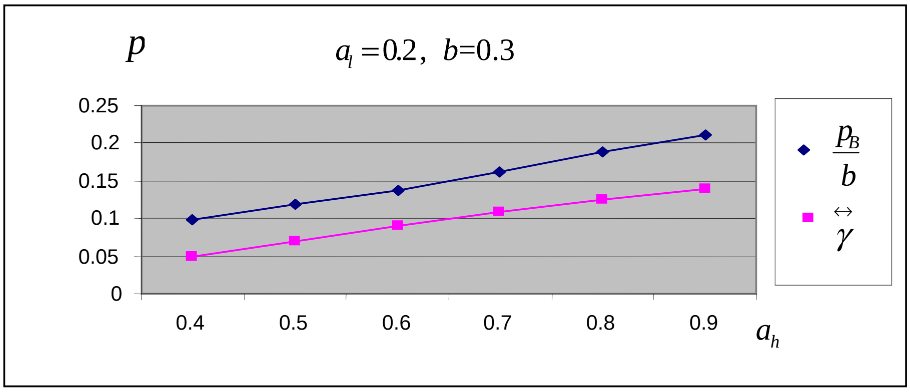

Figure 3.16: Equilibrium characteristic of the subgame (C_h, B_l)

Here also the gap between the explicit price of service B and the implicit price of service B becomes larger when a_h becomes larger.

3.4 Equilibrium Strategy of the Game

We now compare profit under each of the four possibilities. We let a_h and a_l vary in the interval $[0.2,+\infty[$. Figure 3.17 shows firms' profit in each possibility. We always find that:

$$\pi_h^{B_h,B_l} \geq \pi_h^{B_h,C_l} \geq \pi_h^{C_h,B_l} \geq \pi_h^{C_h,C_l}$$

$$\pi_l^{B_h,B_l} \geq \pi_l^{B_h,C_l} \geq \pi_l^{C_h,B_l} \geq \pi_l^{C_h,C_l}$$

We conclude that (B_h, B_l) is an equilibrium in dominant strategy.

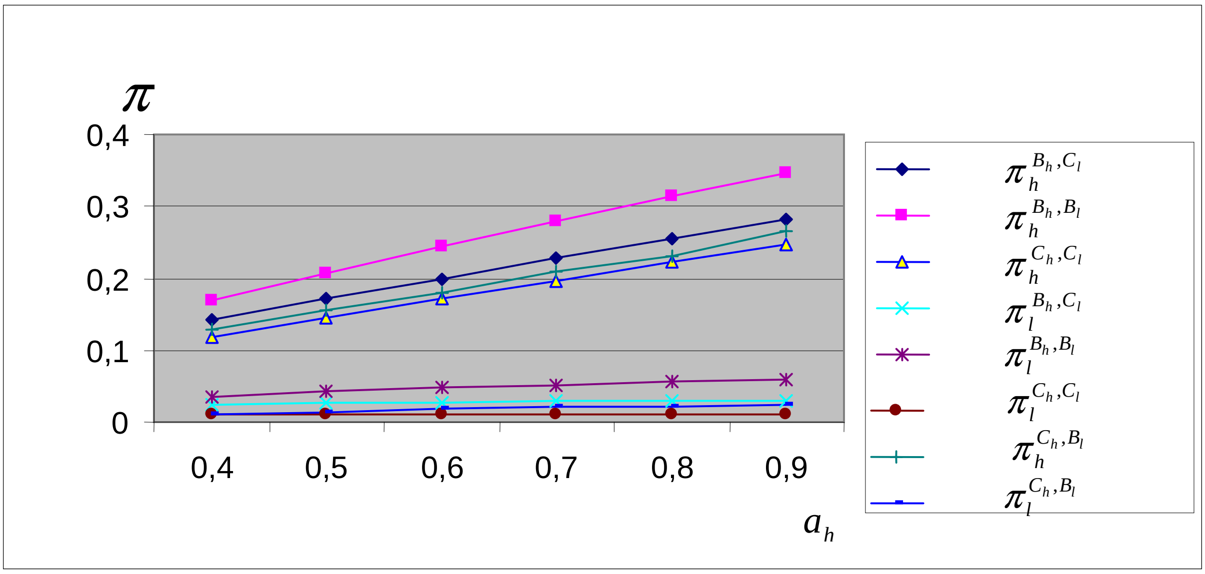

Figure 3.17: Equilibrium Strategy of the Game

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[23] The equilibrium condition $\overset{\leftrightarrow}{\gamma} \geq \frac{p_B}{b}$ is not satisfied for the parameter values that we have chooses for simulation.

Thus we state the following result:

(i) *Pure bundling is a dominant strategy equilibrium for both firms.*

Bundling is a dominant strategy for both firms because it reduces the intensity of the competition between the two firms by increasing the differentiation of services. Therefore firms' profits are higher under (B_h, B_l) than under the other subgames where one of two firms at least sells its services separately.

3.5 Welfare Implications

Now let us see how consumers' surplus and social welfare are affected when the regime shifts from (C_h, C_l) to (B_h, B_l).

For (C_h, C_l), consumers' surplus denoted by CS^S is:

$$CS^C = \int_{\tilde{\theta}}^{1} (\theta a_h - P_h) d\theta + \int_{\bar{\theta}}^{\tilde{\theta}} (\theta a_l - P_l) d\theta + \int_{0}^{1} (\gamma - 0) d\gamma .$$

The first, second and third expression of CS^S are respectively the surplus of purchasers of A_h, A_l and B. We obtain:

$$CS^C = a_h (\frac{1-\tilde{\theta}^2}{2}) - p_h (1-\tilde{\theta}) + a_l (\frac{\tilde{\theta}^2 - \bar{\theta}^2}{2}) - p_l (\tilde{\theta} - \bar{\theta}) + \frac{1}{2}$$

The social welfare denoted by SW^C gives:

$$SW^C = CS^C + \pi_h^{C_h, C_l} + \pi_l^{C_h, C} .$$

For (B_h, B_l), the surplus of consumers of $A_h B$ denoted by CS_h^B is:

$$CS_h^B = \int_{\theta^*}^{\frac{p_{Gh}}{a_h}} \int_{p_{Gh}-\theta a_h}^{1} (\theta a_h + \gamma - p_{Gh}) d\gamma d\theta + \int_{\frac{p_{Gh}}{a_h}}^{1} \int_0^1 (\theta a_h + \gamma - p_{Gh}) d\gamma d\theta$$

$$CS_h^B = \frac{a_h}{2} + (1 + \theta^* - 2\frac{p_{Gh}}{a_h})(\frac{1}{2} - p_{Gh}) - a_h \frac{(\theta^*)^2}{2} + \frac{(a_h \theta^* - p_{Gh})^3}{6 a_h}$$

While the surplus of consumers of $A_l B$ is:

$$CS_l^B = \int_{\gamma^*}^{p_{Gl}} \int_{\frac{p_{Gl}-\gamma}{a_l}}^{\theta^*} (\theta a_l + \gamma - p_{Gl}) d\theta d\gamma + \int_{p_{Gl}}^{1} \int_0^{\theta^*} (\theta a_l + \gamma - p_{Gl}) d\theta d\gamma$$

$$CS_l^B = \frac{\theta^*}{2}\left[1 + (p_{Gl})^2 - 2\gamma^* + a_l(1-\gamma^*)\right] - \frac{(\gamma^* - p_{Gl})^3}{6 a_l}$$

Thus, consumers' surplus under (B_h, B_l) is:

$$CS^B = CS_h^B + C_l^B$$

The social welfare under (B_h, B_l) denoted by SW^B is:

$$SW^B = CS^B + \pi_h^{B_h, B_l} + \pi_l^{B_h, B_l}$$

We now compare social welfare under (C_h, C_l) and (B_h, B_l) for a_h and a_l varying in the interval $[0.2, +\infty[$. Figure 3.18 displays the total economic welfare under (C_h, C_l) and (B_h, B_l). It shows that:

$$SW^B > SW^C.$$

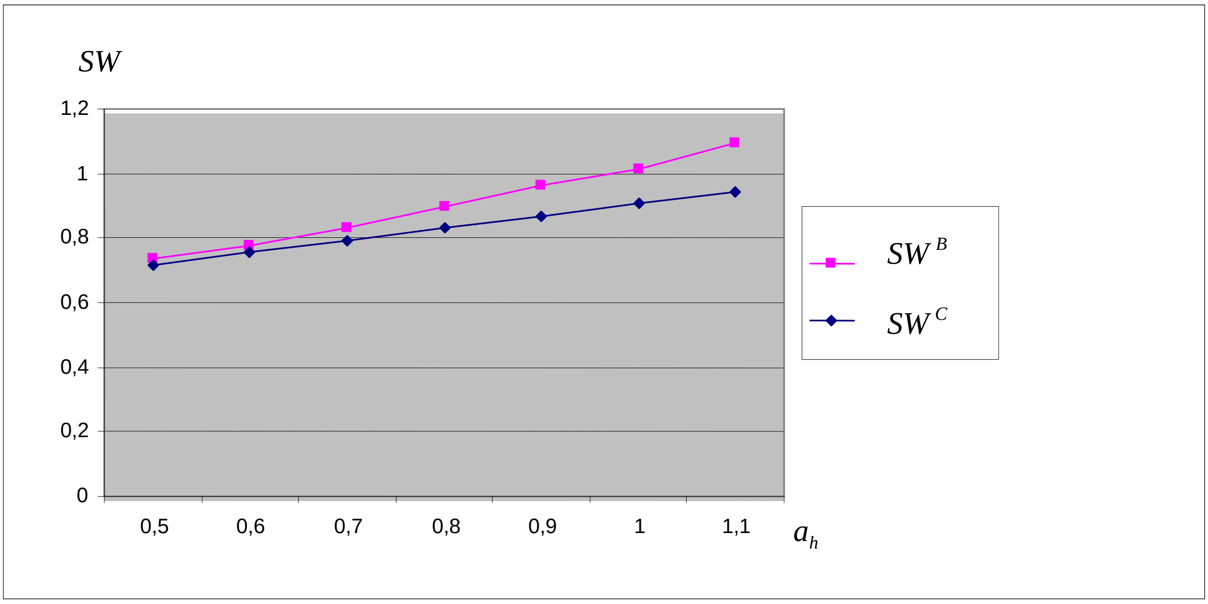

Figure 3.18: Total welfare under the regimes of (C_h, C_l) and (B_h, B_l)

Thus we state the following result:

(ii) *A shift from* (C_h, C_l) *to* (B_h, B_l) *results in a decrease in social welfare when there is a small differentiation between services.*

It is obvious that bundling in this context reduces consumers'surplus. Indeed bundling increases prices and there are more constraints under the regime of (B_h, B_l) because to obtain *B* consumers must purchase $A_l B$ even though they don't want *A*. So for welfare to increase, aggregate profits must raise enough to offset the reduction of aggregate consumer surplus and then result in a potential efficiency gain. For all parameters we have choosen, we find that total welfare increases.

3.6 Concluding Remarks

In the traditional literature on bundling by duopolists, the conclusion is that bundling is a dominant strategy equilibrium for both firms but it is not a profitable strategy for both firms. We find also that bundling is a dominant strategy equilibrium. But contrary to other studies, we find that bundling is a profitable strategy for both firms. The reason is that in the context of vertically differentiated services, bundling can be used as differentiation tool. It then reduces the intensity of competition between the firms and then they make more profits under bundling than they would under component selling. We also find that bundling increases total welfare.

Cable operators and telecommunication companies offer the combination of telephone, television, and Internet as a bundled service. Our results suggest that they would compete more vigorously and would realize less profit if there were restriction on bundling. If buyers care for the quality of services their surplus is reduced under bundling. However, the fact that a single supplier offers all services makes bundling convenient for buyers. So the benefit of the convenience must be balanced with the reduction of consumers' surplus to obtain the effects of bundling on buyers' welfare. Also, the authorities must decide what weight they give to the buyers' surplus and to the suppliers' profits to obtain the net welfare effects of bundling.

Our result should be interpreted under the assumptions that both the variable cost and the fixed cost are zero for each service and services are vertically differentiated. It would be interesting to analyze the case where the fixed costs are positive. Also since we know that firms in communication markets are both horizontally and vertically differentiated, we can study both differentiations to see how the results of this paper are robust to these assumptions.

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Annexes

Annexe 1.2

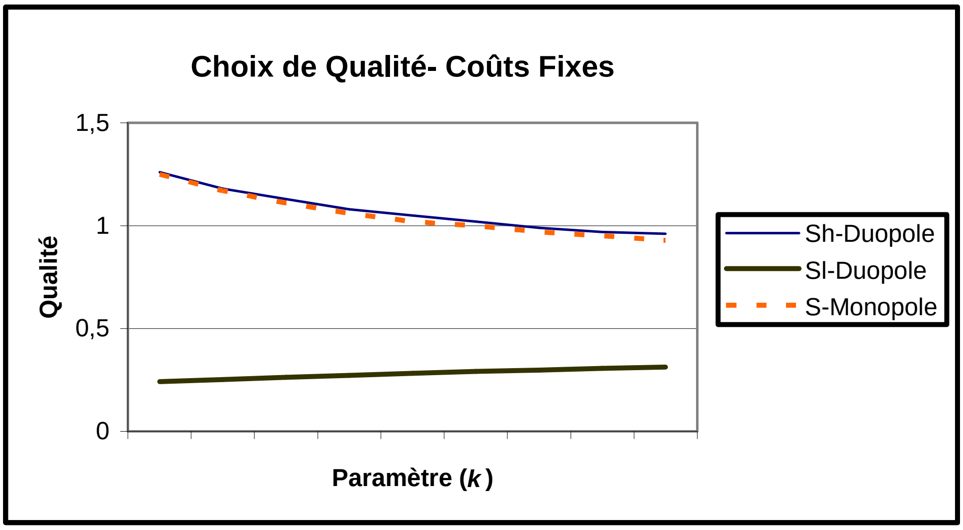


Figure 1.3. Choix de qualité optimal lorsque les coûts sont fixes

Annexe 1.3

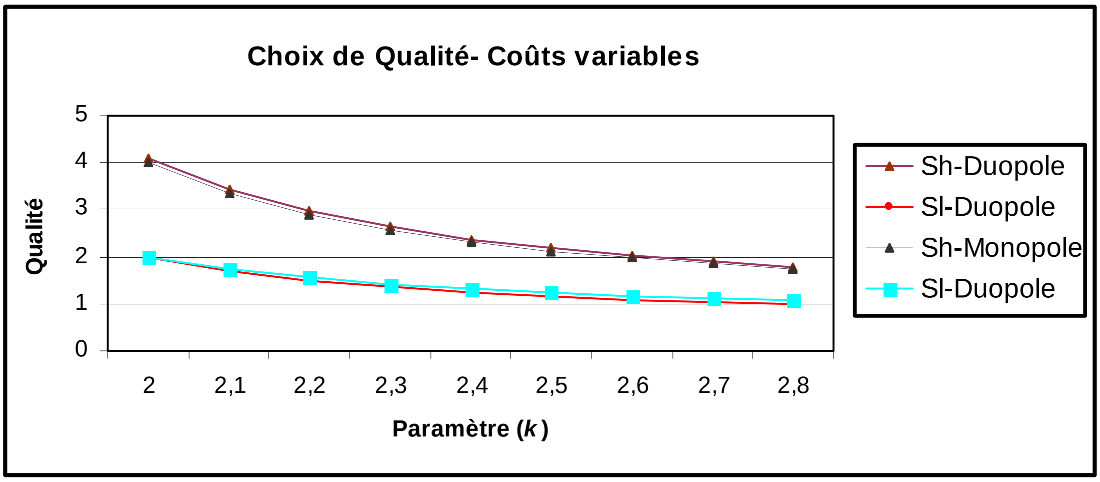


Figure 1.4 : Choix de qualité optimal lorsque les coûts sont variables

Annexe 1.4

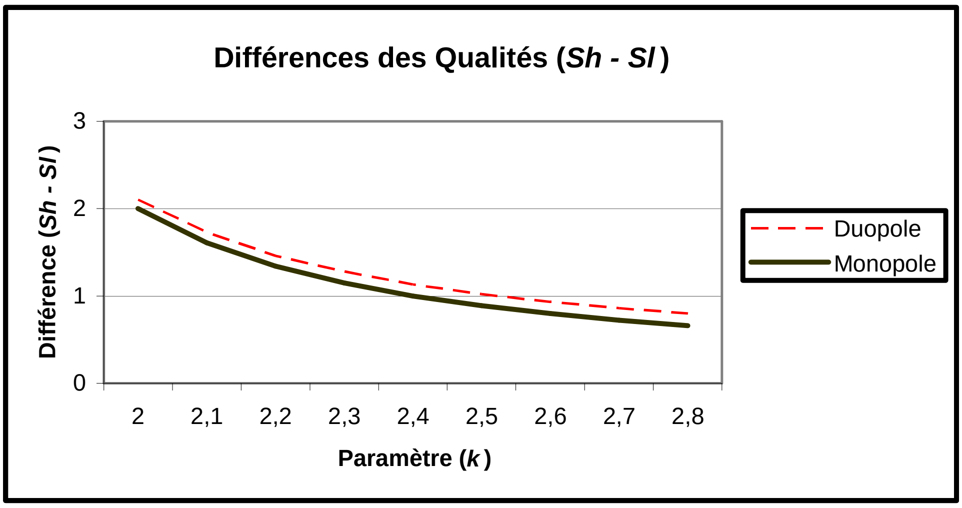


Figure 1.5 : Dispersion des qualités

Annexe 1.5

Tableau 1.1 : Qualité, prix, paramètre de préférence, profit, surplus, et bien-être avant fusion lorsque les coûts sont fixes

k	s_h^D	s_l^D	$s_h^D - s_l^D$	p_h^D	p_l^D	$\tilde{\theta}^D$	$\bar{\theta}^m$	π^D	$BE^D - AAQ$
2	1,26	0,241	1,019	0,53509	0,05117	0,47489	0,2123	0,12985	0,345096
2,1	1,18	0,252	0,928	0,49017	0,05234	0,4718	0,2077	0,12563	0,334184
2,2	1,13	0,263	0,867	0,46028	0,05356	0,46911	0,2037	0,12243	0,328003
2,3	1,08	0,272	0,808	0,43115	0,05429	0,4664	0,1996	0,12017	0,322328
2,4	1,05	0,282	0,768	0,41164	0,05528	0,46401	0,196	0,11823	0,319689
2,5	1,02	0,291	0,729	0,39249	0,05599	0,4616	0,1924	0,11675	0,317305
2,6	0,99	0,298	0,692	0,37416	0,05631	0,45931	0,189	0,11581	0,314969
2,7	0,97	0,306	0,664	0,36043	0,05685	0,45719	0,1858	0,11488	0,314131
2,8	0,96	0,313	0,648	0,35272	0,05744	0,45568	0,1835	0,1143	0,314625

$BE^D - AAQ$ signifie le bien-être avant fusion avec ajustement des qualités.

CS^D signifie le surplus des consommateurs avant fusion.

Annexe 1.6

Tableau 1.2 : Qualité, prix, paramètre de préférence, profit, surplus, et bien-être après fusion lorsque les coûts sont fixes

k	s^m	p^m	$\bar{\theta}^m$	π^m	$BE^m - AAQ$
2	1,25	0,625	0,5	0,15625	0,3125
2,1	1,17	0,585	0,5	0,15344382	0,29969382
2,2	1,11	0,555	0,5	0,15169134	0,29044134
2,3	1,06	0,53	0,5	0,1506586	0,2831586
2,4	1,02	0,51	0,5	0,15013262	0,27763262
2,5	1	0,5	0,5	0,15	0,275
2,6	0,97	0,485	0,5	0,15011393	0,27136393
2,7	0,95	0,475	0,5	0,15043297	0,26918297
2,8	0,93	0,465	0,5	0,15088833	0,26713833

$BE^m - AAQ$ signifie le bien-être après fusion avec ajustement des qualités.

CS^m signifie le surplus des consommateurs après fusion.

Annexe 1.7

Tableau 1.3 : Variation du bien-être après fusion sans ajustement des qualités lorsque les coûts sont fixes et irrécupérables

k	*ΔBE- SAQ*
2	*0,03716*
2,1	*0,03878*
2,2	*0,0404*
2,3	*0,0417*
2,4	*0,04315*
2,5	*0,04445*
2,6	*0,04543*
2,7	*0,04657*
2,8	*0,04758*

ΔBE- SAQ signifie la variation du bien-être après fusion sans ajustement des qualités (les variations sont négatives).

Annexe 1.8

Tableau 1.4 : Variation du bien-être après fusion avec et sans ajustement des qualités lorsque les coûts sont fixes et récupérables

k	$\Delta BE - SAQ$	$\Delta BE - AAQ$
2	0,03135598	0,03259598
2,1	0,03324778	0,03449017
2,2	0,03510233	0,03756134
2,3	0,03669239	0,03916943
2,4	0,0383614	0,042056
2,5	0,03988044	0,04230519
2,6	0,04113968	0,043605
2,7	0,04248578	0,04494771
2,8	0,04370972	0,04748709

$\Delta BE - SAQ$ signifie la variation du bien-être après fusion sans ajustement des qualités (les variations sont négatives).

$\Delta BE - AAQ$ signifie la variation du bien-être après fusion avec ajustement des qualités (les variations sont négatives).

Annexe 1.9

Tableau 1.5: Qualité, prix, paramètre de préférence, profit, surplus, et bien-être avant fusion lorsque les coûts sont variables

k	s_h^D	s_l^D	$s_h^D - s_l^D$	p_h^D	p_l^D	$\tilde{\theta}^D$	$\bar{\theta}^D$	π^D	$BE^D - AAQ$
2	4,09	1,99	2,1	2,2604	0,7479	0,72022	0,375827	0,28557	0,755406
2,1	3,43	1,7	1,73	1,8338	0,6068	0,70925	0,356952	0,252667	0,677275
2,2	2,96	1,5	1,46	1,529	0,5094	0,69833	0,339608	0,228074	0,621596
2,3	2,63	1,35	1,28	1,3217	0,4389	0,68967	0,325134	0,210582	0,579642
2,4	2,37	1,24	1,13	1,1545	0,3858	0,68027	0,31114	0,196075	0,54804
2,5	2,18	1,16	1,02	1,0347	0,3478	0,67349	0,299789	0,184537	0,523277
2,6	2,02	1,09	0,93	0,9333	0,3144	0,6655	0,288398	0,175422	0,503428
2,7	1,89	1,03	0,86	0,852	0,2863	0,65781	0,277985	0,168315	0,487138
2,8	1,79	0,99	0,8	0,7886	0,2667	0,65238	0,26938	0,161576	0,474146

$BE^D - AAQ$ signifie le bien-être avant fusion avec ajustement des qualités.

CS^D signifie le surplus des consommateurs avant fusion.

Annexe 1.10

Tableau 1.6 : Qualité, prix, paramètre de préférence, profit, surplus, et bien-être après fusion lorsque les coûts sont variables

k	s_h^m	s_l^m	$s_h^m - s_l^m$	p_h^m	p_l^m	$\tilde{\theta}^m$	$\bar{\theta}^m$	π^m	$BE^m - AAQ$
2	4	2	2	2,8	1,2	0,8	0,6	0,4	0,6
2,1	3,34	1,73	1,61	2,2993	1,0231	0,79267	0,591374	0,358076	0,53711468
2,2	2,89	1,55	1,34	1,9614	0,9061	0,78748	0,5846	0,327985	0,4919782
2,3	2,56	1,41	1,15	1,7144	0,8152	0,78194	0,578155	0,305596	0,45839368
2,4	2,31	1,31	1	1,5279	0,7506	0,77735	0,572971	0,288457	0,43268621
2,5	2,12	1,23	0,89	1,3872	0,6989	0,77337	0,568207	0,275038	0,4125564
2,6	1,97	1,17	0,8	1,2765	0,6602	0,77032	0,564279	0,26433	0,39649549
2,7	1,84	1,12	0,72	1,1794	0,6279	0,76598	0,560623	0,255649	0,38347283
2,8	1,74	1,08	0,66	1,1058	0,602	0,76327	0,557429	0,248526	0,37278919

$BE^m - AAQ$ signifie le bien-être après la fusion avec ajustement des qualités.

CS^m signifie le surplus des consommateurs après fusion.

Annexe 1.11

Tableau 1.7 : Variation du bien-être après fusion avec et sans ajustement des qualités lorsque les coûts sont lorsque les coûts sont variables

k	$\Delta BE - SAQ$	$\Delta BE - AAQ$
2	0,15560122	0,15540636
2,1	0,14043941	0,14016045
2,2	0,12992005	0,12961824
2,3	0,12168844	0,12124837
2,4	0,11581494	0,11535418
2,5	0,1112868	0,1107207
2,6	0,10754967	0,10693239
2,7	0,10435262	0,10366537
2,8	0,10212676	0,10135692

$\Delta BE - SAQ$ signifie la variation du bien-être après fusion sans ajustement des qualités (les variations sont négatives).

$\Delta BE - AAQ$ signifie la variation du bien-être après fusion avec ajustement des qualités (les variations sont négatives).

Appendix 2.1

To show that consumers with $\theta \in [\bar{\theta}_{GH}, \tilde{\theta}]$ prefer component selling rather than bundling, we must prove for all $\theta \in [\bar{\theta}_{GH}, \tilde{\theta}]$, $CS^{S} > CS_{H}^{PB}$.

$$CS^{S} > CS_{H}^{PB} \Leftrightarrow \int_{\bar{\theta}_{GH}}^{\tilde{\theta}} (\alpha_L \theta - P_A^S - P_L) d\theta > \int_{\bar{\theta}_{GH}}^{\tilde{\theta}} (\alpha_H \theta - P_{GH}) d\theta .$$

$$\Leftrightarrow \frac{(\tilde{\theta} - \bar{\theta}_{GH}^{2})}{2} \alpha_L - (P_A^S + P_L)(\tilde{\theta} - \bar{\theta}_{GH}) > \frac{(\tilde{\theta} - \bar{\theta}_{GH}^{2})}{2} \alpha_H - P_{GH}(\tilde{\theta} - \bar{\theta}_{GH})$$

$$\Leftrightarrow \frac{(\tilde{\theta} - \bar{\theta}_{GH}^{2})}{2} (\alpha_L - \alpha_H) - (P_A^S + P_L - P_{GH})(\tilde{\theta} - \bar{\theta}_{GH}) > 0$$

$$\Leftrightarrow \frac{(\tilde{\theta} + \bar{\theta}_{GH})}{2} (\alpha_L - \alpha_H) - (P_A^S + P_L - P_{GH}) > 0$$

$$\Leftrightarrow \frac{\tilde{\theta}}{2} (\alpha_L - \alpha_H) + \frac{\bar{\theta}_{GH}}{2} (\alpha_L - \alpha_H) - (P_A^S + P_L - P_{GH}) > 0$$

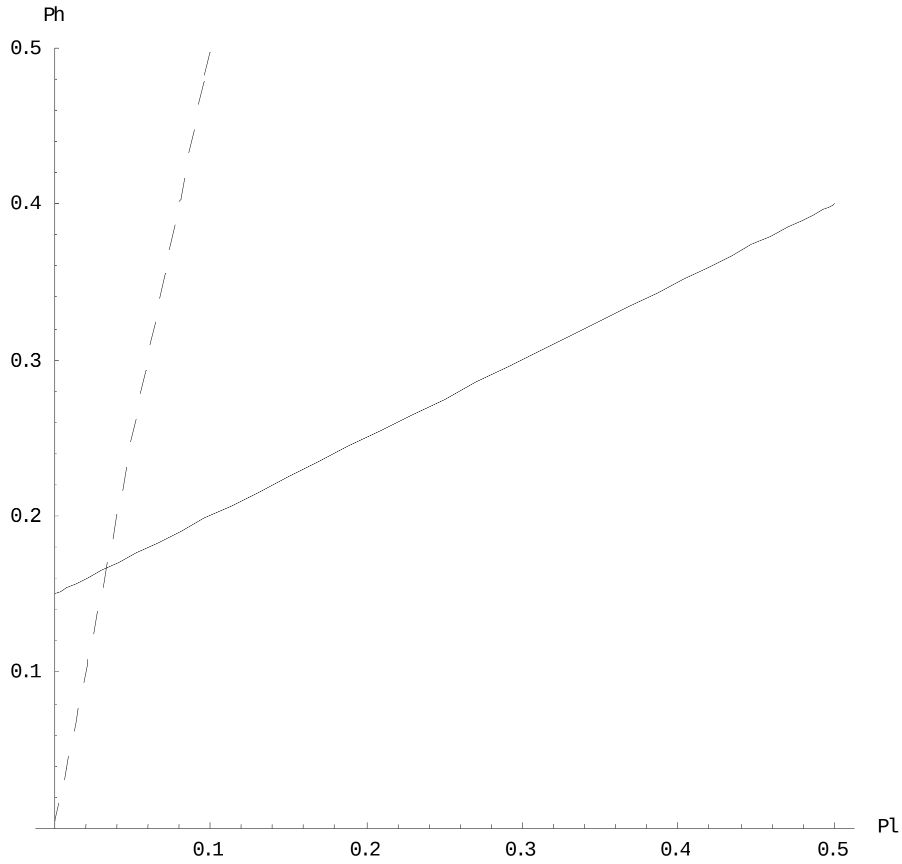
$$\Leftrightarrow -\frac{1}{2}(P_{GH} - P_A^S - P_L) + \frac{\bar{\theta}_{GH}}{2} (\alpha_L - \alpha_H) + (P_{GH} - P_A^S - P_L) > 0$$

$$\Leftrightarrow \frac{1}{2}(P_{GH} - P_A^S - P_L) + \frac{\bar{\theta}_{GH}}{2} (\alpha_L - \alpha_H) > 0 \Leftrightarrow \frac{1}{2}(P_{GH} - P_A^S - P_L) - \frac{P_{GH}}{2} + \frac{P_{GH}}{2} \frac{\alpha_L}{\alpha_H} > 0$$

$$\Leftrightarrow -(P_A^S + P_L) + P_{GH} \frac{\alpha_L}{\alpha_H} > 0 \Leftrightarrow P_{GH} > \frac{\alpha_H}{\alpha_L}(P_A^S + P_L) \Leftrightarrow \alpha_L c(\alpha_H) - \alpha_H c(\alpha_L) > 0$$

By virtue of condition (2.1), we have showed that for all $\theta \in [\bar{\theta}_{GH}, \tilde{\theta}]$, $CS^{S} > CS_{H}^{PB}$.

Appendix 3.2

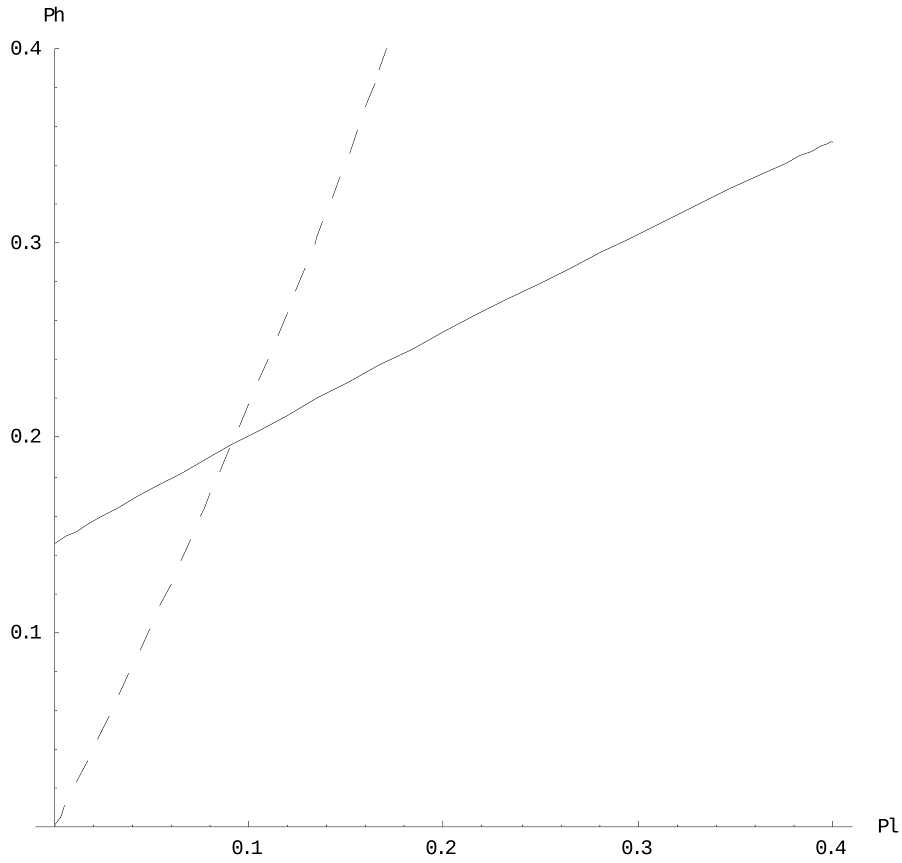


--------------- Firm *l*

___________ Firm *h*

Figure 3.19: Best response function under the regime of (B_h, B_l) when $\frac{p_h}{a_h} \leq \frac{p_l}{a_l}$

Appendix 3.3



--------------- Firm *l*

___________ Firm *h*

Figure 3.20: Best response function under the regime of (B_h, B_l) when $\frac{p_h}{a_h} > \frac{p_l}{a_l}$