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Assouvir la Soif d'Innovation: Modélisation de la Diffusion des Technologies Mobiles

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"Assouvir la Soif d'Innovation: Modélisation de la Diffusion des Technologies Mobiles"

Résumé

L'expérience montre que les technologies de l'information et des communications (TIC), et services de télécommunications mobiles en particulier, peuvent stimuler une croissance économique soutenue et contribuer au développement humain. Au coeur du secteur des TIC, les technologies mobiles sont de plus en plus utilisées comme un outil transformationnel pour favoriser la croissance économique, accélérer le transfert des connaissances, développer les capacités locales, améliorer la productivité et réduire la pauvreté dans de nombreux secteurs. À cet égard, au cours de la dernière décennie, le développement des TIC est devenu un domaine stratégique d'engagement politique dans les économies émergentes. Afin d'accompagner les décideurs politiques et les marketeurs dans la conception des stratégies optimales de développement du secteur des télécommunications, les chercheurs s'intéressent de plus en plus aux obstacles entravant le déploiement des solutions TIC dans le monde en voie de développement. En tant que contribution à ce domaine de recherche, cette étude vise à (i) identifier les déterminants économiques et socioculturels affectant la capacité des pays émergents à adopter les nouvelles technologies et innovations, et à (ii) proposer des principes d'actions et de politiques susceptibles de favoriser la diffusion des solutions TIC dans les pays émergents qui sont caractérisés par une forte inégalité des revenus et par l'aversion au risque.

***Descripteurs** : innovation; diffusion; TIC; technologies mobiles; systèmes dynamiques; modélisation;*

"Quenching the Thirst for Innovation: Modeling the Diffusion of Mobile Technologies"

Abstract

Evidence shows that information and communications technologies (ICT), especially mobile telecommunications services, can lead to sustained economic growth and human development. Mobile technologies are increasingly used as a transformational tool to foster economic growth, accelerate knowledge transfer, develop local capacities, raise productivity, and alleviate poverty in a variety of sectors. In that respect, in the last decade, ICT development has become a key strategic area for policy engagement in emerging economies. To support policy-makers and marketing practitioners in designing optimal telecommunications sector development strategies, an increasing research focus is now being placed on the impediments to implementing ICT solutions in the developing world. As a contribution to this field of research, this study aims at (i) identifying the economic and socio-cultural determinants affecting the capacity of developing countries to adopt new technologies and innovations, and at (ii) defining relevant policy principles likely to foster the diffusion of ICT solutions in emerging economies that are characterized by strong income inequality and uncertainty avoidance.

***Keywords**: innovation; diffusion; ICT; mobile technologies; system dynamics; modeling;*

Principales abréviations

1G	First generation (mobile communications systems)
2G	Second generation (mobile communications systems)
3G	Third generation (mobile communications systems)
AB	Agent-Based
ARCEP	Autorité de Régulation des Communications Électroniques et des Postes
e-ID	Electronic Identity
GDP	Gross Domestic Product
GSM	Global Systems Mobile
GSMA	Global Systems Mobile Association
ICP	International Comparison Program
IDV	Individualism
MAE	Mean Absolute Error
MAS	Masculinity
NFC	Near Field Communication
NGO	Non Governmental Organization
PDI	Power Distance
R&D	Research and Development
RFID	Radio Frequency Identification Device
RMSE	Root Mean Square Error
ROI	Return on Investment
SBC	Switching-Back Cost
SIM	Subscriber Identity Module
SME	Small and Medium Enterprise
SMS	Short Message Service
UA	Universal Access
UAI	Uncertainty Avoidance Index
US	Universal Service

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Résumé

L'expérience montre que les technologies de l'information et des communications (TIC), et services de télécommunications mobiles en particulier, peuvent stimuler une croissance économique soutenue et contribuer au développement humain. La téléphonie mobile a sans aucun doute été le mode de télécommunication ayant eu l'impact le plus significatif et induit les changements les plus positifs dans le monde en développement. Au coeur du secteur des TIC, les technologies mobiles sont de plus en plus utilisées comme un outil transformationnel pour favoriser la croissance économique, accélérer le transfert des connaissances, développer les capacités locales, améliorer la productivité et réduire la pauvreté dans de nombreux secteurs. À cet égard, au cours de la dernière décennie, le développement des TIC est devenu un domaine stratégique d'engagement politique dans les économies émergentes.

Dans le même temps, la percée tant célébrée de la téléphonie mobile dans le monde en développement ne doit pas occulter le fossé qui subsiste entre les pays riches et les pays pauvres en ce qui concerne l'accès aux TIC. Les dynamiques de diffusion des nouvelles technologies dans toutes les régions du monde présentent une hétérogénéité frappante. Pour de nombreuses économies émergentes, l'expansion massive des réseaux de télécommunications à faible coût et des services mobiles à forte valeur ajoutée reste un défi de développement majeur. De plus, cela induit une très forte pression sur le secteur privé et sur les entreprises opérant dans le domaine des TIC, qui sont appelées à développer des stratégies marketing plus inclusives et à engager des investissements importants sur les marchés internationaux.

Afin d'accompagner les décideurs dans la conception des stratégies optimales de développement du secteur des télécommunications, les chercheurs s'intéressent de plus en plus aux obstacles entravant le déploiement des solutions TIC dans le monde en voie de développement.

En tant que contribution à ce domaine de recherche, cette étude vise à (i) identifier les déterminants économiques et socioculturels affectant la capacité des pays émergents à

adopter les nouvelles technologies et innovations, et à (ii) proposer des principes d'actions et de politiques susceptibles de favoriser la diffusion des solutions TIC dans les pays émergents qui sont caractérisés par une forte inégalité des revenus et par l'aversion au risque.

La méthodologie de recherche s'articule autour de la conception d'un cadre holistique pour l'analyse des processus de diffusion des TIC, fondée sur une revue de littérature multidisciplinaire et sur des entrevues menées auprès des Experts dans le domaine de l'innovation et du développement. Afin de saisir les dynamiques non linéaires en jeu et les interactions complexes (boucles de rétroaction) entre les sphères macro- et micro-économiques et marketing, nous utilisons l'approche de modélisation des Systèmes Dynamiques. Conçue au M.I.T. dans les années 1960 et initialement appliquée aux sciences de l'ingénierie, cette approche permet de penser le système d'une manière holiste et d'évaluer les implications des stratégies et des politiques d'action dans des environnements complexes et hautement intégrés. Une fois calibré en utilisant les données disponibles pour la diffusion de téléphones mobiles dans 17 pays, le modèle est utilisé pour explorer diverses options et stratégies de développement des TIC, en permettant de quantifier leur impact sur la vitesse et l'ampleur de la diffusion.

Les principales conclusions de ce travail de recherche sont les suivantes:

1. A l'échelle nationale, l'hétérogénéité socio-économique et autres facteurs endogènes, tels l'aversion au risque, exercent une influence significative sur la dynamique de la diffusion des innovations. Par exemple, dans les pays émergents, de fortes inégalités socio-économiques constituent un frein à l'adoption à grande échelle des nouvelles technologies;

2. Des subventions bien ciblées au cours des phases initiales de commercialisation des technologies mobiles peuvent jouer un rôle déterminant dans leur diffusion massive, en aidant à mobiliser la confiance chez les consommateurs, en stimulant la mise en place des économies d'échelle, et, à plus long terme, en contribuant à l'amélioration de la situation macro-économique. L'identification du moment et de la durée optimales de mise en œuvre de telles politiques de subventions nécessite une analyse détaillée de la capacité financière de la population à acquérir ces produits, tel que expliqué dans la section consacrée à la présentation du modèle.

Les contributions de cette recherche incluent la construction d'un modèle conceptuel intégrant les principaux facteurs qui affectent la diffusion des innovations, l'identification des relations existant entre ces facteurs, et l'analyse de l'évolution dans le temps de l'ensemble du système. Ceci représente un pas en avant vers une meilleure compréhension des problématiques complexes de recherche dans le domaine des innovations technologiques et des théories de la diffusion.

Dans cette perspective, ce travail de recherche espère enrichir les approches conventionnelles et présente un cadre d'analyse holistique pour les décisions de marketing stratégique. Les résultats de ce travail présente un intérêt tangible pour les praticiens et les décideurs marketing, en leur permettant de prendre des décisions plus rationnelles et plus précises, et de concevoir des politiques plus efficaces en vue de promouvoir l'accès aux technologies mobiles et aux innovations.

Introduction

1. LES INNOVATIONS DANS LE SECTEUR DES TELECOMMUNICATIONS

A la fin du XX^{ème} siècle, l'espèce humaine a connu une accélération sans précédent dans les moyens d'accès aux services de télécommunications. Près de 90 pour cent des 6,5 milliards d'habitants de la planète utilisent aujourd'hui un téléphone mobile, plus de 80 pour cent des utilisateurs des portables vivant dans les pays en voie de développement (Chircu et Mahajan, 2009 ; Wireless Intelligence, 2011). Considérablement améliorées depuis leur lancement, les technologies mobiles ont fourni des opportunités inimaginables il y a trente ans à peine. Elles sont de plus en plus utilisées comme un véritable « outil de transformation » pour favoriser la croissance économique, accélérer le transfert des connaissances, développer les capacités locales et accroître la productivité de nombreux de secteurs dans les pays développés et en voie de développement (Banque Mondiale, 2010).

1.1. Le pouvoir transformationnel des technologies mobiles

La communication mobile a littéralement transformé la société (The Economist, 2008). Les appareils mobiles sont devenus un élément essentiel dans le quotidien des populations des pays développés, offrant une vaste gamme de services qui sont maintenant disponibles de manière continue dans toutes les régions couvertes par les réseaux mobiles. La productivité globale dans le monde développé a été améliorée grâce à un large accès à des services comme la messagerie instantanée, les appels vidéo, la conférence multi-parties et la géo-localisation (Qiang, 2009; Banque Mondiale, 2010).

Au cours de la dernière décennie, les télécommunications mobiles sont devenues de plus en plus importantes dans les pays en voie de développement. Un rapport de la Banque Mondiale (2008) a constaté que depuis 1998, les pays à faible et moyen revenus sont plus avancés que les pays à revenu élevé en ce qui concerne le nombre de nouveaux branchements téléphoniques.

Selon la GSMA (2008) «pratiquement tous les nouveaux clients mobiles dans les années à venir seront dans le monde en voie de développement», même si les marchés de remplacement des portables resteront importants dans les pays développés.

L'accès aux téléphones mobiles a, pour la première fois, fourni à de nombreux ménages et communautés défavorisés l'accès à des services publics et privés (Banque mondiale, 2009). Les technologies d'information et des communications (TIC) et, plus spécifiquement, les technologies mobiles, s'imposent ainsi de plus en plus comme l'outil de choix permettant aux gouvernements et les entreprises de repsenser la manière dont ils fournissent des services aux citoyens et aux clients.

Cependant, en dépit de ces progrès, l'énorme potentiel transformationel offert par les services de communications reste encore largement inexploité et est de plus en plus compromis par une inégalité très marquée dans l'accès aux TIC (Norris, 2001; Selwyn, 2004; Chircu et Mahajan, 2009).

Dans la mesure où l'accès à l'information est de plus en plus essentiel dans les activités économiques et sociales, les plates-formes mobiles vont continuer à prendre de l'importance dans les politiques de développement, stimulant l'innovation dans les systèmes de télécommunications et leur expansion. Non seulement les pays en voie de développement doivent avoir accès aux communications vocales de base: il est essentiel pour eux de s'approprier également les toutes nouvelles technologies offrant des possibilités plus larges et ainsi qu'une vaste gamme d'applications mobiles, telles que la banque sur mobile, l'identification électronique, la surveillance de la santé à distance, etc. Le besoin pour des téléphones portables 3G + avec des capacités améliorées n'a jamais été si fortement ressenti qu'aujourd'hui. De nouvelles preuves apportées par Chircu et Mahajan (2009) suggèrent que les pays en voie de développement peuvent « se libérer de la dépendance du sentier des TIC » et avoir directement accès aux dernières technologies mobiles en bâtissant l'infrastructure nécessaire pour les produits et les services innovants.

1.2. L'impact des communications mobiles dans les pays développés et en voie de développement

Des débats importants concernant l'impact des TIC sur la performance économique et la compétitivité en général, et sur la productivité, l'efficacité et l'innovation en particulier, ont dominé le terrain de recherche tout au long de la dernière décennie. Notamment, en cherchant une explication à l'accélération de la productivité et à la croissance économique inattendue dans de nombreux pays développés dans les années 1990 - 2000, de nombreux économistes ont conclu que l'élaboration, l'application et l'utilisation des nouvelles technologies de communication en a été un facteur critique (InfoDev, 2007).

Dans les pays industrialisés, l'augmentation de la production et l'utilisation des TIC a contribué significativement à la croissance économique: de 1996 à 2000 aux Etats-Unis, les nouvelles technologies de communication représentaient 6,3 pour cent de la croissance du PIB et une augmentation de 80 pour cent des gains de productivité du travail. Dans un autre exemple, les investissements dans les nouvelles technologies ont compensé la croissance négative dans d'autres secteurs durant la crise asiatique de 1998. Dans la foulée du ralentissement économique, la Corée du Sud estime que près de la moitié de sa croissance du PIB domestique a été liée aux nouvelles technologies mobiles et au secteur des TIC (Banque Mondiale, 2009).

Il a été démontré que dans les pays en voie de développement, les télécommunications mobiles offrent de nouvelles opportunités pour le développement économique (Banque mondiale, 2008; Qiang, 2009; Banque mondiale, 2009). En effet, les TIC jouent un rôle de catalyseur dans le transfert de connaissances et la diffusion technologique, amplifiant ainsi les avantages compétitifs des nouvelles économies. Dans la mesure où les dynamiques sous-jacentes dans les économies en transition sont beaucoup plus évidentes, des cycles complets se produisent avec une plus grande vitesse et permettent une évaluation plus rapide des résultats. Par exemple, de nombreuses communautés rurales, qui selon un rapport de la Banque mondiale (2009) abritent près de la moitié de la population mondiale et 80 pour cent des pauvres du monde, sont bénéficient d'une manière tangible et quantifiables par les communications mobiles. Par exemple, un certain nombre d'études (Banque mondiale, 2008; Qiang, 2009; Banque mondiale, 2009) ont trouvé des preuves significatives que l'utilisation des téléphones mobiles augmente le PIB dans les pays développés et en voie de développement. Une étude réalisée par McKinsey (2007) a rapporté qu'en Chine les entreprises dans le secteur TIC ont contribué au PIB deux fois plus que les autres. Confirmant ces résultats, Deloitte (2008) a indiqué que les technologies mobiles ont eu un impact sensible sur le PIB dans les six pays analysés : Ukraine, Serbie, Thaïlande, Malaisie, Bangladesh et Pakistan.

D'autres résultats d'un rapport récent de la Banque mondiale (2009) montrent que l'utilisation accrue des technologies de communication mobile a contribué de manière significative à la croissance économique dans les économies émergentes. Ainsi, entre 1996 et 2005, les pays en développement présentant une augmentation de la pénétration mobile de plus 10 téléphones mobiles pour 100 personnes ont bénéficié d'une croissance du PIB par habitant de 0,8 points de pour cent. Dans les pays développés, cette meme augmentation a identifiée en moyenne à 0,6 points de pour cent (Qiang, 2009).

De plus, de nombreux exemples dans les pays en voie de développement montrent que les communications mobiles améliorent l'intégration sociale et financière des populations isolées et fournissent des opportunités de revenus dans les zones rurales au-delà des activités agricoles traditionnelles. Au Bangladesh, une start-up innovante, Grameen Telecom, étend la couverture financière aux zones rurales grâce à la fourniture de micro-crédits. La moyenne des profits des opérateurs de village (intermédiaires et vendeurs de minutes d'appel) est de 700 $ par an, soit plus de deux fois le revenu par habitant. Une entreprise similaire en Afrique du Sud – Wizzit – offre un service qui permet aux utilisateurs, y compris à ceux sans comptes bancaires ou cartes de crédit, d'envoyer de l'argent via le téléphone mobile et de recevoir de la même manière des fonds depuis l'étranger. Ces exemples et d'autres similaires montrent que les acteurs de l'écosystème mobile adoptent des approches novatrices pour tenter d'atteindre les clients ruraux ou marginalisés. En conséquence, de plus en plus d'individus dans les pays en voie de développement, en accédant à la connaissance mondiale, sont capables de libérer le potentiel de leur capital humain et de l'innovation. Les entreprises ont besoin de comprendre et de développer des programmes spécifiques de marketing inclusif permettant aux catégories d'adopteurs marginalisées d'accéder aux services de téléphonie mobile. Ces stratégies marketing seront d'autant plus critiques que les individus des pays en développement n'accèdent pas qu'aux services mobiles, mais peuvent désormais bénéficier de nouvelles technologies pour accéder au savoir global, ce qui à son tour conduit à libérer le potentiel de leur capital humain et à favoriser l'innovation.

Un rapport récent de la Banque mondiale (2011) vient de constater que les entreprises mondiales dans les secteurs manufacturiers et de services qui utilisent les TIC de manière intensive sont plus productives, s'élargissent plus vite, investissent davantage, et sont plus rentables. D'autre part, les entreprises locales sont de plus en plus intégrées dans les chaînes de production mondiale et les marchés, contribuant ainsi à la croissance économique de leur pays et région. Enfin, en adoptant des TIC, les organismes gouvernementaux sont de plus en plus efficaces, contribuant à la croissance à long terme grâce à des gains de productivité (Banque mondiale, 2011).

Ces nombreuses éléments convergent vers la même conclusion selon laquelle la technologie mobile permet de contribuer à la réalisation des objectifs de développement du millénaire (ODM). Officiellement lancés en 2000, les ODM découlent des objectifs de développement internationaux antérieurs et visent à assurer le développement humain et économique à travers la réalisation de huit objectifs et 21 cibles, chacune avec une série d'indicateurs mesurables. Grâce aux possibilités offertes par les TIC au niveau mondial, les technologies mobiles sont considérées comme déterminantes dans la réalisation des ODM.

2. LA DIFFUSION A L'INTERNATIONAL DES TECHNOLOGIES MOBILES

Au cours de la dernière décennie, l'accès aux communications mobiles est devenu un domaine stratégique prioritaire de l'engagement politique dans les économies émergentes. Malgré des résultats initiaux très encourageants, la percée tant célébrée de la téléphonie mobile dans le monde en voie de développement ne doit pas occulter le fossé qui existe entre nations riches et pauvres dans l'accès aux TIC. La dynamique de diffusion des nouvelles technologies dans toutes les régions montre une hétérogénéité frappante. Pour de nombreuses économies émergentes, l'accès aux réseaux de télécommunications et de services mobiles à valeur ajoutée reste un défi majeur du développement.

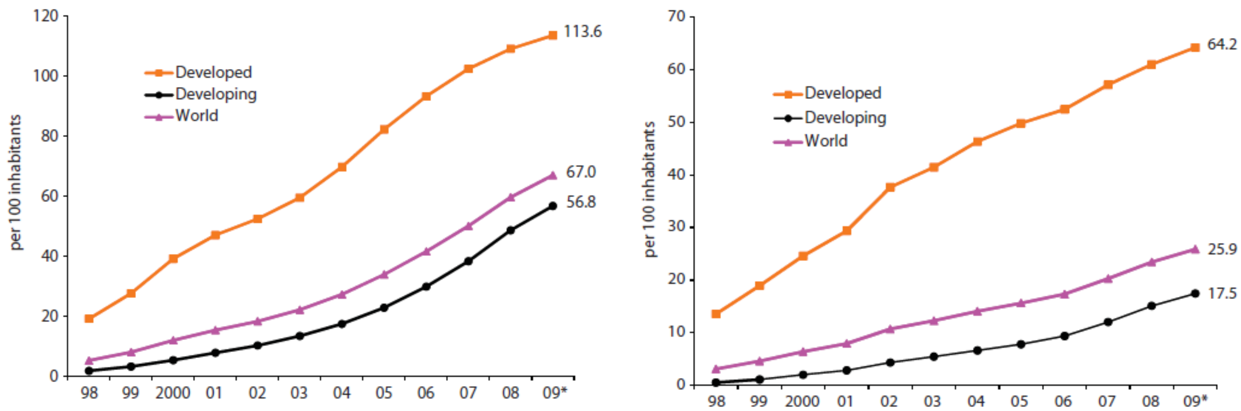
Les recherches antérieures sur les TIC révèlent que les pays en voie de développement ont des niveaux d'adoption de la technologie inférieurs à celui des pays développés, un constat appellé la « fracture numérique » (Dewan et Kraemer, 2000). Toutefois, des recherches plus poussées sur les TIC émergentes est nécessaire pour comprendre l'ampleur de la fracture numérique entre les pays développés et en développement (Knowledge @ Wharton, 2004; Chircu et Mahajan, 2009).

En effet, la diffusion des technologies mobiles est encore très inégale selon les pays. Ces phénomènes ne sont pas nouveaux et les disparités ont été observées notamment à un stade très précoce du cycle de vie du produit (Dekimpe, Parker, Sarvary, 2000; Kumar et Krishnan, 2002; Tellis, Stremersch, Yin, 2003; Chandrasekaran et Tellis, 2008). Cette étape correspond au lancement et à la phase de décollage d'un nouveau produit / de la technologie et est essentielle dans la détermination des schémas de diffusion ultérieurs.

La figure 1 montre les schémas de diffusion hétérogènes d'Internet et de technologies mobiles. Non seulement les modèles de diffusion dans les pays développés diffèrent en mesure de celles du monde en développement, mais l'écart se creuse entre les deux technologies, internet et mobile.

Figure 1: Pénétration Mobile et Internet, pays développés et en voie de développement, 1998-2009

Abonnements Mobiles Abonnements Internet



Source: ITU, 2010; *estimations

Par ailleurs, la littérature sur la pénétration des TIC (Dewan et Kraemer 2000, 2005; Corrocher et Ordanini 2002, Chinn et Fairlie, 2006; Chircu et Mahajan, 2009) documente la façon dont divers facteurs au sein d'un même pays contribuent à l'élargissement de la fracture numérique. Dans ce corps de recherche, toutefois, peu d'attention est consacrée aux actions politiques nécessaires à la réduction de la fracture.

Les entreprises du secteur des TIC, comme les opérateurs de téléphonie mobile par exemple, peuvent aider à atteindre ces objectifs, notamment par la conception et la planification stratégique de leurs efforts de marketing dans le but de rendre les innovations plus abordables et plus accessibles à une plus large catégorie de consommateurs.

Les Objectifs de la Recherche et la Méthodologie

1. LES OBJECTIFS DE LA RECHERCHE ET LES DEFINITIONS

Cette recherche porte sur le thème de la diffusion à internationale des nouveaux produits et technologies qui sont identifiés ici sous le terme d'*innovations*.

1.1. La diffusion des innovations: de quoi s'agit-il?

L'innovation a été étudiée à travers une variété de perspective, y compris dans ses relations à la technologie, au commerce, aux systèmes sociaux, au développement social, et au cadre réglementaire. Naturellement, dans la littérature de spécialité il existe un large éventail d'approches pour conceptualiser l'innovation (Fagerberg et al., 2004).

Plusieurs définitions ont été proposées dans la littérature académique pour le concept d'innovation. Une définition pratique de l'innovation est donnée par Luecke et Katz (2003), qui considèrent l'innovation comme l'incarnation de la connaissance dans des nouveaux produits à valeur ajoutée, dans des procédés ou services inédits. Il s'agit d'une vision de l'innovation plus audacieuse que celle de Rogers (1983) dont la définition initiale de l'innovation était celle d'«une idée, une pratique ou un objet qui est perçu comme nouveau par un individu ou une autre unité d'adoption». Il s'intéresse également à l'ensemble des processur liés à l'innovation - de l'idée créative à sa materisalization même dans un produit concret. Alors que la créativité est généralement considérée comme la base pour l'innovation, cette dernière est en effet la mise en œuvre réussie des idées créatives dans un contexte plus large d'application

(Amabile et al., 1996).

Cette thèse ne tient pas compte des recherches qui ont recours à une définition élargie de l'innovation, comme liée aux nouvelles idées, aux nouveaux comportements propres aux individus ou aux nouveaux procesus au sein des organisations, mais se concentre plutôt sur les innovations conduisant au lancement de nouveaux produits et à leur diffusion. Par conséquent, les mesures administratives, organisationnelles ou celles liées au processus de l'innovation sont volontairement omises. De nombreuses études se sont intéressées à ces questions (Cohen et Levinthal, 1990; Damanpour, 1991 ; Hage, 1999) et Tellis (2008) et donnent un bon aperçu de l'état de la connaissance dans ce domaine.

Dans ce travail de recherche nous allons parler de *produits technologiques* et de *technologie*, de *nouveaux produits* et de l'*innovation*, ainsi que des *technologies de l'information et des communications* (TIC). Cependant, il existe des différences évidentes entre toutes ces notions. Par exemple, comme discuté ci-dessus, la technologie est beaucoup plus complexe que le produit technologique, car elle va au-delà de la matérialisation concrète et de la commercialisation d'un produit. Par exemple, dans le secteur des biens de consommation, la technologie de téflon a été utilisée de manière radicalement novatrice, générant une gamme de nouveaux produits, allant des casseroles recouvertes de bande de téflon antiadhésive jusqu'aux vestes Gore-Tex et chaussures multi-sport. Dans l'industrie des TIC, la technologie Skype est utilisée au-delà de ses fonctions d'origine d'appels sur VoIP (Voix sur IP). Ainsi, mi-2011, Microsoft a acquis Skype pour 8,5 milliards de dollars avec l'intention d'intégrer la technologie dans plusieurs de ses nouveaux produits, tels que sa toute nouvelle console Xbox et ses nouveaux téléphones mobiles Windows.

Il nous semble donc important de préciser que lorsque dans ce travail de thèse l'on utilise les expressions introduites dans le paragraphe précédent, ou plus largement, le terme « *innovation* », nous ne faisons pas expressément référence à la technologie, mais plutôt aux nouveaux produits qui "reposent largement sur les avancées technologiques" (Dekimpe, Parker et Sarvary, 2000). Nous allons ainsi utiliser les termes *innovation* et *nouveaux produits* en sous-entendant que nous nous intéressons à ceux qui ont des origines technologiques.

1.2. Bref aperçu des recherches antérieures dans le domaine de la diffusion des innovations

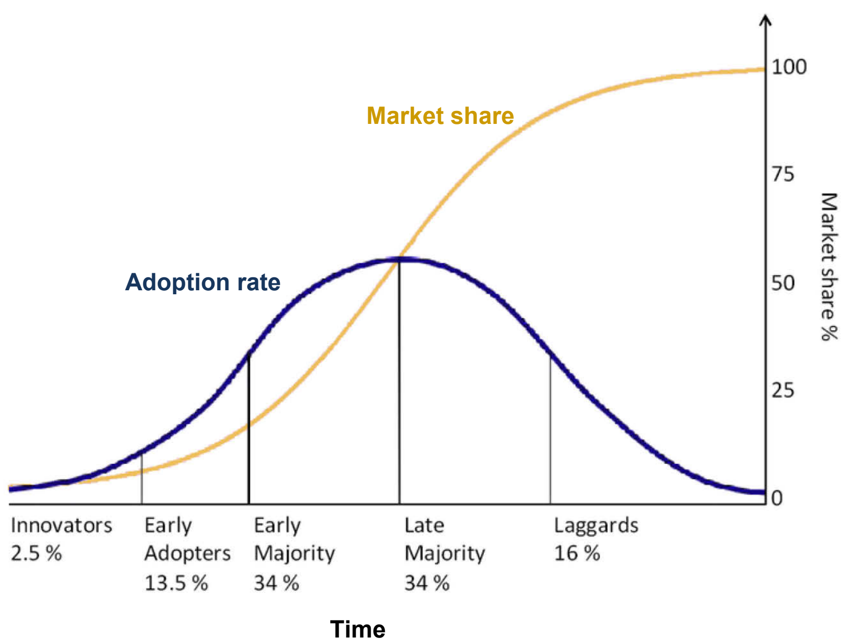
La diffusion des innovations est le processus par lequel de nouvelles idées, nouveaux procédés, nouveaux produits et technologies se répandent à l'intérieur d'un système. Un résumé des idées tirées de la revue de littérature nous aide à envisager l'étude de la diffusion des innovations comme l'étude du pourquoi, comment et à quelle vitesse les innovations se diffusent au sein des populations d'adopteurs potentiels.

Un effort de recherche considérable a été consacré à l'extension du corps des théories de la diffusion. Depuis son introduction aux études de marketing dans les années 60, la littérature sur la diffusion s'est développée à travers un certain nombre de disciplines pour expliquer la manière dont se rependent les innovations à travers un système social. Le schéma général de diffusion est généralement décrit sous la forme d'une courbe en S logistique (Tidd, 2006). Un grand nombre d'études ont été menées dans la littérature de recherche pour tenter de valider empiriquement ce profil sigmoïde, avec une variété de modèles statistiques élaborés à cet effet. Le plus ancien et le plus couramment utilisé est le modèle de diffusion épidémique, qui a ses racines dans les travaux de deux économistes, Grilliches (1957) et Mansfield (1968). Le modèle est basé sur l'hypothèse qu'un groupe homogène d'adopteurs potentiels qui participent à la diffusion des flux d'informations à travers des contacts personnels et la proximité géographique. S'appuyant sur ces conclusions, Rogers (1962, 1976, 1983) et Bass (1969) ont été les pionniers de la recherche sur la diffusion des innovations et des nouveaux produits, traçant le chemin pour les avancées théoriques ultérieures et les validations empiriques du modèle épidémique.

Dans son modèle de diffusion, Bass (1969) distingue deux segments homogènes d'adopteurs: les innovateurs, qui dirigent le décollage du nouveau produit, et qui ne sont pas soumis à la contagion sociale, et les imitateurs, pour qui l'adoption a lieu sous la forme épidémique discutée ci-dessus. Cela génère une «courbe logistique positivement asymétrique» (Karshenas et Stoneman, 1992) qui est devenue une référence à la fois dans l'économie et la recherche marketing.

En parallèle au travail de Bass, Rogers (1962, 1983) a effectué une synthèse de plus de 3000 études sur l'adoption par les consommateurs et la diffusion du produit. Les résultats de cette synthèse comprennent de nombreuses généralisations au sujet de la diffusion des innovations. Sa principale conclusion est que le processus de diffusion est initié par les adoptants pionniers et atteint le cap au décollage lorsque une communauté grandissante d'adeptes est établie et les effets de l'influence des pairs et d'imitation se mettent en mouvement. La diffusion se ralentit lorsque la population d'adopteurs potentiels s'épuise, prenant ainsi la forme d'une courbe sigmoïde.

Figure 1: Contribution des groupes de consommateurs au processus de diffusion d'un nouveau produit – Rogers (1962)



Dans les études marketing, ces généralisations de Rogers ont été utilisées comme un guide pour accélérer le processus de diffusion en utilisant des campagnes de communication spécifiquement adaptées pour atteindre les innovateurs plutôt que la majorité (Gatignon et Robertson, 1985). Or, c'est souvent le processus d'imitation qui entraine le processus de diffusion dans un déroulement plus rapide.

La *vitesse* de diffusion est importante, car si l'on considère la diffusion de nouveaux produits sur le marché, l'un des principaux indicateurs de succès, avec les *ventes* et les *taux de pénétration*, est le *temps*. Le temps de diffusion et de propagation des nouvelles technologies a été étudié de façon systématique (Easingwood, 1988). Bien que le temps de diffusion soit spécifique à chaque pays et technologie, Easingwood (1988) a constaté que le temps nécessaire pour atteindre 75% de pénétration du marché varie de 3,5 ans à 28,4 ans. D'autres résultats suggèrent une période de diffusion de 5 à 50 ans pour que les produits avec une forte composante technologique atteignent 95% du marché potentiel (Stoneman, 1995). Rogers et al. (1971) donnent des exemples frappants de périodes de temps de diffusion, comme les 40 ans qui se sont écoulés avant que le four ait été adopté par la poterie anglaise.

Alors que le modèle de Rogers a très justement capté les concepts de base du processus de diffusion, il ne s'applique pas de la même manière à tous les contextes d'adoption, en particulier à ceux où les caractéristiques démographiques et socio-économiques des adopteurs précoces sont hétérogènes. Cette hétérogénéité diffère fortement d'un pays à l'autre, et lorsequ'on souhaite comprendre les variations dans les trajectoires de diffusion à internationale, cette hétérogénéité doit être intégrée dans le modèle de diffusion. Par ailleurs, de nombreuses études portant sur la diffusion à l'internationale ont montré que les aspects culturels, tels que le comportement individualiste de la personne / la société, ainsi que sa propension à accpeter l'incertitude et à prendre du risque, sont susceptibles d'affecter la diffusion des nouveaux produits (Tellis, Stremersch et Yin, 2003; Kalliny et Hausman, 2007; Chandrasekaran et Tellis, 2008; Van Everdingen, Fok, Stremersch, 2009). En outre, dans certains contextes, comme dans les pays à géographie dispersée et à faible densité de la population, la communication interpersonnelle est très limitée et donc son rôle dans le mécanisme d'adoption n'est pas toujours évident. Dans de telles circonstances, l'hypothèse de contagion sociale naturelle ne tient pas. Par conséquent, cibler un petit groupe de consommateurs d'abord est susceptible d'entrainer une vitesse de diffusion beaucoup plus lente que si la masse d'adopteurs potentiels avait été approchée (Gatignon et Robertson, 1985; Wright et Esslemont 1994; Goldenberg et Oreg, 2007).

D'autre part, les résultats de Rogers ont été systématiquement validés par des études empiriques sur les décisions d'adoption qui sont conditionnées d'une façon importante par les externalités de réseau (Katz et Shapiro, 1986; Markus, 1987, Le Nagard-Assayag, 1999; Le Nagard-Assayag et Manceau, 2001; Rohlfs, 2001). Les externalités de réseau sont une préoccupation majeure dans les industries systémiques, comme les télécommunications, par exemple, où la valeur d'utilisation d'un nouveau produit augmente avec la taille du réseau d'utilisateurs. Toutefois, la communication interpersonnelle n'est pas forcément nécessaire pour que les externalités de réseau exercent une influence sur la diffusion, puisque les adopteurs potentiels peuvent se renseigner sur le niveau de pénétration d'un nouveau produit et décider de l'adopter (Stremersch et Binken, 2009; Peres , Muller et Mahajan, 2010). Par ailleurs, des recherches récentes par Goldenberg, Libai et Muller (2010) suggèrent qu'en séparant les effets de réseau du bouche-à-oreille, les externalités de réseau peuvent avoir un effet paralysant sur les taux de croissance des nouveaux produits et de la rentabilité attendue.

1.3. La motivation de la recherche, les objectifs et les implications potentielles

Comme mentionné dans la section précédente, l'analyse des phénomènes expliquant l'adoption innovante et motivant l'adoption d'imitation lors de la diffusion des innovations à l'international, à la fois dans les pays développés et en voie de développement, a suscité un vif intérêt parmi les chercheurs.

Etant donné que les deux modèles les plus répendus, celui de Bass (1969) et de Rogers (1983), combinent les effets de l'innovation provenant des influences externes avec les effets de communication interpersonnelle, pour en produire une courbe d'adoption sigmoide, aucun des deux ne fournit des éléments de modélisation pertinents dans les marchés où l'influence interpersonnelle est influencée par d'autres facteurs, tels les dimensions socio-culturelles par exemple.

Du point de vue purement théorique, ce travail est influencé par un nouveau courant de recherche qui affirme que la diffusion de nouveaux produits est autant contingente à l'hétérogénéité des consommateurs qu'à l'interaction entre ceux-ci (Dekimpe, Parker et Sarvary, 2000; Van den Bulte et Stremersch, 2004; Berger et Heath, 2007; Pérès, Muller et Mahajan, 2010). Plusieurs études ont révélé que l'hétérogénéité des consommateurs suscite des retards dans la diffusion des innovations (Gatignon et Robertson, 1985; Dekimpe, Parker et Sarvary, 2000). On désigne ici l'hétérogénéité comme la sensibilité variable des adopteurs potentiels aux prix, à l'accessibilité perçue, à l'innovation, ainsi qu'à la propension à succomber à l'influence des pairs, entre autres.

En effet, une telle analyse permet d'étendre et de compléter l'interprétation des caractéristiques des adopteurs, telles que décrites par Rogers (1983) et plus tard reprises par les théories classique de diffusion. Il semble donc intéressant dans ce travail de recherche de tenter de découvrir l'influence de ces spécificités du marché sur la dynamique de ces deux mécanismes – d'adoption par comportement d'innovation et d'adoption par l'imitation – à travers une illustration des boucles de rétroaction sousjascentes aux processus de diffusion. De plus, il est essentiel que cette analyse soit faite tant au niveau national qu'international, ce qui représente une motivation additionnelle pour ce travail de recherche.

Des recherches récentes montrent qu'il existe un intérêt croissant parmi les chercheurs à analyser les différences entre les pays dans le temps du take-off/décollage des nouveaux produits et innovations (Dekimpe, Parker et Sarvary, 2000; Chandrasekaran et Tellis, 2008; Van Everdingen, Fok, Stremersch, 2009). Les principales questions de recherche visent à déterminer si la catégorisation de Rogers d'adopteurs précoces permet de capturer les nuances importantes dans le comportement d'adoption, qui se font sentir dans les pays culturellement et économiquement distincts: comment un changement dans ces paramètres influence le temps de *take-off*/décollage et la diffusion globale des nouveaux produits? Quels autres facteurs influent sur la diffusion de nouveaux produits dans différents pays? Les travaux académiques majeurs référencés dans notre recherche sur ce sujet sont Sterman (2000), Dekimpe, Parker et Sarvary (2000), Tellis, Stremersch et Yin (2003), Chandrasekaran et Tellis (2008), Van Everdingen, Fok, Stremersch (2009), et enfin Peres, Muller et Mahajan (2010). Le consensus qui se dégage est que le temps moyen nécessaire pour le take-off/décollage d'un nouveau produit varie considérablement entre les pays développés et en voie de développement, avec des produits dont les ventes décollent le plus rapidement en Japon, suivi par les Etats-Unis et certains pays européens. Alors que l'on ne connait encore que peu de choses au sujet de la diffusion des innovations dans les économies émergentes d'Afrique, d'Amérique latine et d'Asie, il devient clair que « le décollage est entraîné par la culture et la richesse du pays », en plus d'autres facteurs, tels les caractéristiques du produit (Chandrasekaran et Tellis, 2008). Ce travail de recherche vise à explorer d'avantage les autres facteurs-clés qui ont été trouvés à jouer un rôle important dans la diffusion des innovations à l'internationale.

Avec la compréhension actuelle du mechanisme necessaire à l'amorce du processus de diffusion, il est également nécessaire d'explorer comment l'adoption par *imitation* peut être alimentée par l'adoption par *innovation*. Ceci permetterait de gagner une meilleure compréhension des façons d'accélérer le processus de diffusion des nouveaux produits et technologies, et d'étendre ainsi les opportunités d'adoption à tous les segments de marché.

Comme déjà précisé dans la partie introductive de cette thèse, il est nécessaire d'aider les décideurs politiques et les praticiens du marketing dans la conception des stratégies optimales de développement du secteur des TIC afin de garantir l'inclusion d'une catégorie plus large des adopteurs. Pour cela, il est essentiel d'adopter une approche holistique à l'analyse du processus de diffusion et de mieux comprendre l'impact que certaines actions marketing et politiques pertinentes peuvent avoir sur l'ensemble du système. Il est certain qu'une analyse globale peut aider les gestionnaires à formuler des stratégies qui favorisent la diffusion des innovations technologiques. Jackson (2006) fournit un ensemble de directives sous le nom de *holisme créatif* dont l'ambition est d'être « l'orientation multi-paradigme et multi-méthode dans la gestion des systèmes complexes et dynamiques ».

En adoptant cette approche, la pensée systémique met en avant une vision plus large et holistique de la question de la diffusion des innovations technologiques (O'Connor et McDermott, 1997; Sterman, 2000; Jackson, 2003, 2006). A la différence du réductionnisme scientifique de Descartes, elle propose de représenter les systèmes (e.g les marchés, les industries, les organisations et même les relations humaines) d'une manière holistique, en examinant les interconnexions et les interactions entre les différentes composantes qui forment l'ensemble d'un système. Ce travail de recherche est largement inspiré par cette approche et vise à aborder le processus de diffusion à l'international d'une nouvelle façon, plus complète.

D'un point de vue théorique, la constitution d'un modèle conceptuel intégrant les principaux facteurs affectant la diffusion des innovations, ainsi que l'identification des liens entre eux, tout en capturant l'évolution dans le temps de l'ensemble du système, représente un potentiel pour une meilleure compréhension des questions complexes dans le champ académique des théories de la diffusion et innovations technologiques. Dans cette perspective, ce travail de recherche devrait conduire à la construction d'un modèle dynamique non-linéaire pour la diffusion de nouveaux produits et innovations, en appliquant la méthodologie dse Systèmes Dynamiques, et en le considérant comme un cadre d'analyse holistique pour les décisions de marketing stratégique. Ce dernier objectif présente un intérêt tangible pour les praticiens du marketing et les décideurs politique, leur permettant de prendre des décisions mieux informées et plus pertinentes pour la définition de politiques et d'actions marketing plus efficaces.

La section suivante présente plus en détail les choix méthodologiques de cette recherche.

2. L'APPROCHE METHODOLOGIQUE

La méthodologie de recherche porte sur la conception d'un cadre holistique pour l'analyse des processus de diffusion des TIC, basée sur une revue de littérature multidisciplinaire et entrevues menées auprès des Experts dans le domaine de l'innovation et du développement. Afin de saisir les dynamiques non linéaires en jeu et les interactions complexes (boucles de rétroaction) entre les sphères macro- et micro-économiques et marketing, nous utilisons l'approche de modélisation des Systèmes Dynamiques. Conçue au M.I.T. dans les années 1960 et initialement appliquée aux sciences de l'ingénierie, cette approche permet de penser le système d'une manière holiste et d'évaluer les implications des stratégies et des politiques d'action dans des environnements complexes et hautement intégrés.

La méthodologie utilisée dans ce travail est détaillée ci-dessous.

2.1. Le modèle conceptuel

2.1.1. L'identification des dynamiques et facteurs clés

La recherche a commencé par l'identification des facteurs pertinents influençant la diffusion des innovations dans l'industrie des télécommunications. Puisqu'une classification des facteurs identifiés par leur niveau d'importance n'aurait pas fait apparaître la profondeur de l'analyse, nous avons considéré le contexte de la diffusion des innovations comme un système dynamique, influencé par cet ensemble de facteurs. Dans cette optique, non seulement les facteurs eux-mêmes sont importants, mais le sont également les interdépendances qui existent entre eux.

Nous avons conduit une revue de littérature multidisciplinaire et mené des entrevues auprès des experts du secteur, afin de saisir les dynamiques non linéaires en jeu et les interactions complexes (boucles de rétroaction) présentes dans le système de diffusion des innovations.

2.2. Vers une approche holiste de la diffusion des innovations

Après avoir identifié les facteurs pertinents, notre démarhce a consisté à prendre du recul et à adopter une approche holistique envers ce que constitue un «système» dans la diffusion des innovations. L'objectif ici était de construire un modèle dans lequel les facteurs précédemment identifiés sont intégrés d'une manière qui est pertinente à la fois par rapport au contexte de la recherche et à la question posée. En d'autres termes, la structure du modèle devrait permettre d'étudier et d'illustrer le comportement du modèle, en testant les actions politiques qui sont pertinentes et réalisables dans le monde «extérieur» (par exemple, le recours aux simulations pour explorer des situations reelles qui peuvent conduire à des idées et des résultats utiles sur le terrain).

2.3. Le modèle quantitatif

Partir d'une approche qualitative vers un modèle quantitatif a été une étape nécessaire pour la validation des tests quantitatifs et du modèle de diffusion proposés. Finalement, l'objectif de cette étape a été de passer d'une visualisation et d'une compréhension générale des forces et des boucles de rétroaction en jeu dans l'écosystème de diffusion de nouveaux produits, vers un modèle mathématique capable de produire les résultats quantitatifs d'un processus de diffusion, à partir d'un ensemble de données.

Une fois le modèle a été entièrement paramétré, les schémas de boucles de rétroaction qualitatifs ont été traduits dans un modèle de système dynamique complet, représenté par un modèle informatique utilisant la logiciel de modélisation Vensim®. Une fois calibré grâce au recours aux données disponibles pour la diffusion de téléphones mobiles 3G dans 17 pays, le modèle est utilisé pour explorer diverses options et stratégies de développement des TIC, permettant de quantifier leur impact sur la vitesse et l'ampleur de la diffusion.

Les historiques des données de vente ont été recueillies pour 17 pays: Argentine, Belgique, Brésil, Danemark, Estonie, Finlande, France, Allemagne, Irlande, Italie, Pays-Bas, Norvège, Pologne, Russie, Espagne, Turquie et Royaume-Uni.

La principale utilisation du modèle de système dynamique n'est pas de fournir un outil permettant de prévoir les ventes de produits en détail. Sa fonction principale est d'aider à la compréhension du comportement général d'un processus de diffusion complexe et d'identifier les comportements et influences respectifs de toutes les dynamiques en jeu dans un écosystème basé sur une structure dense de boucles de rétroaction.

2.4. L'analyse du modèle et les implications

Une fois le modèle calibré, la dernière phase a consisté à:

- évaluer la performance du modèle calibré en termes de qualité de l'ajustement aux données historiques, en la comparant avec le modèle de référence de Bass (1969) ;
- explorer la sensibilité de comportement du modèle aux paramètres de contexte majeurs, tels que les caractéristiques socio-économiques ou culturelles ;
- identifier des recommandations spécifiques pour accélérer la diffusion des produits, la définition et l'exécution des scénarios spécifiques, tout en quantifiant leurs impacts sur la diffusion du produit.

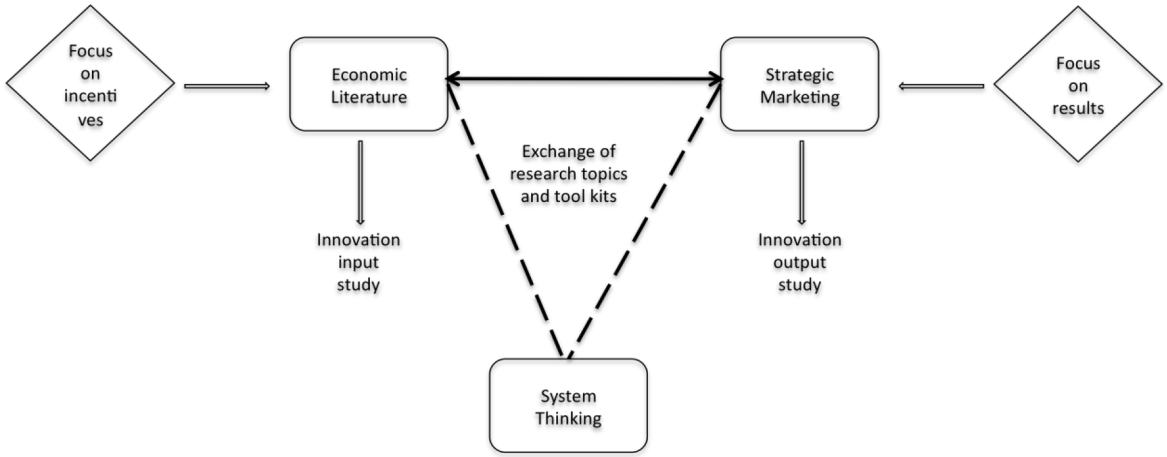
Le Cadre Théorique

1. LA REVUE DE LITTERATURE

Dans notre tentative pour résumer la recherche dans le domaine de la diffusion des innovations et nouveaux produits, nous avons passé en revue les grands travaux dans le domaine de l'économie et du marketing avec un accent sur ce dernier, suivi par un aperçu des recherches pertinentes dans la dynamique des systèmes. Dans cette revue de littérature, nous avons recherché à la fois la nouveauté théorique et la validation empirique des concepts liés à la diffusion des innovations technologiques dans l'industrie des télécommunications. Nous avons trouvé qu'il y avait une prépondérance de travaux théoriques, due à une disponibilité réduite de données relatives au processus de diffusion. Cette opinion est étayée dans une enquête réalisée par Ahuja, Lampert et Tandon (2008). En analysant ces deux courants de littérature, ils affirment qu'il pourrait y avoir « des avantages de pollinisation croisée», à travers un échange de problèmatiques de recherche et d'outils.

Ainsi, nous suggérons qu'une approche plus holistique au processus de diffusion soit considérée et qu'elle inclue un aperçu des deux courants de la littérature. La raison principale pour une approche holistique est que le holisme encourage l'utilisation des analogies trans-disciplinaire, en accordant une attention à « la fois à la structure et au processus » ce qui nous permet de lier « théorie et pratique dans un cycle virtueux d'apprentissage » (Sterman, 2000).

Figure 2: Conceptualisation de la relvue de littérature



Dans cette recherche, nous allons utiliser principalement la méthodologie des Systèmes Dynamiques. Nous avançons que cette approche a démontré sa capacité à améliorer la compréhension du comportement dynamique des systèmes complexes, tels que les environnements de diffusion des innovations. Nous nous appuierons sur cette discipline qui se situe à la croisée entre la littérature de marketing stratégique et économique (comme illustré dans la figure 2).

2. LES CONCLUSIONS DE LA REVUE DE LITTERATURE

Dans le processus de revue de littérature, nous avons été à la recherche de connaissances et, si possible, de preuves empiriques, relatives aux principaux facteurs affectant la diffusion des innovations technologiques, ainsi qu'aux interdépendances qui existent entre ces facteurs.

En conséquence, nous avons trouvé un nombre significatif de facteurs que nous avons organisés en 7 grandes catégories, qui sont:

- Les facteurs liés au produit
- Les facteurs marketing
- Les facteurs de l'industrie
- Les facteurs économiques

- Les facteurs démographiques
- Les facteurs culturels
- Les facteurs réglementaires

La section suivante présente les facteurs de chaque catégorie et les enseignements issus de la revue de la littérature.

2.1. Résumé des facteurs affectant la diffusion des innovations

Les facteurs identifiés par la revue de littérature, ainsi que leur description, l'effet estimé sur la diffusion et les références dans la litérature académique, sont présentés au tableau 2.

Afin de construire un modèle de diffusion plus réaliste et plus robuste, la revue de la littérature doit être accompagnée par une analyse qualitative, permettant de compléter et d'affiner la liste des facteurs / variables identifiés. En outre, en adoptant une approche exploratoire au phénomène de diffusion à l'international, nous arrivons à révéler d'autres connexions inconnues entre les différentes variables mesurées.

La section suivante présente les résultats des entretiens menés avec des experts du secteur.

Tableau 1: Facteurs affectant la diffusion des innovations, tels qu'identifiés dans la revue de littérature

	Facteur	Effet	Références
Facteurs liés au produit	Avantage/valeur-ajoutée	Positif	Jain, Mahajan and Muller, 1991; Henard and Szymanski, 2001;
	Degré d'innovation	Mixte	Robertson, 1967; Cooper and Kleinschmidt, 1987; Montoya-Weiss and Calantone, 1994; Joshi and Sharma, 2004;
Facteurs marketing	Prix	Positif	Bass, 1980; Bass and Bultez, 1982; Kalish, 1985; Horsky, 1990;
	Bouche-à-oreille	Mixte	Bass, 1969;
	Publicité	Positif	Horsky and Simon, 1983; Kalish, 1985;
	Distribution	Positif	Jones and Ritz, 1991; Lilien, Rao and Kalish, 1981;
Facteurs de l'industrie	Externalités de réseau	Mixte	Le Nagard-Assayag and Manceau, 2001; Rohlfs, 2001; Katz and Shapiro, 1985; Xie and Sirbu, 1995; Goldenberg, Libai and Muller, 2010;
Facteurs économiques	GDP (élevé)	Positif	Golder and Tellis, 1998; Clarke and Wallsten, 2006;Qiang and Rossotto, 2009;
	l'index Gini (bas)	Positif	Chandrasekaran and Tellis, 2009; Tellis, Stremersch, Yin, 2003;
	Budget disponible (élevé)	Positif	Fuss et al., 2005;
Facteurs démographiques	Hétérogénéité de la population	Negatif	Tellis, Stremersch, Yin, 2003;
	Croissance démographique	Positif	Mahajan and Peterson, 1978; Sterman, 2000;
Facteurs culturels	Aversion au risque	Negatif	Hofstede, 1980; Ganesh, Kumar and Subramanian, 1997; Parker, 1997; Tellis, Stremersch, Yin, 2003;
	Individualisme	Negatif	
Facteurs réglementaires	Systèmes de financement/ subventions	Mixte	Kalish and Lilien, 1983; Laffont and Tirole, 2000; Estache et al. 2002; Navas-Sabater et al., 2002; Muente-Kunigami and Navas-Sabater, 2010;
	Standardisation	Mixte	Saugstrup and Henten, 2004; Gans, King, and Wright, 2004; Rouvinen, 2006;

L'Etude Exploratoire

1. LES ENTRETIENS AVEC LES EXPERTS DU SECTEUR

La revue de littérature présentée ci-dessus est essentiellement fondée sur les théories de la diffusion des innovations et des critiques de modèles de diffusion. Celles-ci avaient été développées à partir des statistiques et des données sur les produits innovants disponibles. Peu permettent d'explorer les perceptions des décideurs de l'industrie des TIC et leurs opinions sur les facteurs affectant la diffusion des innovations.

Il est donc apparu nécessaire de confronter les résultats de la revue de littérature avec les enseignements des entrevues des praticiens. Un total de 22 entretiens exploratoires ont été menés avec des experts du secteur, représentant chacun un acteur majeur de l'industrie des télécommunications et des TIC. Au moment de l'entrevue, les personnes interrogées occupaient des postes de gestion et de direction dans leurs entreprises et avaient une connaissance significative dans le domaine de l'innovation.

La section suivante résume la méthodologie employée pour réaliser l'étude exploratoire et présente une analyse des résultats.

2. LA METHODOLOGIE DE L'ETUDE EXPLORATOIRE

L'objectif global de cette étude est d'explorer les perceptions des praticiens, des experts de l'industrie et des décideurs dans les secteurs des télécommunications et des TIC, quant aux principaux facteurs affectant la diffusion des innovations sur la scène internationale. Afin d'atteindre ces objectifs, les entretiens étaient semi-structurés et réalisés dans le cadre d'une communication bidirectionnelle mais bien ciblée. Le guide d'entretien comportait un ensemble prédéfini de questions ouvertes, certaines formulées à l'avance et d'autres découlant naturellement de l'entrevue, offrant la flexibilité nécessaire pour explorer plus en détails dès lors que cela était nécessaire. Suivant le principe de saturation, nous avons arrêté des entretiens lorsque l'information recueillie était devenue trop répétitive et n'apportaient pas d'informations nouvelles.

Pusiqu'il s'agit d'une étude exploratoire, celle-ci n'avait pas l'ambition de cibler un groupe spécifique de personnes ou d'entreprises et c'est donc pour cela que l'échantillon final n'est pas forcément représentatif. Cependant, le choix des personnes/compagnies à interviewer a été guidé par l'idée d'interviewer une variété d'acteurs qui font partie de la chaîne de valeur dans le secteur des télécommunications. Cette industrie est très fragmentée et contient un grand nombre d'acteurs impliqués dans la chaine logistique des solutions destinées à l'utilisateur final.

2.1.1. Le choix des personnes/compagnies à interviewer

Dans chaque entreprise, nous avons essayé d'identifier des individus bien informées des sujet de l'innovation et qui occupent, en même temps, un poste de gestion ou ont un rôle décisionnel dans l'entreprise. Le Tableau 2 offre un aperçu des positions occupées par les représentants de chaque société interrogée.

Tableau 2: Liste détaillée des personnes/entreprises interrogées lors de l'étude exploratoire

	Nom de l'entreprise (en ordre alphabétique)	Poste occupé	Pays/Région
1.	ARCEP	Manager for Regulation on Interconnection and wholesale (fixed, broadband, mobile)	France
2.	Avery Dennison	RFID Market Development Manager	UK/USA
3.	Ericsson	Director of worldwide packet technologies research group	Global
4.	EU Commission	Director of Information Society and Media	Europe
5.	Forum SMSC	Managing Director	France
6.	Gemalto	Executive Vice-President (EVP) Operations	Global
7.	Google	Head of Global Development Initiatives	USA
8.	Intel	Manager for Intel World Ahead	USA
9.	Intelecon Consulting	Director of Consulting and Partner	Global
10.	ITIF	Foundation President	USA
11.	McKinsey Consulting	Manager	Europe
12.	Microsoft	Director for Humanitarian Systems	USA
13.	Nokia	Senior Manager for Emerging Markets	Finland
14.	NXP	Segment Marketing Manager RFID at NXP Semiconductors	Germany
15.	Orange	Marketing Manager	Europe
16.	Mercatel Association	Director	France
17.	Siemens	Innovation Manager	Germany

	Nom de l'entreprise (en ordre alphabétique)	**Poste occupé**	**Pays/Région**
18.	STMicroelectronics	Secure mobile and NFC Marketing Manager	Switzerland
19.	Telecom Italia	Director, Future Center	Italy
20.	Telefonica	Manager	Latin America
21.	The World Bank	Manager of the Global ICT Unit	Global
22.	Vodafone	Manager	Latin America

Plus loin nous présentons les principaux résultats qui sont basés sur l'analyse des entretiens réalisés et les exemples/commentaires spécifiques apportés par nos interlocuteurs. À ce stade, nous n'avons pas à vérifier l'exactitude des déclarations faites, puisque notre objectif était d'identifier leurs perceptions de la réalité actuelle et comprendre ce qui fait sens pour cette communauté de décideurs.

3. LES CONCLUSIONS DE L'ETUDE EXPLORATOIRE

La section suivante est consacrée à la présentation des points communs identifiés entre les différents entretiens. Le Tableau 3 ci-dessous présente un résumé des conclusions de la recherche exploratoire.

Tableau 3: Résumé des résultats de l'étude exploratoire

	Description	Impact estimé sur la diffusion	Comparé aux enseignements de la revue de littérature
Attractivité du produit et le marketing mix	Cela inclut les caractéristiques du produit et la valeur-ajoutée qui justifient le coût et l'effort d'adopter;	***Positif*** lorsque la perception de l'attractivité des produits est élevée;	convergent
Capacité économique pour acceder au produit	Détermine le niveau durable des prix à supporter pour acceder au produit;	***Positif*** lorsque la capacité économique est élevée ;	convergent
Perception du risque et les couts de retractation	Concerne la probabilité que le nouveau produit / innovation échoue sur le marché, avec le coût associé à la retractation et le retour vers le produit initial;	***Negatif*** lorsque le risque et les couts sont perçus comme trop élevés ;	convergent
Propension culturelle pour l'incertitude et le risque	Définit la facilité à adopter les innovations et à prendre des risques (en contraste avec l'aversion au risque et à l'incertitude)	***Positif*** lorsque l'aversion au risque est basse;	convergent
Interventions du gouvernement/ actions marketing	Comprend les différents schémas de financement, les marchés publics et les interventions telles que la normalisation imposée, *ceteris paribus*	***Mixte*** puisque l'effet de chaque politique doit être évalué dans le contexte du système, souvent complexe et interlié;	convergent

Externalités réseau, penguin/herd effect	Comprend les mécanismes qui peuvent potentiellement déclencher le processus de diffusion telles les externalités directes et indirectes qui alimentent l'adoption et / ou l'effet troupeau qui résout le problème de «œuf et la poule »	***Positif*** en présence d'externalités de réseau etd effets de troupeau;	convergent
Accès au savoir	Concerne les avantages de l'interaction avec des consortiums, des groupes de travail et les réseaux d'experts;	***Positif*** si la valeur de ces interactions peut être spécifiquement identifiée et exploitée;	complementaire
Conditions héritées et existantes sur le marché (le monopole, par exemple)	Describes the market characteristics at the time when diffusion of innovations occur;	***Mixte*** Décrit les caractéristiques du marché au moment où la diffusion des innovations se produit;	complementaire

En conclusion, la recherche exploratoire a permis d'identifier les opinions des experts du secteur sur les facteurs majeurs qui affectent la diffusion des innovations. Les enseignements tirés de ces entretiens et decrit plus haut dans ce texte, améliorent considérablement notre compréhension du processus de diffusion.

Globalement, les résultats de l'étude exploratoire sont à peu près convergents avec les conclusions de la revue de la littérature, et même parfois complémentaires, ajoutant de nouvelles preuves confirmatoires ou des nouvelles dimensions à considérer.

Le Modèle de Systèmes Dynamiques

1. LE MODELE CONCEPTUEL

Plusieurs variables importantes ont été identifiées lors de la revue de littérature et et des entretiens avec les experts de l'industrie. Bien que leur impact sur la diffusion des innovations soit difficile à quantifier et encore plus difficile à prévoir, des indications précieuses pourraient toutefois être tirées de cet exercice. Cette section présente le modèle conceptuel et quantitatif développé, sur la base des résultats de la revue de littérature et des entrevues. Bien sûr, pas tous les facteurs cités par les experts ou identifiés dans la littérature ont pu être pris en compte et effectivement intégrés dans le modèle. Nous avons utilisé une approche des systèmes pour développer un modèle de systèmes dynamiques, visant dans le contexte spécifique de cette recherche la représentation à la fois simple et holistique des phénomènes de diffusion. Les variables qui sont finalement intégrées dans le modèle sont celles qui font plus de sens pour aider à la compréhension des dynamiques à l'œuvre dans le système auquel nous nous intéressons.

Conçue au M.I.T. dans les années 1960 et initialement appliquée aux sciences de l'ingénierie, cette approche permet de penser le système d'une manière holiste et d'évaluer les implications des stratégies et des politiques d'action dans des environnements complexes et hautement intégrés. Cette approche a de maintes fois démontré être un outil d'analyse efficace dans une grande variété de situations, tant académiques que managériales, et s'applique le mieux dans des situations où il est essentiel de comprendre le comportement d'un système complexe, mis en mouvement par des boucles de rétroaction (positives ou négatives). Dans cette recherche, notre analyse est basée sur une représentation en Systèmes Dynamiques du modèle de diffusion de Bass (1969), intégrant les deux grands types de mécanismes d'adoption: l'adoption par *innovation* et celle *imitative*. En effet, les deux sont necessaires à l'amorce du processus de diffusion, et il est important d'explorer comment l'adoption par *imitation* peut être alimentée par l'adoption par *innovation*. L'approche par les Systèmes Dynamiques permet de gagner une meilleure compréhension des manières d'accélérer le processus de diffusion des nouveaux produits et technologies, et d'étendre ainsi les opportunités d'adoption à tous les segments de marché.

Chaque mécanisme contribue de façon spécifique et déterminante au modèle de diffusion globale: l'occurrence, le calendrier et la vitesse de decollage des ventes d'un produit – tous sont entièrement liés à la dynamique l'adoption par *innovation*, ce qui déclenche plus tard, la propagation massive des comportements *d'imitation*. Alors que la majorité des adoptants vont éventuellement fonder leur décision sur l'exemple de leurs pairs, la phase d'adoption par innovation joue un moment déterminant dans le cycle de diffusion du produit.

En suivant les conclusions de Tellis et al. (2003) sur l'influence des facteurs socio-économiques et culturels sur le décollage des ventes du produit, nous nous sommes concentrés dans cette recherche sur l'analyse des dynamiques de diffusion dans la phase initiale. En utilisant la modélisation en Systèmes Dynamiques, nous allons décompresser le mécanisme d'adoption par l'innovation, en explorant le rôle de différentes dimensions (tels que l'inégalité des revenus, l'accessibilité des produits, l'aversion au risque, etc) dans son développement. Suite à la revue de littérature et des entretiens, nous avons identifié et choisi de développer quelques aspects clés de la dynamique de diffusion des innovations. Ces nouvelles boucles de rétroaction (composantes) viennent en tant qu'extensions du modèle de diffusion de base, qui est celui de Bass (1969), comme suit:

Composante 1: **Le modèle de diffusion de base**
Composante 2: **L'accessibilité des produits**
Composante 3: **L'abordabilité des produits**
Composante 4: **L'effet de la confiance**

Composante 5: **Le levier économique**

Complément à la Composante 1: **La dynamique d'imitation**

2. L'APERÇU DU MODELE

Le modèle de Systèmes Dynamiques complet, intégrant les six composantes mentionnées plus haut, est présenté sur la Figure 3. Le modèle contient 36 variables. La classification de chaque variable est décrite sur la Figure 4.

Figure 3: Aperçu global du modèle de diffusion

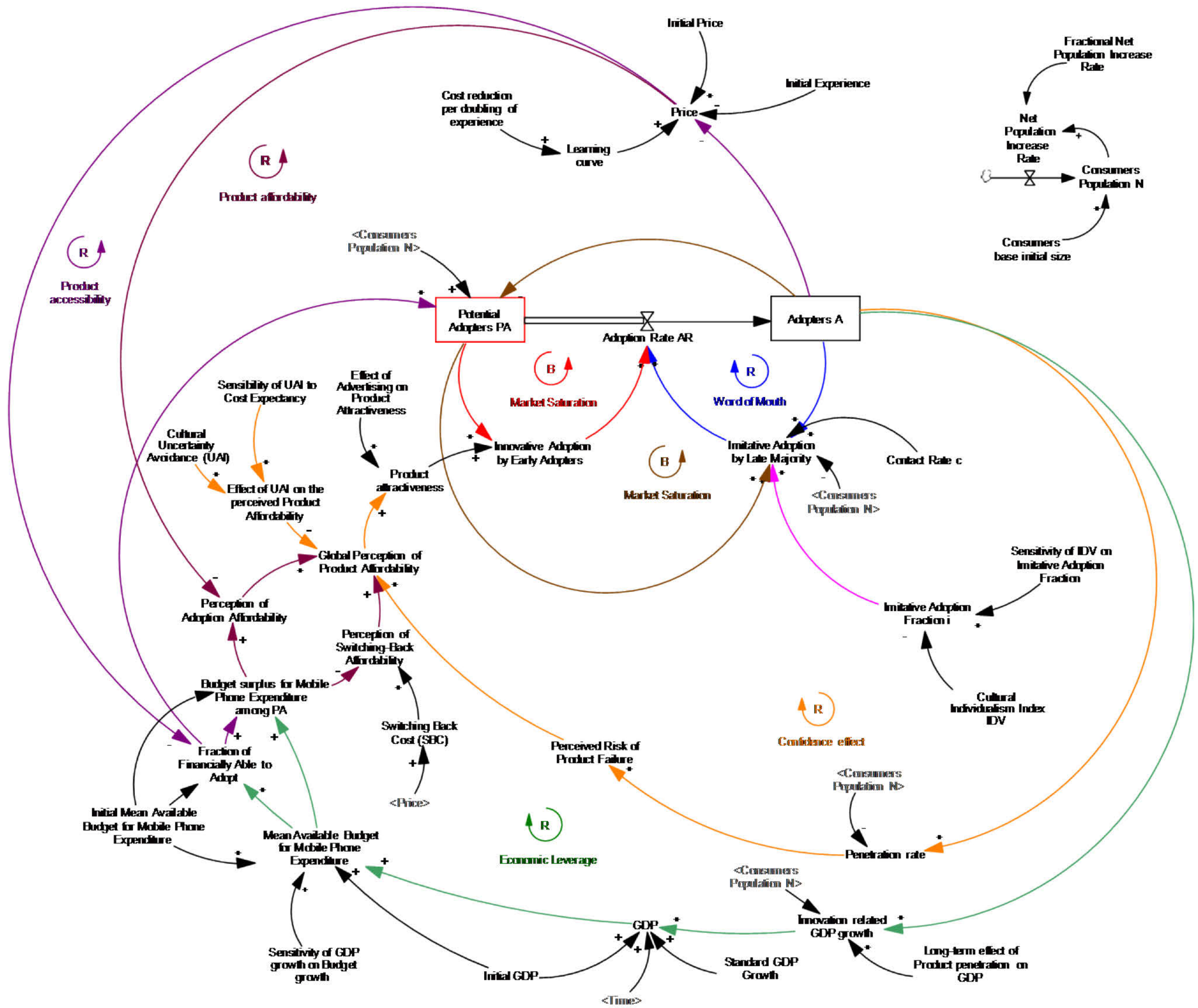
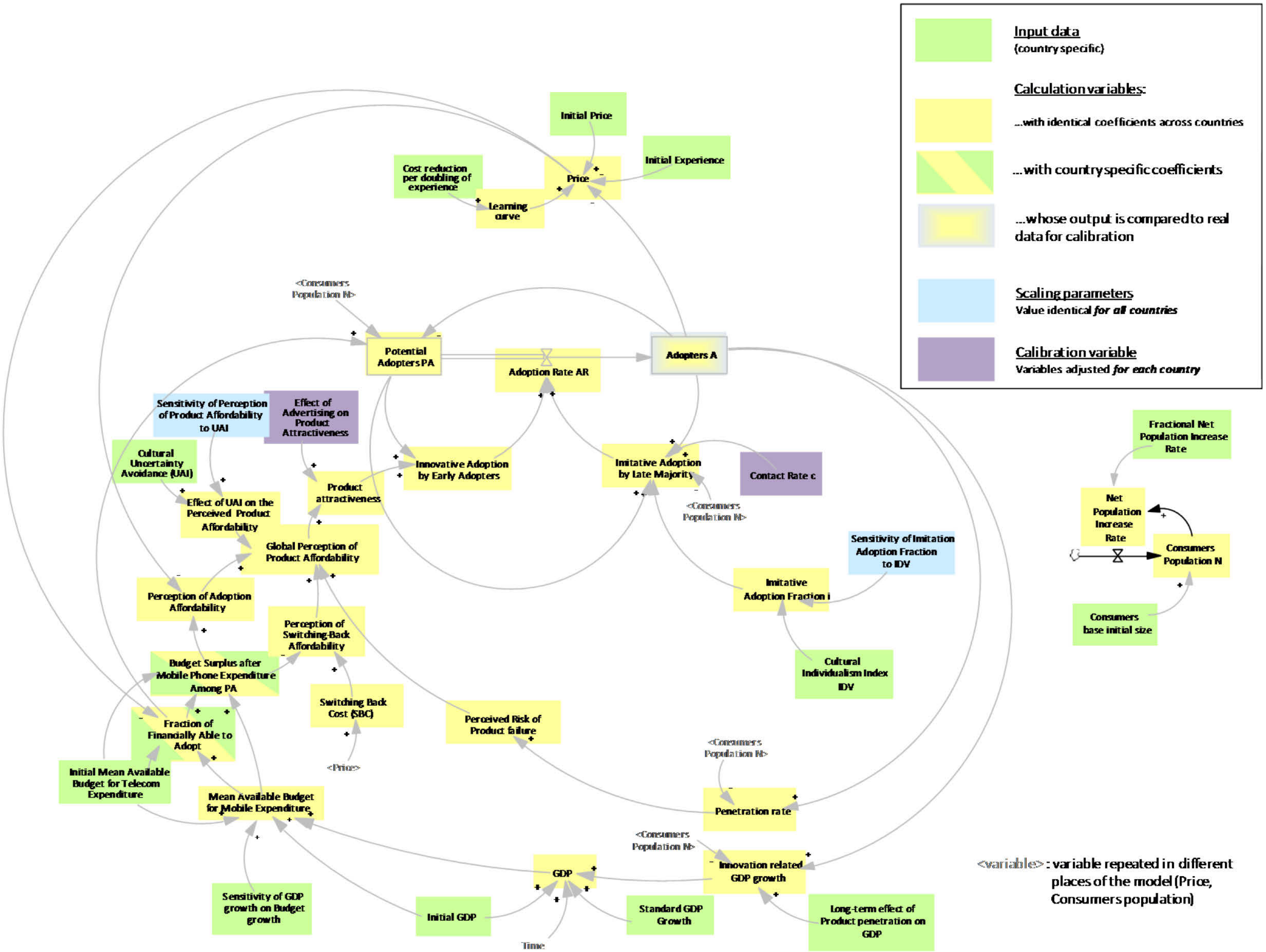


Figure 4 : Aperçu du modèle avec la classification par type de variables



3. LE CALAGE DU MODELE DES SYSTEMES DYNAMQUES

3.1. La sélection des données de ventes

L'exercice de calage a été effectué sur la base d'historiques de diffusion des téléphones mobiles 3G dans 17 pays:

Tableau 4: Liste des pays sur lesquels nous avons travaillé

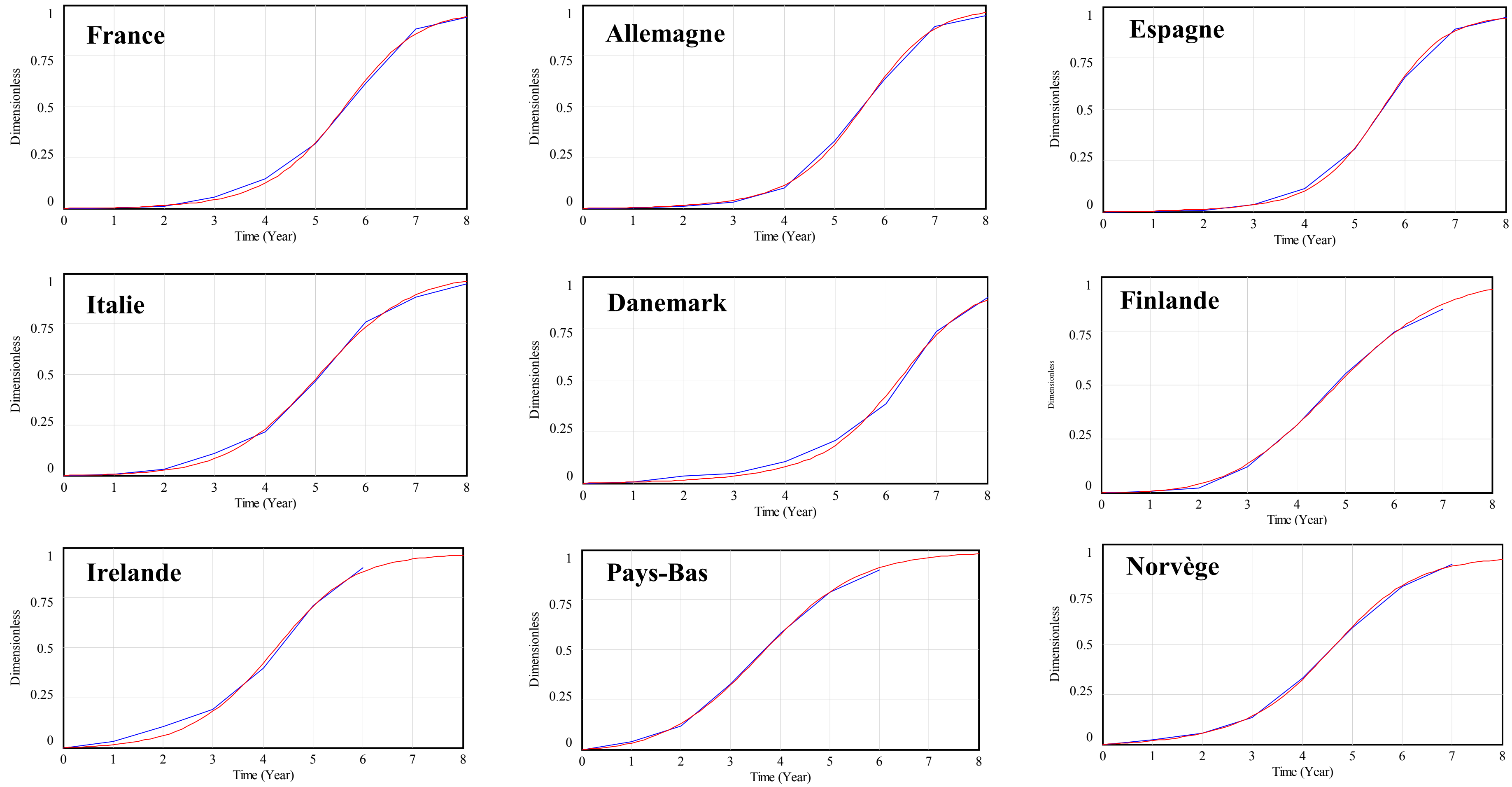
Groupe	Pays	
Pays OECD	France	Germany
	Spain	Italy
	Denmark	Finland
	Ireland	Netherlands
	Norway	UK
	Belgium	
Europe de l'Est	Poland	Estonia
	Russia	
Proche-Orient	Turkey	
Amerique Latine	Argentina	Brazil

Des observations trimestrielles (Dataxis - données historiques et de prévisions - Mobile Broadband Digital) étaient disponibles de 2003 à 2006, et après 2006 les données annuelles (Yankee Group - données historiques et prévisions) ont été utilisés pour caler le modèle.

3.2. Les résultats du calage

Le calage du modèle a été réalisée pour les 17 pays en utilisant le module de calage disponible sur le logiciel Vensim DSS ®. Le modèle comportant deux degrés de liberté (taux de contact et l'effet de la publicité), la qualité du calage est très satisfaisante pour l'ensemble des 17 pays, comme illustré sur les Figure 5, Figure 6 et Figure 7 plus loin.

Figure 5: Taux de pénétration des mobiles 3G dans les pays de l'OCDE - Simulations et observé



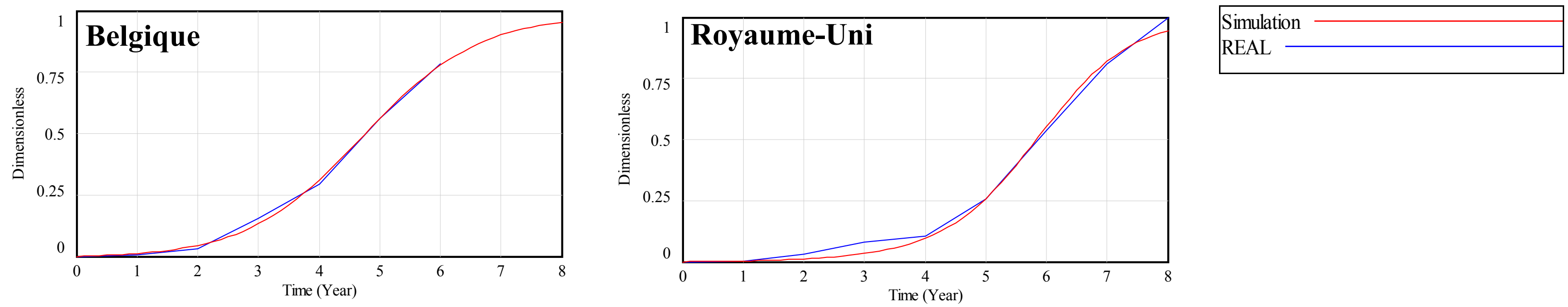


Figure 6: Taux de pénétration des mobiles 3G dans les pays de l'Europe de l’Est et le Moyen-Orient- Simulations et observé

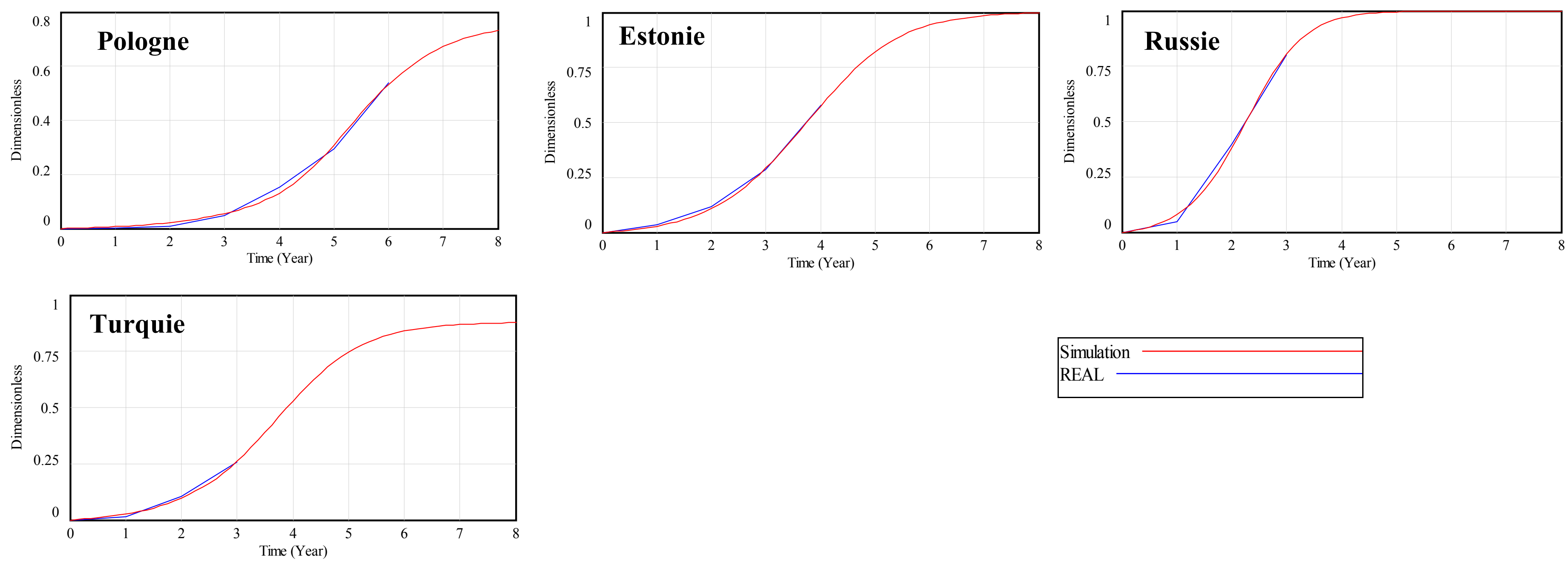
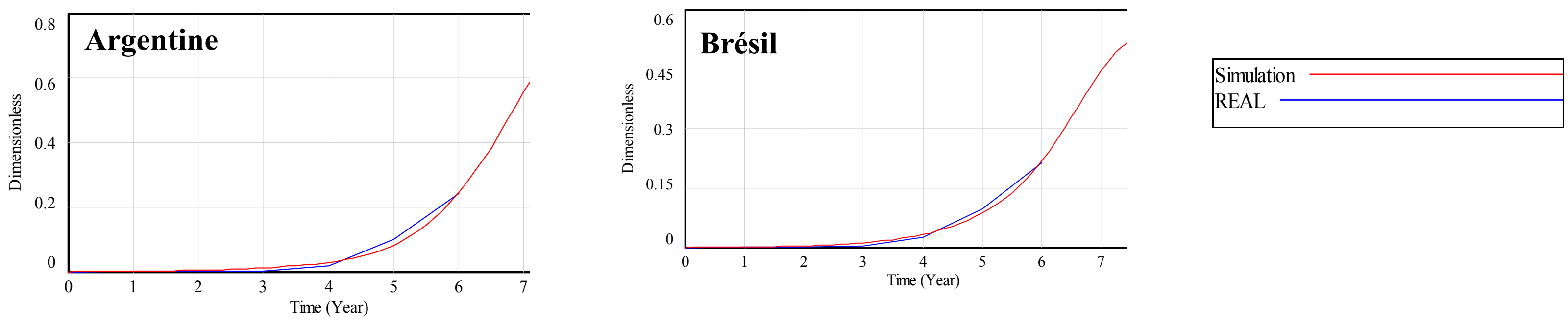


Figure 7: Taux de pénétration des mobiles 3G dans les pays de l'Amérique Latine- Simulations et observé



La qualité de l'ajustement a été évaluée en utilisant différentes métriques, qui confirment toutes un très bon ajustement atteint grâce au calage effectuée.

Tableau 5: Indicateurs de la qualité de l'ajustement – modèle dévéloppé et calé

					Indices d'inégalité de Theil		
	Nombre d'observations	R2	MAE / Mean	RMSE	Bias Fraction	Unequal Variance Fraction	Unequal Covariance Fraction
France	8	0.9986	3.3%	1.39%	0.01	0.00	0.99
Allemagne	8	0.9992	2.9%	1.15%	0.09	0.02	0.89
Espagne	8	0.9998	1.4%	0.60%	0.04	0.18	0.78
Italie	8	0.9983	3.2%	1.57%	0.00	0.07	0.93
Danemark	8	0.9961	6.3%	2.20%	0.16	0.00	0.84
Finlande	7	0.9985	2.9%	1.34%	0.13	0.01	0.86
Irelande	6	0.9961	5.0%	2.36%	0.23	0.05	0.72
Pays-Bas	6	0.9994	1.5%	0.84%	0.02	0.03	0.95
Norvège	7	0.9996	1.4%	0.64%	0.03	0.03	0.94
Royaume-Uni	8	0.9955	5.5%	2.74%	0.23	0.01	0.76
Belgique	6	0.9978	3.4%	1.33%	0.00	0.03	0.97
Pologne	6	0.9958	6.7%	1.31%	0.03	0.09	0.88
Estonie	4	0.9992	2.5%	0.69%	0.16	0.15	0.69
Russie	3	0.9969	4.4%	2.06%	0.17	0.23	0.61
Turquie	3	0.9958	4.9%	0.75%	0.09	0.25	0.66
Argentine	6	0.9886	12.5%	0.96%	0.02	0.03	0.95
Brésil	6	0.9939	9.8%	0.66%	0.08	0.08	0.84

Résultats et Discussion

L'objectif de cet exercice de modélisation a été de développer un modèle de diffusion intégrant plusieurs concepts socio-économiques et culturels suggérés par la revue de littérature et les interviews d'experts.

Avant de présenter les résultats des simulations, nous avons évalué l'application spécifique du modèle Système Dynamique développé dans cette recherche pour répondre aux objectifs de la recherche. Afin d'estimer la valeur ajoutée et les limites d'une telle extension du modèle de référence de Bass, nous avons comparé la qualité de l'ajustement des simulations dans les deux modèles. Cependant, le but principal de cet exercice étant de concevoir des politiques pertinentes et de tester le système en vue d'une amélioration du processus de diffusion, les résultats clés présentés ci-dessous s'intéressent surtout à la capacité du modèle à intégrer les politiques et de répondre correctement aux actions marketing.

1. Comparaison des qualites d'ajustement des modeles de diffusion

Comme avec le modèle étendu, la qualité de l'ajustement du modèle de Bass calé est excellente dans tous les cas. Etant donné que la calibration des deux modèles a été exécutée à l'aide des deux degrés de liberté, mentionnés ci-dessus, une comparaison directe de l'ajustement des indicateurs aux données statistiques peut être réalisée. Le tableau ci-dessous présente ces résultats.

Tableau 6: Indicateurs de la qualité de l'ajustement – modèle de référence (Bass, 1969) et le modèle dévéloppé et calé (modèle dév.)

	Nombre d'observations	R2 Modèle réf.	R2 Modèle dév.	MAE / Mean Modèle réf.	MAE / Mean Modèle dév.	RMSE Modèle réf.	RMSE Modèle dév.	Calage[1]: modèle Dév. vs Réf.
France	8	0.9985	0.9986	3.7%	3.3%	1.73%	1.39%	+
Allemagne	8	0.9985	0.9992	3.4%	2.9%	1.71%	1.15%	+
Espagne	8	0.9997	0.9998	1.6%	1.4%	0.92%	0.60%	+
Italie	8	0.9981	0.9983	3.1%	3.2%	1.63%	1.57%	0
Danemark	8	0.9953	0.9961	7.4%	6.3%	2.57%	2.20%	+
Finlande	7	0.9950	0.9985	5.7%	2.9%	2.44%	1.34%	++
Irelande	6	0.9965	0.9961	4.7%	5.0%	2.16%	2.36%	-
Pays-Bas	6	0.9987	0.9994	2.2%	1.5%	1.23%	0.84%	+
Norvège	7	0.9993	0.9996	2.1%	1.4%	0.97%	0.64%	++
Royaume-Uni	8	0.9911	0.9955	8.7%	5.5%	3.90%	2.74%	++
Belgique	6	0.9982	0.9978	3.9%	3.4%	1.36%	1.33%	0
Pologne	6	0.9975	0.9958	13.2%	6.7%	3.05%	1.31%	++
Estonie	4	0.9994	0.9992	2.1%	2.5%	0.61%	0.69%	-
Russie	3	0.9957	0.9969	5.1%	4.4%	2.26%	2.06%	+
Turquie	3	0.9853	0.9958	8.4%	4.9%	1.34%	0.75%	++
Argentine	6	0.9938	0.9852	9.3%	8.6%	0.71%	0.76%	0
Brésil	6	0.9936	0.9939	9.2%	9.8%	0.64%	0.66%	0

Ainsi, dans les 17 pays, le modèle étendu semble offrir des meilleurs résultats de calage que le modèle de référence à l'ensemble des données de vente des mobiles 3G. La qualité de l'ajustement pourrait être qualifiée de nettement meilleure dans 5 cas, un peu mieux dans 6 cas, sans un changement considérable dans 4 cas, et quelque peu détériorée dans 2 cas.

Les graphiques suivants sur la gauche représentent les courbes de pénétration ajustées pour le modèle étendu et celui de Bass, ainsi que la courbe historique. Les chiffres sur la droite permettent de mieux visualiser la valeur des résidus pour chaque courbe, tout au long de la période de diffusion.

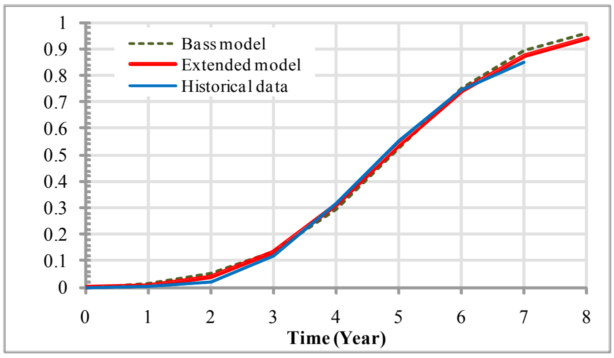
Les quatre premiers ensembles de graphiques se concentrent sur les pays où une

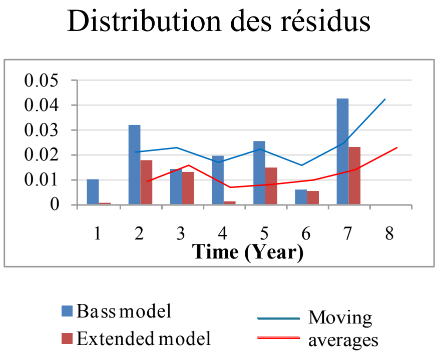
[1] Qualifications générales utilisées pour la comparaison de la qualité de l'ajustement: "++": amélioration significative; «+»: une certaine amélioration; "0": pas d'amélioration claire; "-": une certaine détérioration.

amélioration significative d'ajustement a été observé sur la base des indicateurs RMSE et MAE /MEAN:

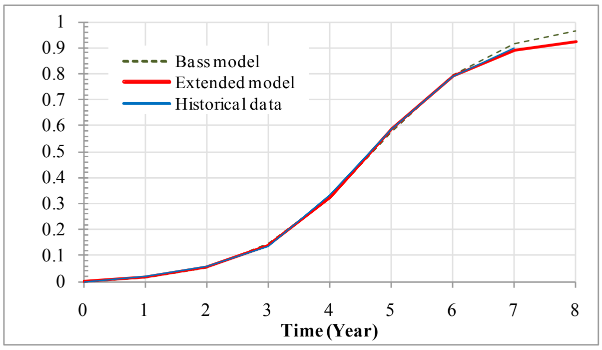
Figure 8: Les courbes Historiques vs. Ajustées et le Résidus: modèle de référence (Bass, 1969) et le modèle dévéloppé et calé (ext. model)

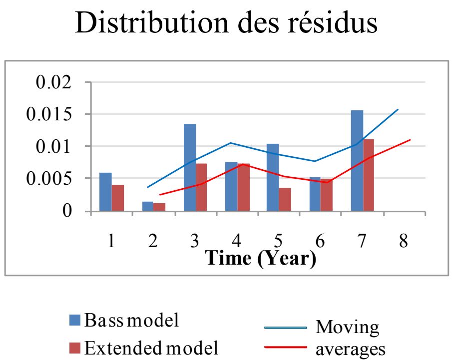
Finlande



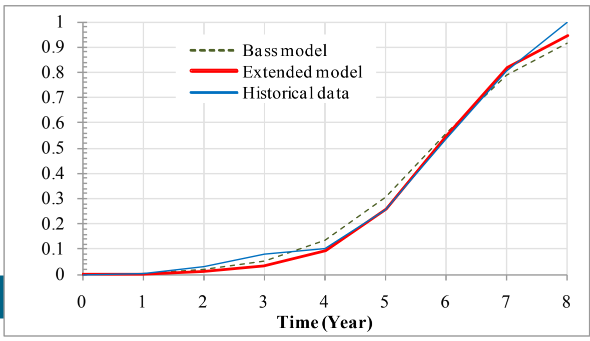


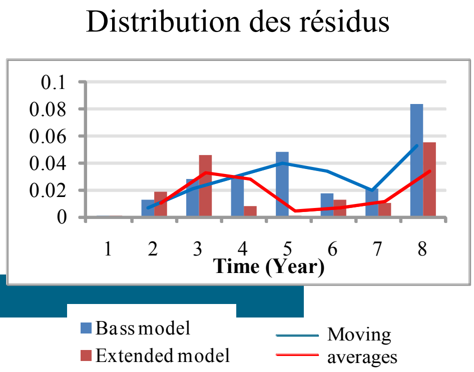
Norvège





Royaume-Uni





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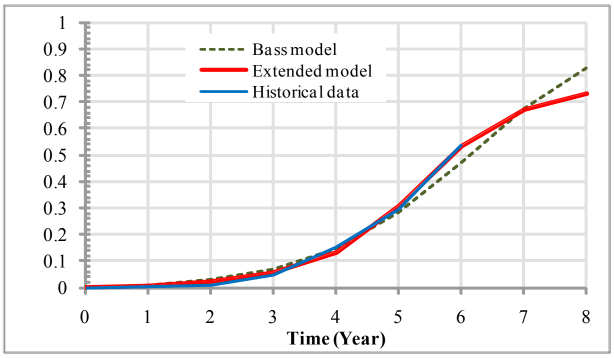
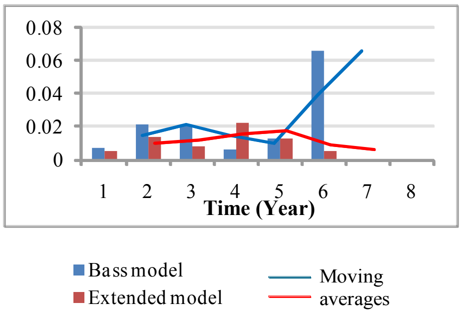
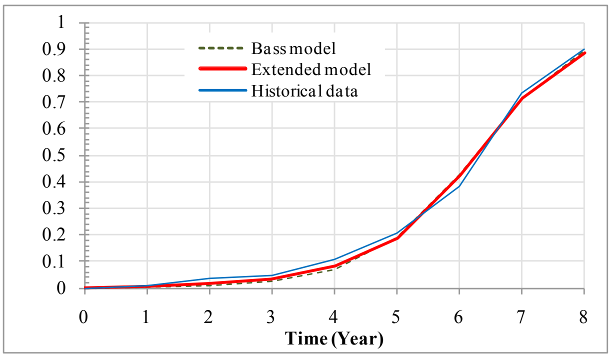


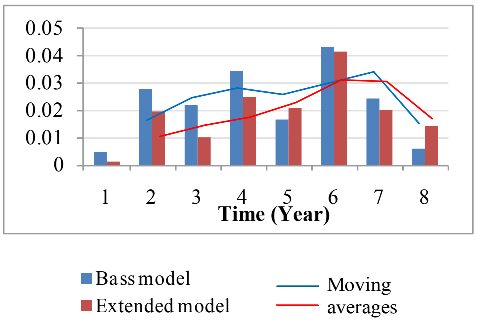
Distribution des résidus



Danemark



Distribution des résidus



Le calage amélioré refléterait donc la valeur ajoutée des extensions du modèle, notamment de l'ajout des dimensions socio-économiqes (composantes 2 et 4), qui reflètent deux dimensions majeures de la diffusion des produits télécoms: l'hétérogénéité socio-économique des marchés et les effets de confiance.

2. ANALYSE DU COMPORTEMENT DU MODELE DEVELOPE

Le modèle de diffusion de référence, basé sur le modèle de diffusion de Bass (1969), a été étendu avec l'ajout de quatre nouvelles boucles de rétroaction (nouvelles composantes du modèle) qui ont été construites en utilisant les enseignements de la revue de littérature et des entretiens.

Ces extensions sont détaillées dans le Tableau 7:

Tableau 7: Résumé des boucles de rétroaction / nouvelles composantes ajoutées au modèle de diffusion de Bass (1969)

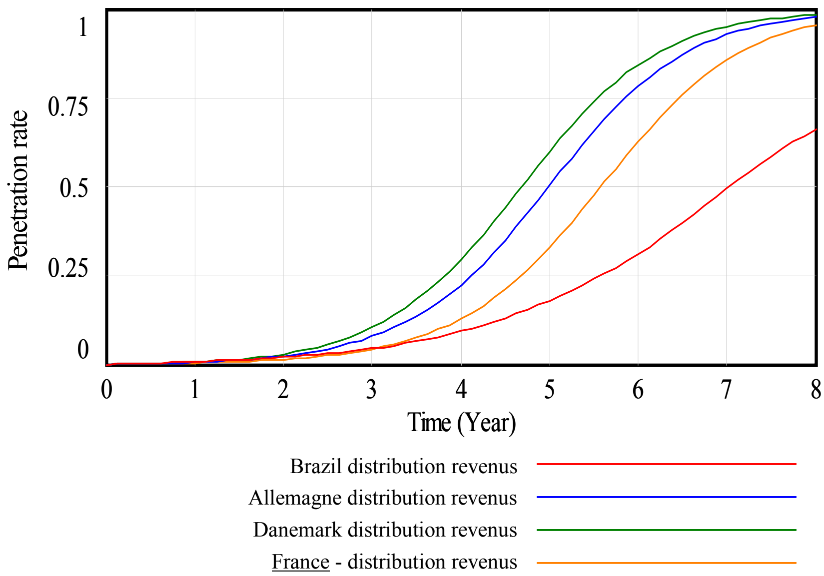
Nom de la composante du modèle	Concept/dynamique capturés	Variables clés représentées dans le modèle
Accessibilité du produit	- Marketing mix	- Prix
	- Hétérogénéité des marchés	- Fraction de la population ayant la capacité financière d'adopter
Abordabilité du produit	- Hétérogénéité des marchés	- Budget telecom disponible après adoption du produit
	- Coût total d'adoption	- Indice d'Aversion au Risque - Coût de retour au produit initial - Perception globale de l'abordabilité du produit
Effet de confiance	- Effet « pingouin »	- Risque percu d'échec du produit
Levier économique	- Effets de la technologie mobile sur le PIB	- Effet à long-terme de la penetration du produit sur la croissance du PIB

La sensibilité du modèle à ces variables clés est d'un intérêt particulier pour les décideurs marketing, qui peuvent apprécier l'importance relative des aspects tels que *l'inégalité des revenus* et *l'évitement de l'incertitude/aversion au risque* lors du lancement d'un produit nouveau et de sa diffusion à l'internationale.

Pour illustrer une telle sensibilité, nous avons considéré la France comme le contexte de diffusion de référence, et analysé la sensibilité des deux facteurs sur la dynamique de la diffusion:

- **L'inégalité des revenus**

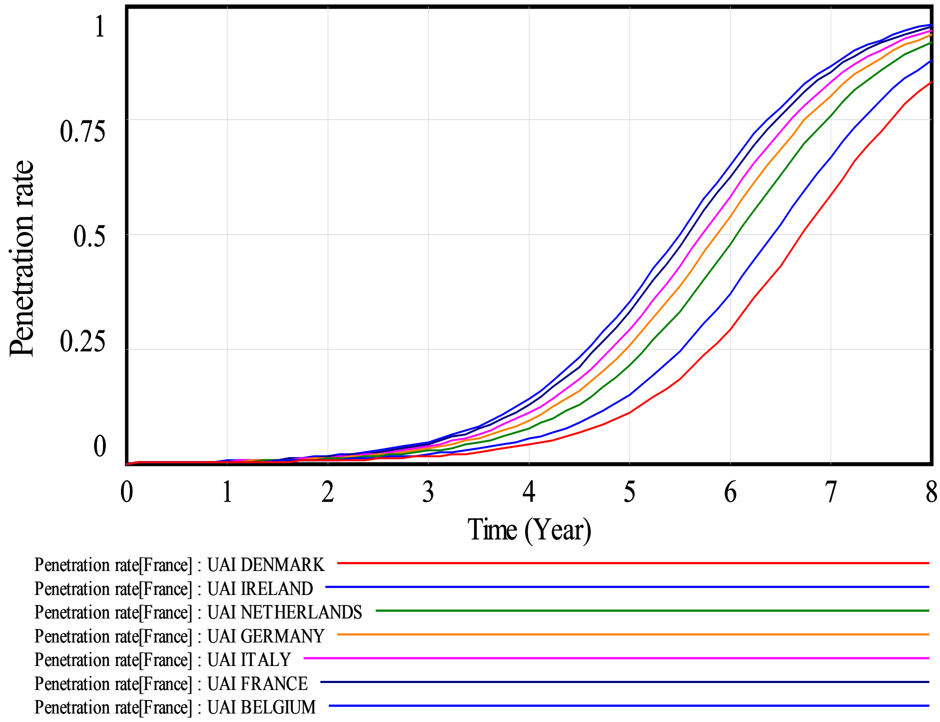
Figure 9: Taux de pénétration des téléphones mobiles 3G en France + 3 variations de la courbe de distribution des revenus



L'homogénéité des revenus est favorable à l'accéleration de la dynamique de diffusion: tous les autres aspects étant égaux par ailleurs, y compris le niveau économique national, le schéma de distribution des revenus observée parmi les pays de l'OCDE induit une différence de presque 1 an dans le délai de diffusion. Etendu aux pays à revenu faible avec des inégalités dans les revenus plus élevées, la différence dans le timing de pénétration du marché atteint 4 ans.

- **L'index UAI d'évitement de l'incertitude/aversion au risque**

Figure 10: Taux de pénétration des téléphones mobiles 3G en France + 6 variations des niveaux de l'UAI



En conclusion, la caractéristique culturelle d'évitement de l'incertitude est un facteur important à prendre en considération lors de l'analyse des dynamiques de diffusion des innovations: tous les autres paramètres étant égaux par ailleurs, des niveaux d'aversion au risque différents peuvent induire une accélération ou un ralentissement de la vitesse de diffusion de plus de 1 an.

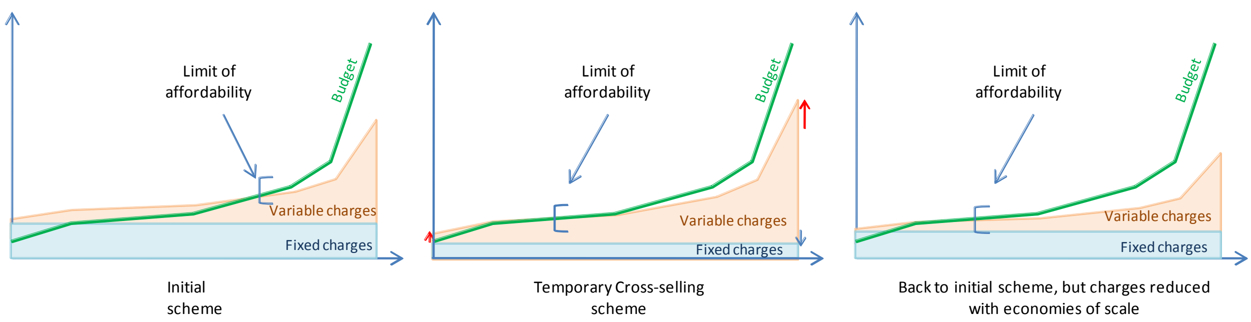
4. Les politiques d'action et implications de la recherche

Les décideurs politiques dans le secteur des télécommunications sont confrontés à des objectifs contradictoires: assurer l'accès universel aux services de télécommunications, tout en favorisant la croissance dans les segments les plus compétitifs de leur économie. Les entreprises de télécommunications, elles, sont appelées à développer des stratégies marketing plus inclusives et à engager des investissements importants sur les marchés internationaux.

Un prix abordable est la condition essentielle pour atteindre le premier ojectif, tandis que le second motive les opérateurs à offrir et à développer des services commercialement attrayants – à l'attention des clients à plus hauts revenus. La définition des structures de prix qui puissent soutenir adéquatement et veiller à l'équilibre de ces priorités est donc un défi majeur, conduisant à la conception et à l'application d'une variété de stratégies par les régulateurs et les opérateurs.

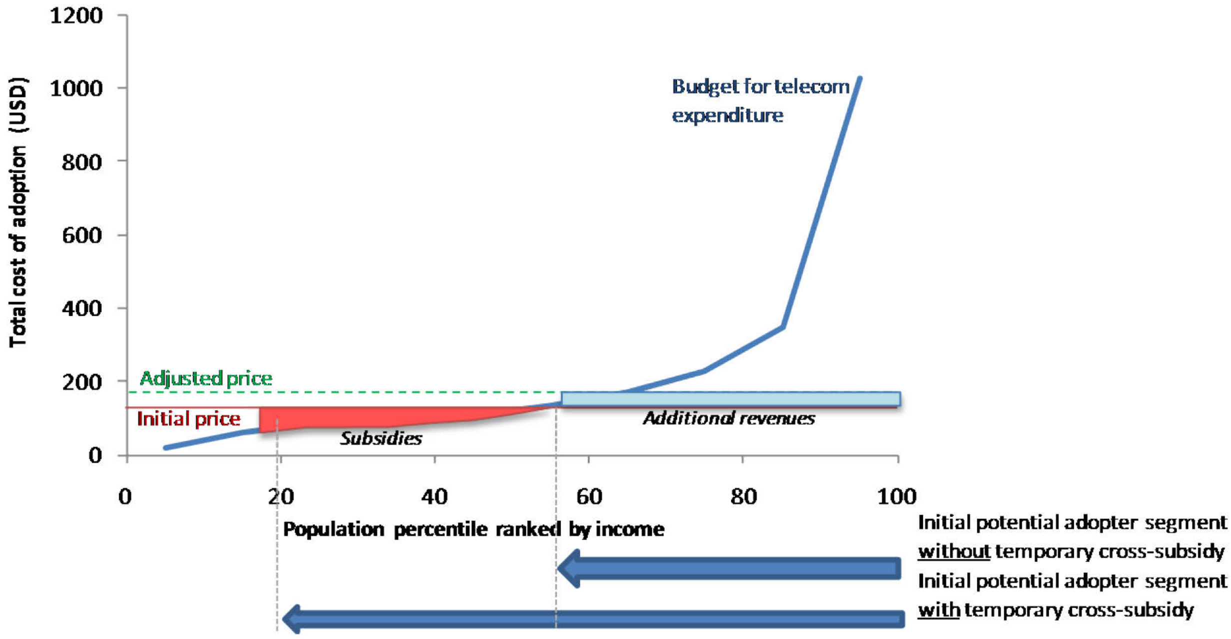
L'applicabilité d'une telle stratégie pourrait, par exemple, reposer sur l'ajustement de la structure tarifaire, en réduisant momentanément les coûts de connexion et en les subventionnant avec la hausse des charges variables. La corrélation positive entre les revenus des ménages et la consommation de services de télécommunications assurerait mécaniquement une subvention croisée entre les groupes de revenus, comme l'illustre sur la Figure 11.

Figure 11: Illustration de l'impact des stratégies de vente croisée (sur le graphique le profil du budget, l'axe X = population classée par niveau de budget telecom)



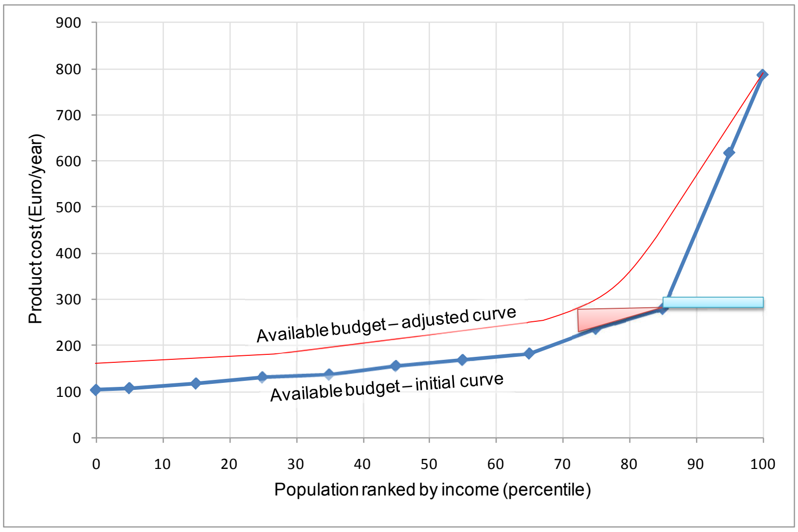
Nous utilisons notre modèle de Systèmes Dynamiques pour tester différents scénarios de subventions croisées. L'approche adoptée est schématiquement illustrée sur la Figure 12: les lignes horizontales vertes et rouges représentent respectivement le prix initial, économiquement optimal pour l'entreprise, et le prix ajusté, par une augmentation de 10%.

Figure 12: Le méchanisme de subventions croisées très tôt dans le procesus de diffusion (exemple du Brésil)



Nous nous sommes concentrés sur l'étude de cas du Brésil, qui est un des pays les plus inégalitaires au niveau de la distribution des revenus. Tant que cet ajustement du coût de 10% est maintenu pour les groupes à revenu élevé, la base des adopteurs potentiels s'élargit, comme le montre la Figure 13.

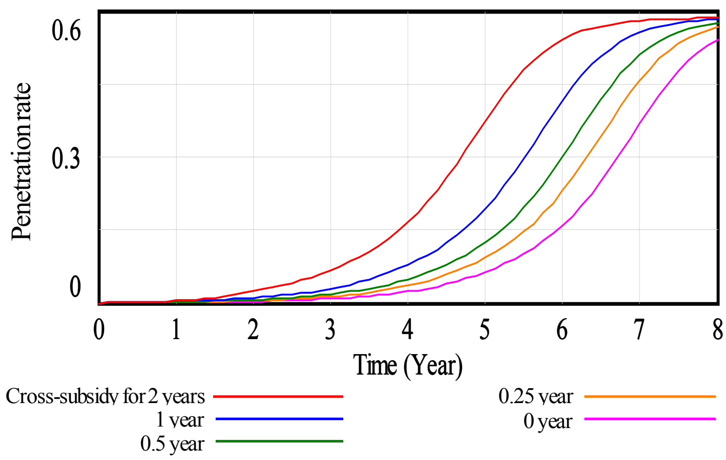
Figure 13: Courbes de budget disponible à travers la population, compte tenu du mécanisme de subventions croisées avec l'augmentation de prix de 10%



Note: la signification des couleurs rouges et bleues est le meme que sur la Figure 12.

Comme illustré ci-dessous, les subventions croisées à un stade précoce de la diffusion peuvent considérablement accélérer le décollage du produit. Un tel mécanisme, mis en œuvre pendant un an, juste après la commercialisation du produit, permettrait de réduire le temps de décollage de 3,9 ans à 2,6 ans. Ceci est illustré dans la Figure 14, avec des simulations pour le Brésil.

Figure 14: La vitesse de diffusion pour les programmes de subvention croisée à durée variable (Brésil)



Principales Conclusions de la Recherche

En conclusion, cette recherche a permis d'explorer les processus complexes de diffusion des innovations, et d'en acquérir une meilleure compréhension, qui sera utile pour aider les décideurs politiques et practiciens marketing a mettre en place des stratégies de développement sectorielles plus inclusives.

A partir d'une revue de littérature pluridisciplinaire et d'entretiens réalisés avec des experts du secteur de l'innovation et du développement, cette recherche a permis de concervoir un cadre holistique d'analyse des processus de diffusion ICT, permettant d'intégrer les mécanismes d'adoption par innovation et par imitation.

Au cours de cette recherché, nous avons tout d'abord identifié les facteurs principaux affectant les dynamiques de diffusion, ainsi que les interdépendances entre ces facteurs. Les résultats de la revue de littérature ont été confirmés par les éléments recueillis au cours des entretiens avec les experts sectoriels. D'une manière générale, les résultats de la recherche exploratoire corroborrent ceux des la revue de littérature, et leur sont parfois complémentaires, mettant en lumière de nouvelles dimensions à explorer. Par exemple, les aspects liés à l'accès aux savoirs, tels que l'auto-organisation des réseaux d'experts et l'émergence de consortia ont été évoqués lors des entretiens. Le contexte du marché, tel que l'existence d'un monopole ou un héritage d'infrastructures, ont également pu être ajoutés à la liste des facteurs considérés influencer la diffusion. Nous avons utilisé une approche de pensée système pour developer un modèle Système Dynamique de diffusion, avec l'objectif de représenter de manière complète et holistique les phénomènes de diffusion dans le contexte spécifique de cette recherche. Bien entendu, tous les facteurs cités par les experts sectoriels ou identifiés dans la littérature n'ont pas pu être pris en compte et intégrés au modèle. Cependant, nous considérons qu'une large gamme de facteurs ont été pris en compte et injectés dans un modèle Systèmes Dynamiques hautement intégré et calé. Ce modèle Systèmes Dynamiques comprend 36 variables, organisées en 6 composantes principales. En comparaison avec les modèles de Bass de référence, notre extension du modèle de diffusion incorpore deux nouvelles dimensions – culturelle et socio-économique –, résultant dans la construction de 4 nouvelles boucles de rétroaction : l'accessibilité du produit, l'abordabilité du produit, les effets de confiance culturels et les leviers économiques. Comme présenté en détails dans ce rapport, nous considérons que ces nouvelles dimensions et ces boucles de rétroaction représentent un apport indispensable à l'analyse de la diffusion des innovations. Cela est confirmé par l'excellente qualité du calage du modèle étendu avec les données historiques, fournissant des résultants particulièrement intéressants lorsqu'ils sont comparés au modèle de Bass de référence.

Plus important encore, nous avons pu explorer davantage comment le système se comporte dans son intégralité sous l'influence de cet ensemble de facteurs. En utilisant les données disponibles pour la diffusion de téléphones mobiles dans 17 pays, émergents et dévéloppés, nous avons illustré le role significatif que jouent les dimensions socio-économiques et culturelles dans le processus de diffusion.

Sur la base de ces résultats, nous affirmons qu'au-delà de la relation évidente entre le prix et les niveaux nationaux économiques, les modes de répartition des revenus entre les pays, ainsi que la caractéristique culturel d'évitement de l'incertitude, doivent être pris en considération lors de l'analyse de la stratégie de lancement d'une nouvelle technologie / produit. En outre, et afin d'aider les décideurs et les entreprises de télécommunications dans la conception des stratégies optimales de développement du secteur, qui favoriseraient l'inclusion d'une plus large catégorie d'adopteurs, nous avons utilisé notre modèle non-linéaire pour tester des politiques pertinentes de nature à favoriser la diffusion des technologies mobiles.

Les principales conclusions de ce travail de recherche sont les suivantes:

1. A l'échelle nationale, l'hétérogénéité socio-économique et d'autres facteurs endogènes, tels l'aversion au risque, exercent une influence significative sur la dynamique de la diffusion des innovations. Par exemple, dans les pays émergents, de fortes inégalités socio-économiques constituent un frein à l'adoption à grande échelle des nouvelles technologies;

2. Des subventions bien ciblées au cours des phases initiales de commercialisation des technologies mobiles peuvent jouer un rôle déterminant dans leur diffusion massive,

en aidant à mobiliser la confiance chez les consommateurs, en stimulant la mise en place des économies d'échelle, et, à plus long terme, en contribuant à l'amélioration de la situation macro-économique. L'identification du moment et de la durée optimales de mise en œuvre de telles politiques de subventions nécessite une analyse détaillée de la capacité financière de la population à acquérir ces produits, tel que expliqué dans la section consacrée à la présentation du modèle.

Les contributions académiques et managériales pourraient potentiellement avoir un impact. D'un point de vue academique, ce travail répond à un intérêt de recherche qui prévaut dans le marketing des innovations et l'économie de développement, en proposant une approche à la fois rigoureuse et novatrice pour la modélisation de la diffusion des innovations. Les apports de cette recherche incluent la construction d'un modèle conceptuel intégrant les principaux facteurs qui affectent la diffusion des innovations, l'identification des relations existant entre ces facteurs, et l'analyse de l'évolution dans le temps de l'ensemble du système. Ceci représente un pas en avant vers une meilleure compréhension des problématiques complexes de recherche dans le domaine des innovations technologiques et des théories de la diffusion.

Les résultats de ce travail présentent un intérêt tangible pour les praticiens et les décideurs marketing, en leur permettant de prendre des décisions plus rationnelles et plus précises, et de concevoir des politiques plus efficaces en vue de promouvoir l'accès aux technologies mobiles et aux innovations.

La contribution managériale de ce travail de thèse se compose d'un cadre d'analyse et d'un outil holistique pour la conception des stratégies qui visent à étendre l'accès aux TIC et aux technologies mobiles pour une catégorie d'adopteurs plus large. Nous espérons qu'avec les résultats de ce travail de recherche les professionnels du marketing et les décideurs politiques sont maintenant munis des outils nécessaires pour aider à assouvir la soif d'innovation de ces consommateurs.

Limites de la Recherche et Futurs Axes de Recherche

Au-delà de ses resultants et contribution à ce champ de recherché, cette étude comprend bien sûr un certain nombre de limites soulignées ci-après.

5. LES LIMITES DE LA RECHERCHE EN COURS

Ce travail comporte des limites évidentes. Les premières sont liées à l'étude exploratoire : peu d'entretiens se sont intéressés aux pays en développement dans le cadre de cette recherche. Dans la mesure où l'objectif de cette étude est d'aider les pays en développer à accéder aux ICT et aux technologies mobiles, il aurait été souhaitable d'inclure dans la liste des personnes consultées des individus provenant de ces pays. Ceci dit, plusieurs managers exécutifs ont partagé leur vision globale des marchés. Ensuite, tous les facteurs mentionnés par les experts du secteur ou identifiés par dans la littérature n'ont pas pu être pris en compte et intégrés au modèle des Systèmes Dynamiques.

Par ailleurs, plusieurs sources dans la littérature ont suggéré le développement de la composante *leviers économiques*. L'effet de retroaction de cette boucle comporte un délai de plusieurs années entre la pénétration du produit et son impact sur l'économie du pays.

Outre ces limites liées à la disponibilité des données, qui ont constitué une véritable contrainte dans le cas de cette recherche, l'utilisation de séries de données plus longues de pays en voie de développement (expl. Diffusion de la 2G en Afrique) auraient été pertinente.

6. LES FUTURS AXES DE RECHERCHE

Le modèle s'est basé sur un nombre important d'hypothèses et de simplifications nécessaires pour procéder à une paramétrisation adéquate et à la représentation d'un certain nombre de concepts qualitatifs. Cette section propose d'identifier les thèmes clés qui mériteraient en priorité une analyse approfondie, afin d'améliorer la robustesse et la pertinence du modèle. Ces thèmes ont été divisés en deux catégories : ceux qui relèvent des dynamiques de la demande (marchés clients) et ceux qui relèvent aux dynamiques de l'offre (dynamiques micro-économiques, industrielles, technologiques, etc.)

La présente recherche s'est intéressée avant tout à la diffusion des produits du point de vue de la demande. Aux niveaux macro-économique, industriel et réglementaire, de nombreux concepts mériteraient d'être également modélisés, afin d'offrir une meilleure compréhension des dynamiques de diffusion. L'extension du modèle Système Dynamique serait particulièrement utile pour développer les problématiques suivantes, dont l'importance a été de fait évoquée lors des entretiens avec les experts du secteur :

- Quelles sont les dynamiques d'implication de nouveaux opérateurs sur un nouveau marché, et comment celles-ci sont-elle, en particulier, liées :
  - à la compétitivité économique et aux dynamiquees de réduction des prix ? Un autre champ de recherche qui pourrait compléter et améliorer la robustesse du modèle pourrait s'intéresser aux dynamiques de réduction des prix à travers les économies d'échelle. Dans le cas de la diffusion internationale, les economies d'échelles pourraient être considérées non seulement au niveau de chaque marché national, mais comme stimulées également par les gains d'efficacité et d'expérience accumulés sur d'autres marchés.
  - le développement de consortiums de R&D ou de groupes de travail, favorisatn l'émergence de standards technologiques (renforcant l'attractivité du produit et les coûts d'opportunité pour les consommateur hésitants) ?

- Quel roles les gouvernements jouent-ils dans le soutien à ces groups de travail, dans l'attraction de nouveaux opérateurs sur le marché, ce qui stimule les baisses de prix ?

- Comment les enterprises définissent-elles le timing pour leurs campagnes marketing, et comment l'intéraction des medias peut-elle influencer leur impact sur les dynamiques de la demande ?

Des événements et des dynamiques spécifiques à des niveaux institutionnels et de de gestion stratétique peuvent altérer significativement la forme en S classique des courbes de diffusion. Leur integration dans un modèle de diffusion étendu permettraient en particulier de mieux comprendre et de mieux capturer certaines trajectoires de diffusion. Nous laissons ces champs d'investigations comme futures axes de recherche et d'effort.

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Quenching the Thirst for Innovation : Modeling the Diffusion of Mobile Technologies

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Disclosure

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”Quenching the Thirst for Innovation: Modeling the Diffusion of Mobile Technologies”

Abstract

Evidence shows that information and communications technologies (ICT), especially mobile telecommunications services, can lead to sustained economic growth and human development. Mobile technologies are increasingly used as a transformational tool to foster economic growth, accelerate knowledge transfer, develop local capacities, raise productivity, and alleviate poverty in a variety of sectors. In that respect, in the last decade, ICT development has become a key strategic area for policy engagement in emerging economies. To support policy-makers and marketing practitioners in designing optimal telecommunications sector development strategies, an increasing research focus is now being placed on the impediments to implementing ICT solutions in the developing world. As a contribution to this field of research, this study aims at (i) identifying the economic and socio-cultural determinants affecting the capacity of developing countries to adopt new technologies and innovations, and at (ii) defining relevant policy principles likely to foster the diffusion of ICT solutions in emerging economies that are characterized by strong income inequality and uncertainty avoidance.

***Keywords**: innovation; diffusion; ICT; mobile technologies; system dynamics; modeling;*

”Assouvir la Soif d'Innovation: Modélisation de la Diffusion des Technologies Mobiles”

Résumé

L'expérience montre que les technologies de l'information et des communications (TIC), et services de télécommunications mobiles en particulier, peuvent stimuler une croissance économique soutenue et contribuer au développement humain. Au coeur du secteur des TIC, les technologies mobiles sont de plus en plus utilisées comme un outil transformationnel pour favoriser la croissance économique, accélérer le transfert des connaissances, développer les capacités locales, améliorer la productivité et réduire la pauvreté dans de nombreux secteurs. À cet égard, au cours de la dernière décennie, le développement des TIC est devenu un domaine stratégique d'engagement politique dans les économies émergentes. Afin d'accompagner les décideurs politiques et les marketeurs dans la conception des stratégies optimales de développement du secteur des télécommunications, les chercheurs s’intéressent de plus en plus aux obstacles entravant le déploiement des solutions TIC dans le monde en voie de développement. En tant que contribution à ce domaine de recherche, cette étude vise à (i) identifier les déterminants économiques et socioculturels affectant la capacité des pays émergents à adopter les nouvelles technologies et innovations, et à (ii) proposer des principes d’actions et de politiques susceptibles de favoriser la diffusion des solutions TIC dans les pays émergents qui sont caractérisés par une forte inégalité des revenus et par l'aversion au risque.

***Descripteurs** : innovation; diffusion; TIC; technologies mobiles; systèmes dynamiques; modélisation;*

Main abbreviations

1G	First generation (mobile communications systems)
2G	Second generation (mobile communications systems)
3G	Third generation (mobile communications systems)
AB	Agent-Based
ARCEP	Autorité de Régulation des Communications Électroniques et des Postes
e-ID	Electronic Identity
GDP	Gross Domestic Product
GSM	Global Systems Mobile
GSMA	Global Systems Mobile Association
ICP	International Comparison Program
ICT	Information and Communications Technologies
IDV	Individualism
MAE	Mean Absolute Error
MAS	Masculinity
NFC	Near Field Communication
NGO	Non Governmental Organization
PDI	Power Distance
R&D	Research and Development
RFID	Radio Frequency Identification Device
RMSE	Root Mean Square Error
ROI	Return on Investment
SBC	Switching-Back Cost
SIM	Subscriber Identity Module
SME	Small and Medium Enterprise
SMS	Short Message Service
UA	Universal Access
UAI	Uncertainty Avoidance Index
US	Universal Service

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Summary

Evidence shows that information and communications technologies (ICT), especially mobile telecommunications services, can lead to sustained economic growth and human development. Mobile telecommunications are without any doubt the ones that triggered most of the positive changes and impact in the developing world[2]. Being central to the ICT sector, mobile technologies are increasingly used as a transformational tool to foster economic growth, accelerate knowledge transfer, develop local capacities, raise productivity, and alleviate poverty in a variety of sectors. In that respect, in the last decade, ICT development has become a key strategic area for policy engagement in emerging economies.

However, the much celebrated breakthrough of mobile telephony in the developing world must not obscure the chasm between rich and poor nations in accessing ICT. The diffusion dynamics of new technologies across regions show a striking heterogeneity. For many emerging economies, the massive expansion of low-cost telecommunications networks and value-added mobile services remains a major development challenge. In addition, this puts a tremendous pressure on private sector and ICT firms operating in the space, who are expected to develop more inclusive marketing strategies and commit to important investments on international markets.

To support policy-makers and marketing decision-makers in designing optimal ICT sector development strategies, an increasing research focus is now being placed on the impediments to implementing ICT solutions in the developing world.

As a contribution to this field of research, this study aims at (i) identifying the economic and socio-cultural determinants affecting the capacity of developing countries to adopt new technologies and innovations, and at (ii) defining relevant policy principles likely to foster the diffusion of ICT solutions in emerging economies that are

[2] Mobile telecommunications are by far the leading area of growth of the ICT sector and therefore, in the context of this research, will be used to exemplify the ICT sector itself.

characterized by strong income inequality and uncertainty avoidance.

The research methodology focuses on designing a holistic framework for the analysis of ICT diffusion processes, based on a multidisciplinary literature review and conclusive interviews conducted among innovation industry and development experts. In order to capture the non-linear forces at play and the complex interactions (feedback loops) between macroeconomic, corporate and consumers dynamics, we use the System Dynamics modeling approach. Designed at M.I.T. in the 1960s and originally applied to engineering science, this system thinking approach enables to assess the implications of policy strategies in complex and highly integrated environments. Once calibrated using available mobile phone diffusion data for 17 countries, the model is used to explore various ICT development policy options and quantify their impact on diffusion speed and extent.

The key findings of this research work are that:

1. Country-wide socio-economic heterogeneity and endogenous cultural drivers, such as uncertainty avoidance, significantly influence the dynamics of innovation diffusion across countries. For instance, emerging economies with strong income inequalities and social stratification are more prone to face exacerbated challenges in the large-scale adoption of new technologies;
2. Well-targeted subsidies in the early stages of mobile technologies diffusion can play a determinant role in their massive diffusion, helping to overcome initial confidence barriers, leveraging economies of scale, and, in the longer-term, triggering macroeconomic positive feedback mechanisms. Temporary cross-subsidizations at the early stages of product diffusion can, in particular, significantly accelerate market penetration. Defining the optimal timing and duration of such subsidizing approaches requires a detailed analysis of the product affordability across the population, as explained in the modeling approach section. In particular in income unequal countries, it is recommended wait for economies of scale to draw adoption costs down, and postpone cross-subsidy programs until the product starts to become affordable to the upper segment of mass-markets.

In terms of research contribution, building up a conceptual model incorporating the major factors affecting the diffusion of innovations, along with identifying the linkages among them and capturing the evolution over time of the entire system, represents a potential for enhanced understanding of the complex issues in the academic field of technological innovations and diffusion theories.

In this perspective, this research work hopes enriching conventional wisdom and presents a holistic framework analysis for strategic marketing decisions. The later presents a tangible interest to marketing practitioners and policy-makers, enabling them to take better informed and more accurate decisions, and design more effective policy actions in extending reach to innovations.

Introduction

7. Innovations in the Telecommunications Industry

At the edge of the 20th century, human kind witnessed an unprecedented increase in access to telecommunications services. With nearly 90 percent of the world's 6.5 billion people now using a mobile, there is emerging consensus about the unprecedented spread of mobile technologies (The Economist, 2008). In addition, nearly 80 percent of mobile phone users live in developing countries (Wireless Intelligence, 2009; Chircu and Mahajan, 2009). Vastly improved mobile technologies have provided opportunities unimagined barely thirty years ago and are increasingly used as a transformational tool to foster economic growth, accelerate knowledge transfer, develop local capacities, and raise productivity in a variety of sectors in both developed and developing countries. The private sector firms have been actively involved in developing and promoting the usage of mobile technologies worldwide.

First generation (1G) mobile communications systems introduced in industrialized countries in the early 1980s offered simple wireless voice services based on analog technology. These 1G systems provided low quality voice services and were very limited in capacity and geographic coverage. Furthermore, the high price was prohibitive for most of the world's population.

Less than a decade afterwards, the second generation (2G) digital systems that developed in Europe[3] and the USA[4] were able to provide a number of improved services, including: better voice quality, higher capacity, global roaming capability, lower power consumption, and support for simple non-voice services like SMS. However, weak global telecommunications systems continued to hinder growth. For example, the differing 2G technologies were not inter-operational and there were

[3] Mainly GSM, based on TDMA technology
[4] Mainly IS95, based on CDMA technology

difficulties with roaming between GSM and IS95 standards. In addition, the low bit rate of 2G systems[5] could not meet subscribers' demand for new and faster non-voice services.

With the advent of the third generation (3G) systems in the early 2000s, mobile devices became more than just telephones. The capabilities of 3G networks allowed the convergence of value-added data and voice services on the same mobile device. The advanced devices, or 'smart phones' that were commercialized at the same time as the 3G launch supported traditional voice services, as well as Internet access and multimedia mobile applications, dramatically changed the culture of communication globally. Coupled with emerging technologies like Bluetooth, GPS, and biometrics authentication, the potential for blossoming innovations in the telecoms industry has proven to be tremendous. As a result of the development of mobile applications, a device previously useful simply for its voice services, was now a multi-functional mobile device with ever expanding capabilities (Dawson, 2010; The New York Times, 2010). The marketing efforts of companies and private firms in the ICT space were now oriented towards the winning strategies that will help take full advantage of these opportunities.

One example of such an innovation that has literally shaken the telecommunications landscape is Apple's iPhone. The successful launch of Apple's iPhone in the US, and its subsequent introduction across a large number of countries has generated exceptional media coverage and a vivid interest from both the industry players and the end users (Yoffie, 2008; Medvetchi-Dahan, Manceau and Geffroy, 2009). Many experts call the iPhone—especially the newest release (iPhone 3GS)—a 3.5G supported product because the protocol that it supports (HSDPA) is seen as an evolution of the 3G standard[6].

Paradoxically, the iPhone mobile device launched in the US and initially marketed as a luxury product for high-end mobile users in developed countries has progressively gained international fame and has begun entering markets in developing countries—partly due to a variety of innovative mobile applications that are being

[5] 9.6kbps for GSM
[6] AT&T forums, 2008, http://forums.wireless.att.com, accessed August, 2010.

created for users with limited access to conventional services. Examples of these applications include the following: recent medical applications that have been developed for iPhone users in areas where remote health monitoring is vital, mobile banking applications for otherwise unbanked users in Tanzania and Kenya, or disaster risk management applications for iPhone users in regions with high risk of natural disasters, such as Haiti or the Philippines. The mobile platform is also now able to deliver services such as voting, payment of migrant workers, and health care and education programs—services that the poorest people previously had difficulty accessing, but are now being extended to them in a timely and cost-effective manner. As a result, the demand for mobile applications is rapidly growing among these vulnerable communities in developing countries.

7.1. The transformational power of mobile technologies

Mobile communication has literally transformed society as its outreach increased. Mobile devices have become a regular part of people's lives in developed countries, providing a vast array of services now available on a continuous basis in all regions covered by mobile networks. Overall productivity in the developed world has been enhanced due to wide access to services such as instant messaging, video calls, multi-parties conferencing, and geolocation (Qiang, 2009; The World Bank, 2010).

In the last decade, mobile telecommunications have become increasingly important in the developing countries as well. The World Bank (2008c) found that since 1998, low and lower-middle income countries have outnumbered high income countries in number of new telephone connections established.

According to GSMA (2008) "virtually all new mobile customers in the coming years will be in the developing world," although replacement markets will remain important in developed countries, especially as users upgrade from second to third generation digital services and as they upgrade their first-generation handsets for smart phones. This is a tremendous opportunity for the private sector and the firms operating in the ICT space see new markets and business opportunities presented to them.

Access to mobile phones has, for the first time ever, provided poor households and communities access to public and private services (The World Bank, 2009). As noted in the examples above, information and communications technologies (ICTs) and, more specifically, mobile technologies are quickly emerging as the new frontier—transforming the way governments and businesses alike perform and deliver services to citizens and customers. Table 8 details some of the latest innovations in the mobile applications and citizen services in the developing countries, along with their estimated social impact.

Table 8: Examples of innovative uses of mobile technology for the delivery of citizen services

Sector	**Technology**	**Application**	**Description**	**Country**	**Comments**
Education	SMS-based	UNESCO Learning	Literacy program delivered through mobile phone to rural female learners: www.unesco.org	Pakistan	The pilot reached 250 females aged 15-24 years with high success rate (over 8%);
Health	Mobile application	MPedigree	Fight against counterfeit medicines www.mpedigree.org	Ghana	Estimated to over 30% in Ghana, the counterfeit malaria drugs and others can have deadly impact; a simple SMS can prevent at least 20% of those deaths;
	Mobile application	iStethoscope	Diagnostic application on iPhone www.peterjbentley.com	origin: USA	Can be used as a mobile health diagnosis system in remote rural areas;
	Various	Vidu Suwa	A patient-centric e-health solution including an e-Consultation clinic, a web-based e-Health-record system and a m-communication system www.vidusuwa.com	Sri Lanka	Very successful, this pilot project wins the national Best e-Content award in 2009;

Sector	Technology	Application	Description	Country	Comments
Agriculture	SMS-based	eSoko	Using mobiles for market prices for farmers who can decide what crops to grow and what prices to charge at harvest : http://www.rwandagateway.org	Rwanda	Farmers are also given additional training such as using the computer, tele-centers, business development and managerial skills ;
	SMS-based	Farmer	SMS-based trading platform linking producers and buyers; www.farmer.lk	Sri Lanka	Connecting farmers to traders makes market dynamics more transparent and fair ;
Disaster Risk Management	Mobile application	Instedd	Early detection and response to major health-related events and disasters : www.instedd.org	origin: USA	Has been tested in Cambodia and other SE-Asia with great success in flu pandemic DRM ;
	Mobile application	eCapra	SIG web platform for disaster risk evaluation : www.ecapra.org	Haiti	Applies to Central American countries with high risk of hurricanes, tsunamis..
	Mobile application	OpenStreetMap	A free editable map of the whole world	Global	Regions at risk or in conflict zones (Afghanistan, etc) can be mapped

Sector	Technology	Application	Description	Country	Comments
			www.openstreetmap.org		this way;
e-Gov/e-ID	Mobile application	e-ID Estonia	eID-cards on mobiles to access and use secured e-Gov services to citizens www.id.ee	Estonia	Launched in 2006, the service already reached 400 000 users of Mobile-ID
	SMS-based	e-Gov Recruitment	A SMS-based recruitment system to notify potential candidates of their job search result: www.rca.gov.om	Oman	Successful illustration of an e-Gov public service delivered via the mobile platform;
	Mobile application	eJustice system (UYAP)	A platform ensuring a fast, reliable and accurate judicial system : www.uyap.gov.tr	Turkey	With over 18 000 lawyers registered, the system is a success and allows lawyers and citizens realize their justice-related works without going to the Court;
Food Security	SMS-based	RapidSMS	Nutrition & Food Security surveillance data collection system	Malawi	At least one-third of infant deaths are related to acute malnutrition;

Sector	Technology	Application	Description	Country	Comments
			www.rapidsms.org		
M-banking	Mobile application	M-Pesa	Money transfers to unbanked poors www.safaricom.co.ke	Kenya	6.5 million subscribers by May 2009 with 2 million daily transactions in Kenya alone;
	Mobile application	Ngpay	Pay bills, shop and bank easily and securely with the mobile phone www.ngpay.com	India	Potentially impactful in regions with no access to computerized systems;

In spite of this progress, however, the enormous potential of the radical transformation of communications services is still largely untapped and is increasingly compromised by a widening gap in access to ICT (Norris, 2001; Selwyn, 2004; Chircu and Mahajan, 2009). All the stake-holders, including the private sector and firms in the ICT industry, are expected to act towards narrowing the gap.

As the requirements for enhanced access to information in social and economic activities increase, the importance of mobile platforms for the development agenda will continue to expand, thus triggering innovation and development in telecommunications systems. Not only do the developing countries need access to basic voice communications: it's critical for them to catch-up on the newest technologies offering broader possibilities and a vast array of mobile applications, such as mobile banking, electronic identification, remote health monitoring, etc. The need for 3G+ mobile phones with enhanced capabilities has never been felt so strongly before. New evidence found by Chircu and Mahajan (2009) suggests that developing countries can "break free from ICT path dependency" and leapfrog with the latest mobile technology allowing for the required infrastructure for innovative products and services. These in turn can allow private companies that operate on the ICT market to expand their business and thus stimulate countries' ability to achieve economic development.

7.2. The impact of mobile communications in the developed and developing countries

Significant debates over the impact of information and communications technologies on economic performance and competitiveness in general, and on productivity, efficiency, and innovation in particular have dominated the field over the last decade. Notably, in seeking an explanation for the acceleration in productivity and economic growth experienced in many developed countries in the 1990s and early 2000s, many economists have considered the development, application, and use of new communications technologies as a critical factor (InfoDev, 2007).

In the industrialized countries, increased ICT production and usage has contributed significantly to economic growth: from 1996 to 2000 in the US, new communications technologies accounted for 6.3 percent of the GDP growth and for an 80 percent increase in labor productivity gains. In another example, investments in new technologies offset negative growth in other sectors during the 1998 Asian crisis. In the aftermath of the economic downturn, South Korea estimated that nearly half of its domestic GDP growth was related to new technologies and mobile communications sectors (The World Bank, 2009).

In the developing countries, mobile telecommunications have been shown to sustain new opportunities for economic development (World Bank, 2008; Qiang, 2009; World Bank, 2009). Indeed, ICTs have a catalytic role in the knowledge transfer and technological diffusion, thus amplifying the competitive advantages of fast-learning economies. As the dynamics in transition economies are much more obvious, complete cycles occur with higher velocity and allow for a more rapid evaluation of the results. For example, many rural communities—which according to a World Bank report (2009) are home to nearly one-half of the world's population and 80 percent of the world's poor—are impacted by mobile communications in tangible, quantifiable ways. For instance, a number of studies (World Bank, 2008; Qiang, 2009; World Bank, 2009) have found significant evidence that the use of mobile phones boosts overall GDP in both developed and developing countries. An analysis conducted by McKinsey (2007) reported that in China start-up companies in the mobile technologies business contributed twice as much to GDP, as mobile operators. Confirming these results, Deloitte (2008) reported that mobile technologies had a sensible impact on GDP, in all six countries analyzed (Ukraine, Serbia, Thailand, Malaysia, Bangladesh, and Pakistan).

Other findings from a recent World Bank report (2009) show that the increased use of mobile communications technologies has contributed significantly to economic growth in emerging economies. Namely, between 1996 and 2005, developing countries with an average increase of 10 more mobile phones per 100 people benefited from a GDP per capita growth of 0.8 percent points. In the developed countries, in average, every ten percentage point boost in penetration rates yielded GDP percentage points increase of 0.6 (Qiang, 2009).

Further, examples from developing countries show that mobile communications improve the social and financial inclusion of isolated populations and provide income opportunities in rural areas beyond traditional agricultural activities. In Bangladesh, an innovative mobile start-up—Grameen Telecom—extends telecom coverage to rural areas through provision of micro-finance and wholesale capacity to village operators. The average profits of village operators are $700 per year—more than twice the country's income per capita. A similar company in South Africa—Wizzit—offers a service that allows users, including those without bank accounts or credit cards, to send money phone to phone and receive international remittances. It is of tremendous importance to both citizens and private companies (operators), and examples reflected here are closely linked to the business and marketing management fields.

Indeed, these and other similar examples show that players in the mobile ecosystem are taking innovative approaches in attempting to reach out to rural customers, either by offering village phone programs in Asia, low-denomination recharges for prepaid phones in East Africa, or combined voice and agricultural information SMS services in Latin America. They need to understand and develop fully-fledged inclusive marketing programs to get onboard as many mobile users as possible. As a result of these marketing strategies, more and more individuals in developing countries can benefit from new technologies and access global knowledge, which in turn leads unleashing the potential of their human capital and innovativeness.

Moreover, the World Bank (2011) found that global enterprises in both manufacturing and service sectors that use ICT intensively are more productive, grow faster, invest more, and are more profitable. On the other hand, local companies are increasingly integrated into global production chains and markets, thus contributing to economic growth. Finally, by engaging with ICTs, government agencies are becoming more efficient, contributing to long-term growth through productivity gains

(World Bank, 2011).

This extensive evidence supports the statement that mobile technology helps addressing the millennium development goals (MDGs). Officially established in 2000, the MDGs derive from earlier international development targets and aim to achieve human and economic development through the attainment of eight goals with 21 targets, each with a series of measurable indicators[7]. Due to extended reach and game-changing possibilities offered by the ICTs globally, they are regarded as instrumental in achieving sensible MDG results.

8. Diffusion of Mobile Technologies Across the World

In the last decade, extending both accessibility and affordability to mobile communications has become a key strategic area for policy engagement in emerging economies. Despite encouraging early results, the much celebrated breakthrough of mobile telephony in the developing world must not obscure the chasm between rich and poor nations in accessing ICTs. The diffusion dynamics of new technologies across regions show a striking heterogeneity. For many emerging economies, the access to telecommunications networks and value-added mobile services remains a major development challenge. It is also shaping the environment of the telecommunications sector, having significantly increased the complexity and the challenges faced by the telecom operators, who are expected to develop these new technologies and products in order to service a broad category of customers, in the most inclusive manner possible. Besides, the telecom operators and private companies involved in the mobile value-chain have to understand and take into account the dynamics at play in the international diffusion process when planning their production (supply-chain) operations across countries or planning their

[7] United Nations Millennium Development Goals website: http://www.un.org/millenniumgoals/bkgd.shtml retrieved August 2010.

marketing actions, for example. Hence, the diffusion of innovations is becoming a strategic issue both for the operators and the economy as a whole.

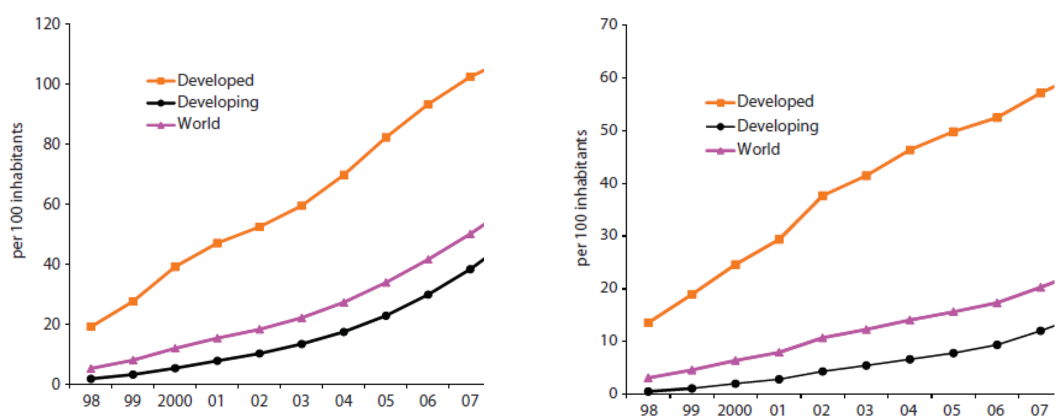
Previous research on ICTs reveals that developing countries have lower technology adoption levels than that of developed countries—a finding termed the *digital divide* (Dewan and Kraemer, 2000). However, further research with emerging ICTs is needed in order to understand the extent of the digital divide between the developed and developing countries (Knowledge@Wharton, 2004; Chircu and Mahajan, 2009). Indeed, diffusion of mobile technologies is still very unequal across regions and particular countries. These phenomena are not new and disparities have been notably observed at a very early stage of product life cycle (Dekimpe, Parker, Sarvary, 2000; Kumar and Krishnan, 2002; Tellis, Stremersch, Yin, 2003; Chandrasekaran and Tellis, 2008). This stage corresponds to the launch and take-off phase of a new product/technology and is critical in determining the subsequent diffusion patterns.

Figure 1 shows the heterogeneous diffusion patterns of both Internet and mobile technologies. Not only the patterns of diffusion in the developed countries differ in extent from the ones in the developing world, but the gap is widening in both internet and mobile technologies context.

Figure 1: Mobile and Internet penetration, developing and developed countries, 1998-2009

Mobile phones suscriptions

Internet suscriptions



Source: ITU, 2010; *estimates

Moreover, literature on ICT penetration (Dewan and Kraemer 2000, 2005; Corrocher and Ordanini, 2002, Chinn and Fairlie, 2006; Chircu and Mahajan, 2009) documents how various cross-country characteristics contribute to the *widening* of the *digital divide.* In this body of work, however, little attention is dedicated to the necessary policy actions that can lead to a *narrowing* of the divide. This is important also from a managerial perspective, as meeting this huge demand simply implies that the private sector/firms in the ICT space are expected to develop marketing strategies that would allow for more inclusive marketing actions and financing schemes. For example, mobile operators have to plan and reengineer their supply-chains to be able to operate at a global level and help quenching the thirst for innovation of a broader segment of population. At the same time, they are increasingly requested to lower their services' prices to become more affordable. Therefore, marketing practitioners, as policy-makers, are equally concerned by the complexity of the diffusion patterns in the common goal to extend the reach to ICTs.

9. Extending Reach to ICT and Mobile Technologies

In the light of the evidence exposed in the previous sections, it becomes clear that there is a chance for the developing world to enhance capacity to compete in the global knowledge economy by harnessing the power of new technologies to leapfrog ahead economically.

However, developing countries lack a sustained strategy for accessing the knowledge economy and it is clear that the diffusion of innovations and technologies is still highly inequitable. This is unacceptable, primarily because the observed disparities in accessing ICTs penalize the most marginalized people in society. More can, and should, be done in order to foster universal access to new technologies, in particular to the mobile telephony, whose impact on economic welfare and social inclusion has been discussed earlier.

For many developing countries, the massive expansion of low-cost telecommunications networks and value-added mobile services remains a major development challenge. To support policy-makers and marketing practitioners in designing optimal telecommunications sector development strategies, an increasing research focus is now being placed on the impediments to implementing ICT solutions in the developing world.

Recent assessment by the World Bank (2010) on the state of access to telecommunications in rural and low-income areas revealed that overall, governmental policies aimed at increasing universal service for marginalized populations, "have not evolved sufficiently in line with the latest market and technological trends." Additional efforts are therefore needed for governments and companies to understand the heterogeneity in the diffusion patterns of the new technologies and to design well thought mechanisms for universal access (UA) and universal service (US) (Muente-Kunigami and Navas-Sabater, 2010).

Embracing a broader perspective on the diffusion of innovations and including relevant factors in the framework of diffusion analysis is pertinent not only to the academic community, but also to the strategic marketing practitioners and policy-makers. Chircu and Mahajan (2009) and the World Bank (2011) argue that mobile technologies can create leapfrogging opportunities for developing countries. Given the wide array of mechanisms available for decision makers to increase access to ICTs in general, and mobile technologies in particular, targeted policy actions could minimize the digital divide and support inclusiveness and growth. Indeed, given a favorable environment, developing countries are able to escape the path of dependency through well-targeted policy actions, designed to achieve increased access to mobile communications. Private sectors and firms operating in the ICT space, like the mobile operators for example, can help achieve these objectives, by strategically designing and planning their marketing efforts to make innovations more affordable and available to a broader category of consumers.

Research Objectives and Methodology

10. RESEARCH OBJECTIVES AND DEFINITIONS

This research pertains to the field of international diffusion of new products and technologies that are identified here under the term *innovations*.

10.1. Diffusion of innovations: what are we talking about?

Innovation has been studied in a variety of contexts, including in relation to technology, commerce, social systems, economic development, and policy framework. Naturally, there is a wide range of approaches to conceptualizing innovation in the scholarly literature (Fagerberg et al., 2004).

Several definitions have been proposed in the research literature for the concept of *innovation*. A convenient definition of innovation is given by Luecke and Katz (2003), who consider innovation as “the embodiment of knowledge in original and valued new products, processes, or services”. This is a bolder vision of innovation than Rogers’ (1983) initial definition of it as “an idea, practice, or object that is perceived as new by an individual or other unit of adoption”. It also advances the scope of innovation – from the creative idea itself to the crystallization of it into a concrete product. While creativity is typically seen as the basis for innovation, the later is the successful implementation of creative ideas within a broader context of application (Amabile et al., 1996).

This dissertation does not consider research that uses the extended definition of innovation, as related to new ideas or behaviors new to organizations or individuals, but rather focuses on innovations, leading to new product launches and diffusion. Therefore, it leaves out the administrative, organizational or process-related innovations. Numerous studies have been concerned with these issues (Hage, 1999; Cohen and Levinthal, 1990; Damanpour, 1991) and Tellis (2008) provides a good overview of the state of art in this field.

Also, in this research, we shall make the difference between a *sustained* and *disruptive* innovation. In his book The Innovator's Dilemma, Christensen (1997) describes the conditions under which a disruptive technology can literally takeover a well-established market. After a thorough analysis of product successes and failures in the disk drive and other industries, the author suggested a set of rules, which he called *principles of disruptive innovations*, and that became, in the years to follow, a highly influential guidance in managerial decision-making. In the process, however, *disruptive technology* became a buzz word, being used in contexts that often go far beyond the claims Christensen originally made. As recent research shows (Vaishnav, 2008) some technologies that the media and industry experts prematurely point out as disruptive often fail to displace the existing industrial order.

Acknowledging that, in his following book, The Innovator's Solution, Christensen (2003) replaced *disruptive technology* with the term *disruptive innovation* because he recognized that few technologies are intrinsically disruptive or sustaining in character. According to his new appraisal, it is the strategy or business model that the technology enables that creates the disruptive impact.

Going further, in this research work we will talk about technological product and technology, new product and innovation, as well as information and communication technologies (ICTs). However, there are obvious differences among these notions. For instance, as discussed above, technology is far more complex than just technological product, since it goes beyond the concrete materialization and commercialization of a product. For example, in fast-moving consumer goods market, the Teflon technology has been used in drastically innovative ways, generating a range of new products, from Teflon non-stick fry-pans to Gore-Tex multi-sport shoes.

In the ICT industry, the very innovative Skype technology is being used beyond its original VoIP (Voice over Internet protocol) functionality. In fact, Microsoft acquired Skype for $8.5 billion in 2011, intending to integrate the technology in several new products, such as its newest Xbox game console and Windows mobile phones.

Therefore, it is important to clarify that when using the above terms, or more broadly, *innovation*, in this dissertation work we do not specifically mean *technology*, but rather relate to *new products* that "rely extensively on technological advancements" (Dekimpe, Parker and Sarvary, 2000). We will be working with the term *innovation* and *new products* that have technological origins. We will not be working on other *sources of innovation.*

Moreover, in this research work, we shall make a distinction between two different notions often associated with the study of innovation: the *sources of innovation* and the *innovation production.* There is an obvious underlying assumption that the academic and managerial interest lies in enhancing the positive effect of both types of innovation determinants. Previous research has focused both on the sources (input) and the production (output) of innovation (Ahuja, Lampert and Tandon, 2008; Cohen and Levin, 1989). Although this distinction may look as a simplification, separating these two concepts is of primary importance. Several scholars (Fisher and Temin, 1973; Henderson, 1993; Link, 1980) argue that they must be necessarily distinguished in order to foster understanding of the innovation dynamics. To the extent that these determinants are related to different questions, and may therefore have different answers, there is a need to distinguish between them (Henderson, 1993).

Incidentally, numerous studies have been conducted in order to identify the appropriate factors favoring the emergence of innovation: from enterprise structure to organizational cultures, passing by design process improvement and inspiring management practices. According to Drucker (1985), within a company or industry, "opportunities can be found in unexpected occurrences, incongruities of various kinds, process needs, or changes in an industry or market". Therefore, the *sources of innovation* lie in a systematic practice of innovation. Moreover, he argues that innovation is real work that can be managed like any other corporate function. Outside the company, opportunities arise from demographic changes, changes in perception or new knowledge. “There is some overlap among the sources, and the potential for innovation may well lie in more than one area at a time” (Drucker, 1985).

On the other hand, the *innovation output* relates to the factors affecting the successful productivity of the innovation and, therefore, it’s actual diffusion in the potential market (Majumdar, 2000; Ahuja, Lampert and Tandon, 2008).

However, it is important to notify early at this stage that under the denomination of some of the factors may lay variables that occur both upstream and downstream in the process of diffusion of technological innovations. For example, networks and consortia can leverage one industry’s capacity to innovate (i.e. invest in R&D efforts), but also may have decisive effect on the diffusion of already existing technologies, via lobbying efforts for example. A more detailed overview of factors and their impact of the diffusion of innovations will be detailed in a dedicated section of this dissertation.

10.2. Brief overview of previous research on the diffusion of innovations

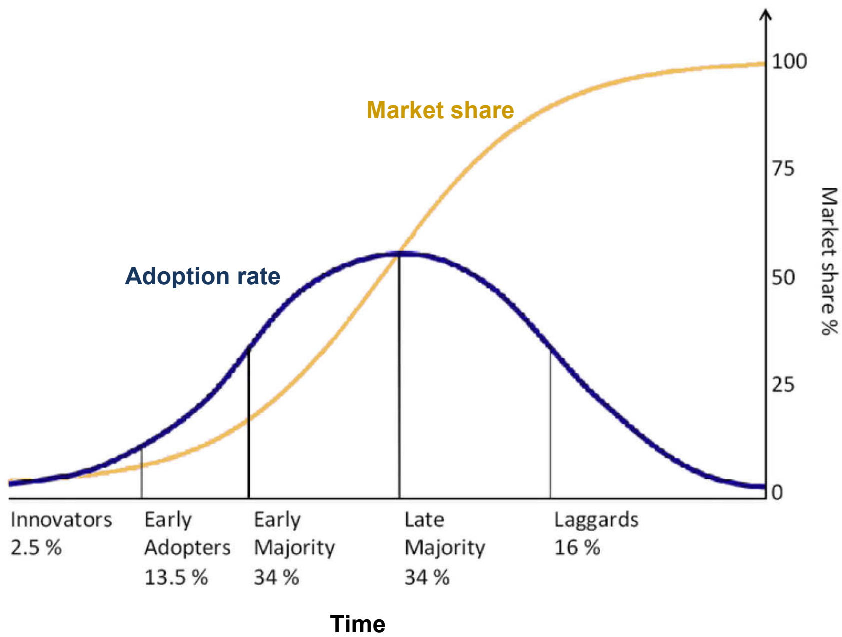
The diffusion of innovations is the process through which new ideas, new processes, new products and technologies are spreading out within a system. A summary of insights, drown from the academic literature, helps us envision the study of the *diffusion of innovations* as *the study of why, how and at what speed innovations disseminate through populations of potential adopters.*

A considerable research effort has been dedicated to extending the body of diffusion theories. Since its introduction to marketing studies in the early ‘60s, the diffusion literature has developed across a number of disciplines to explain the spreading out of innovations throughout a social system. The general pattern of diffusion is typically described as a S-shaped (logistic) curve (Tidd, 2006). A large number of studies have been undertaken in the research literature in an attempt to empirically validate the sigmoid fit, with a variety of statistical models being developed along the road. The earliest, and is still the most commonly used, is the epidemic model, which has its roots in the work of two economists, Grilliches (1957) and Mansfield (1968). The model is based on the assumption of a homogeneous group of potential adopters, who participate in propelling the flow of information by personal contact and geographical proximity. Building on these findings, Rogers (1962, 1976, 1983) and Bass (1969) pioneered the research on the diffusion of innovations and new products, laying down the path for subsequent theoretical advances and empirical validations of the epidemic model.

In his diffusion model, Bass (1969) distinguishes two homogeneous segments of adopters: the innovators, who lead the new product take-off, but are not subject to social contagion, and the imitators, for whom adoption occurs under the epidemic form discussed above. This generates a "positively skewed logistic curve" (Karshenas and Stoneman, 1992) which has become influential in both economics and marketing research.

In parallel to Bass' work, Rogers (1962, 1983) performed a synthesis of over 3000 previous studies of consumer adoption and product diffusion. The results of this synthesis include numerous generalizations about the diffusion of innovations. His major finding is that the diffusion process is initiated by pioneering adopters and reaches the *take-off* milestone when a growing community of adopters is established and the effects of peer influence and imitation kick-in. It then levels-off, when the population of potential adopters becomes exhausted, thus taking the shape of a sigmoid curve.

Figure 15: Contribution of groups of consumers to product diffusion – Rogers (1962)



In marketing studies, Rogers' generalizations have been used as guidance for speeding up the diffusion process by using specifically adapted communication campaigns to reach *innovators* first versus later adopters (Gatignon and Robertson, 1985).

As it turns out, in Rogers' categorization of adopters and the respective adoption model developed, there is an underlying assumption that *early adopters* will trigger the diffusion process due to the personal influence on the *early* and *late majority* segments. This is believed to be possible through interpersonal communication and word-of-mouth advertising. Rogers' diffusion model, capturing these adoption dynamics, aims at illustrating how a tiny percent of *innovators* (2,5%) and *early adopters* (13,5%), who initiate a new product's diffusion through *innovative adoption*, can subsequently enhance the diffusion process and trigger *imitative adoption* from the remaining *majority* of adopters (68%) and the *laggards* (16%). Thus, once the product gains acceptance, Rogers' recommendation was to progressively tailor advertising and media vehicles to appeal to each new adopter category targeted, with the net effect expected to speed up the diffusion process.

The *speed* metric is important because when considering new products diffusion on the market, one of the major indicator of success, together with sales and penetration rates, is *time*. Diffusion time was studied and monitored in a systematic way with respect to spread out of different new technologies by Easingwood (1988). Although *time* period is technology and country specific, Easingwood (1988) found that the time required achieving 75% market penetration ranges from 3.5 years to 28.4 years. Other findings suggest a diffusion period of time from 5 to 50 years for technology-related products to achieve 95% of potential market (Stoneman, 1995).

Rogers and al. (1971) give some striking examples of diffusion time lag, such as 40 years before the tunnel oven was adopted by the English pottery.

While Rogers' model has quite rightly shaped the basic concepts and scope of the diffusion process, it does not apply equally well to all adoption contexts, in particular those where the demographic and socio-economic characteristics of the *early adopters* are heterogeneous, thus reshaping the expected dynamics of both *innovative* and *imitative* adoption. This heterogeneity strongly differs from one country to another, and for one to understand the variations of international diffusion, it has to be properly encapsulated into a diffusion model. Furthermore, numerous studies on cross-country and international diffusion have shown that cultural aspects, such as the individualistic behavior of the target group/society, as well as its propensity to embrace uncertainty and risk taking, are likely to affect the diffusion of new products (Tellis, Stremersch and Yin, 2003; Kalliny and Hausman, 2007; Chandrasekaran and Tellis, 2008; Van Everdingen, Fok, Stremersch, 2009). Also, in some contexts, like in countries with scattered geography and low population density, the interpersonal communication is very limited and therefore its role in the adoption mechanism is not obvious. In such circumstances, the natural social contagion assumption does not hold, and therefore targeting a small group of consumers first is likely to cause the rate of diffusion to be much slower than had the mass market been approached (Gatignon and Robertson, 1985; Wright and Esslemont 1994; Goldenberg and Oreg, 2007).

On the other hand, Roger's findings have been consistently validated by empirical studies on adoption decisions that are conditioned in some important way by network externalities effect (Katz and Shapiro, 1986; Markus, 1987, Le Nagard-Assayag, 1999; Le Nagard-Assayag and Manceau, 2001; Rohlfs, 2001). We will analyze these phenomena in a dedicated section of this Chapter, but already would like to highlight that network externalities are of primary concern in systemic industries, such as telecommunications, where the value of use to any single adopter is a function of the size of the network of other users. However, interpersonal communication is not necessarily needed for network externalities to exercise influence on diffusion, since potential adopters can find out about the penetration level of a new product and decide adopting it as their confidence in successful diffusion raises (Stremersch and Binken, 2009; Peres, Muller and Mahajan, 2010). Moreover, recent research by Goldenberg, Libai and Muller (2010) suggests that by separating the network effects from the word-of-mouth, the network externalities may well have a chilling effect on new product growth rates and consequent profitability.

10.3. Research motivation, objectives and potential implications

As seen in the previous section, understanding what explains the *innovative* adoption take-off and what drives the *imitative* adoption across markets of the world, in both developed and developing countries, has garnered increasing interest among researchers.

Given that both Rogers (1983) and Bass (1969) models combine the effect of innovation from external influences with the effect of interpersonal communication to model a sigmoid adoption curve, neither provides insights on modeling diffusion in markets where interpersonal influence is failing or strongly influenced by other factors, such as socio-cultural dimensions for example. From a purely theoretical perspective, this work is influenced by the bourgeoning research branch arguing that new products diffusion is as contingent to consumer heterogeneity as it is to consumer interaction (Dekimpe, Parker and Sarvary, 2000; Van den Bulte and

Stremersch, 2004; Berger and Heath, 2007; Peres, Muller and Mahajan, 2010). Several studies found evidence that consumer heterogeneity delays the diffusion of innovations (Gatignon and Robertson, 1985; Dekimpe, Parker and Sarvary, 2000). Here consumer heterogeneity is understood as adopters' varying sensitivity to price and perceived affordability, cultural innovativeness and propensity to succumb to peer influences, among others.

Indeed, such analysis enables to extend and complement the interpretation of adopters' characteristics described by Rogers (1983) and later resumed by the classic diffusion theories. It seemed therefore interesting in this research work to seek uncovering the influence of these market specificities on the dynamics of both *innovative* and *imitative* adoption mechanisms, by visually illustrating the feedback loops at play in the diffusion process. In addition, there is a need for this analysis to be done at both national and international levels, which represented another motivation for this work.

Recent research shows that there is a growing interest among scholars in analyzing the differences across countries in time to take-off of new products and innovations (Dekimpe, Parker and Sarvary, 2000; Chandrasekaran and Tellis, 2008; Van Everdingen, Fok, Stremersch, 2009). The key research questions relate to whether Rogers' categorization of early adopters allowed for capturing important nuances in the adoption behavior occurring in culturally and economically distinct countries: how does a change in these parameters influence the time to take-off and the overall diffusion of new products? What other factors affect the diffusion of new products across different countries? The majors academic work referenced in our research on this topic are Sterman (2000), Dekimpe, Parker and Sarvary (2000), Tellis, Stremersch and Yin (2003), Chandrasekaran and Tellis (2008), Van Everdingen, Fok, Stremersch (2009) and finally Peres, Muller and Mahajan (2010). The emerging consensus is that the average time to take off varies substantially between developed and developing countries, with products taking off fastest in Japan, followed by the United States and some European countries. While still little is known about the diffusion of innovations in emerging economies of Africa, Latin

America and Asia, it becomes clear that "the take off is driven by culture and wealth", in addition to other drivers, such as product characteristics (Chandrasekaran and Tellis, 2008). This research work will explore further on a considerable set of drivers which have been found to play an important role in the international diffusion of innovations.

With the current understanding of the take-off engine setting in motion the diffusion mechanism, there is also a need to explore how the *imitative adoption* can be additionally fuelled by the *innovative* adoption. The reason for this is to further gain understanding on how to speed up the diffusion process of new products and technologies, thus extending the adoption opportunities to each market segment.

As already specified in the introductory part of this dissertation, there is need to help both policy-makers and marketing practitioners in designing optimal ICT sector development strategies to ensure the inclusion of a broader category of adopters. To do that one needs to take a holistic approach to the analysis of the diffusion process and gain relevant understanding on the impact certain policies or marketing actions can have on the entire system. There is evidence that a holistic analysis can help managers make a success of their practice and address broad, strategic issues regarding the diffusion of technological innovations. In a comprehensive review Jackson (2006) provides a set of guidelines under the name of *creative holism* that seeks to be "multi-paradigm, multi-methodology and multi-method orientation in highly complex dynamic systems".

Embracing this approach, systems thinking is taking a broader and holistic view on the issue of technological innovations diffusion (O'Connor and McDermott, 1997; Sterman, 2000; Jackson, 2003, 2006). Standing in contrast to Descartes' scientific reductionism, it proposes to view systems (i.e. markets, industries, organizations, and even human relations) in a holistic manner, by examining the interconnections and interactions between the components that compose the entirety of a system. This research work is largely inspired by this approach and will take new, more complete look at the process of diffusion.

From a theoretical standpoint, building up a conceptual model incorporating the major factors affecting the diffusion of innovations, along with identifying the linkages among them and capturing the evolution over time of the entire system, represents a potential for enhanced understanding of the complex issues in the academic field of technological innovations and diffusion theories. In this perspective, this research work should lead to building a non-linear dynamic model for the diffusion of new products and innovations, by applying the system dynamics methodology and presenting it as a framework analysis for strategic marketing decisions. The later presents a tangible interest to marketing practitioners and policy-makers, enabling them to take better informed and more accurate decisions, and design more effective policy actions.

The following section will present more in detail the methodological choice for this research.

11. Methodological Approach and Research Overview

The research methodology focuses on designing a holistic framework for the analysis of mobile technologies diffusion processes, based on a multidisciplinary literature review and conclusive interviews conducted among innovation and development experts. In order to capture the non-linear forces at play and the complex interactions (feedback loops) between macroeconomic, corporate and consumers dynamics, we use the System Dynamics modeling approach. It enables us to assess the implications of policy strategies in complex and highly integrated environments.

The methodological approach envisioned for this research embraces two major challenges:

- describing in a holistic approach the complexity and diversity of factors at play in innovations diffusion dynamics by building an integrated diffusion model; and
- exploring model behavior and suggesting relevant policy actions and recommendations towards reaching the research objectives;

The system dynamics approach used the modeling purposes is a methodology designed for analyzing and understanding complex feedback systems. Influencing factors, time delays as well as dynamic relations between factors and effects can be assumed and used for simulations and scenarios building (Morecroft, 1985; Sterman, 2000; Schmidt, 2006). Whereas the aim of system dynamics modeling is to better understand the relationship between underlying structure and behaviour of the feedback system, it can also — at least in principle — be used for forecasting (Milling, 1986; Lyneis, 1998; Schmidt and Baier, 2006). Notwithstanding the broader possibility of the system dynamics methodology, in this research work we'll only explore the modeling approach, allowing for enhanced understanding of the dynamics at play in the diffusion process. The objective of this research is to better understand the telecom diffusion dynamics and to help policy-makers and companies design sound product diffusion strategies, but not to propose a predicting tool.

The detailed modeling methodology used in this work is described below in the 4 following steps that are walking us throughout the process.

11.1. Conceptual model building

11.1.1. Identification of factors and dynamics at play

The research will start with the identification of the relevant factors influencing the diffusion of innovations in the telecommunications industry. Since ranking the identified factors by level of importance wouldn't bring up the desired depth of analysis, we take a system thinking approach and consider the context of innovations diffusion as a dynamic system, influenced by this set of factors. In this framework of analysis, not only the factors themselves are important, but so are the existing interdependencies among them.

Through a multidisciplinary literature review and conclusive interviews conducted among innovation and development experts, we'll aim at capturing the non-linear forces at play and the complex interactions (feedback loops) between macroeconomic, industry-level, corporate and consumers dynamics.

The objectives of this first step are to perform a broad review of the major factors and dynamics at play in innovation diffusion in the telecommunications sector. As previously discussed, diffusion dynamics are extensively studied in the literature under a wide range of thematic angles (corporate strategy, consumer dynamics, industry structure, regulatory aspects, etc.), and many conceptual models are proposed to describe diffusion processes. At this stage, the approach has been to:

- briefly review the reference conceptual models on new products diffusion and explain the core model and different sub-models to be used and developed in this work;

- carry out a literature review allowing to highlight the most relevant and powerful diffusion drivers, applicable to the new products and innovations in the telecom industry. This later enabled to extend and adapt the reference diffusion model, according to our specific research theme;
- conduct a series of semi-structured interviews with major players in the telecom ecosystem (including the regulators and civil society representatives) to complete this broad and holistic overview of the relevant diffusion factors.
- subsequently to this general review, select a list of variables and identify dynamics to be included and formalized in the conceptual model. This selection was carried out : (i) to focus as much as possible on factors and dynamics relevant to the latest technological innovations in the telecom industry, as most frequently mentioned in the literature and during interviews, and (ii) to perform the quantitative analysis that will require available historical data and feasible parameterization.

This first step led to the qualitative formulation of specific rationale, each of them being formalized into model sub-components. These rationales, explained in conceptual terms, describe the relationship (positive or negative influence) between variables in the diffusion process, and identified the key feedback loops.

11.2. Bridging towards a more holistic approach to diffusion of innovations

Once we've identified the factors our goal was to take a step back and adopt a holistic approach to what constitutes a "system" in the diffusion of innovations. The objective here was to build a model in which the factors previously identified are embedded in a manner which is relevant to both the context and the question of the study. In other words, the structure of the model should allow further exploring the behavior of the model, by testing policy actions which are relevant to what can be realistically done in the "outside" world (e.g. use simulations to explore real-life cases and managerial situations which can lead to useful insights and results.)

Through System Dynamics modeling we will aim to represent in a holistic manner the highly interrelated system and environment where unfolds the diffusion process. The later is affected by a large number of factors. While our goal is to have a holistic approach and represent/include the identified factors in the model, it is also our goal to keep only the variables which are relevant to the phenomena studied. This will be guided by our field expertise and numerous years of experience in the sector, as well as the interactions with policy-makers and marketing practitioners to whom this work is destined. Last but not least, the choice of variables has also been dictated by the availability of historical data and relevant assumptions. More on the limitations of the research will be found in Chapter 7.

11.3. Quantitative model set-up

Stepping up from a qualitative approach to a quantitative model was a necessary phase towards the quantitative testing and validation of the proposed diffusion model. Ultimately, the objective was to shift from a general visualization and understanding of the forces and feedback loops at play in the new product diffusion ecosystem, to a mathematical model able to yield the quantitative results of a diffusion process, from a set of input data.

The main activities at this stage were to :

- identify the exogenous factors and verify that input data was available to process them;
- parameterize the endogenous variables to link each of them mathematically to the set of exogenous variables.

Once the model was fully parameterized, the qualitative casual loop diagram were translated into a complete System Dynamics model, represented through a computerized model using the System Dynamics modeling software Vensim®.

11.4. Model calibration

11.4.1. General approach

As mentioned earlier, system dynamics model building is a conceptual exercise requiring a significant range of choices and assumptions, both at the qualitative (selection of a limited number or factors) and at the quantitative (parameterization) modeling phases. Before proceeding to analysis of simulations and results interpretation, it was therefore necessary to verify the relevance of the model behavior, by confronting simulation results to historic data. Two essential principles had to be taken into consideration:

To make sure the computerized model is capable of yielding diffusion results consistent with observed data, the amount of hard data used for the calibration had to be large enough to assess the model's relevance and its explanatory power.

The ecosystem in which telecom products are developed and diffused is far too complex and wide to be captured by a single model. Therefore our ambition was not to predict, through the proposed model, the subsequent diffusion patterns. More realistically, the objective was to propose a holistic, integrative understanding of the role played by a number of factors on the whole diffusion process, considering that:

1. their importance had been mentioned by sector experts and practitioners and/or brought up in previous academic research;
2. few system dynamics models focusing of innovation diffusion had previously taken into consideration all these aspects.

As a consequence of principle 2., and despite substantial efforts taking into consideration principle 1., the ambition of this research was not to achieve an exhaustive calibration of the model.

This did not however compromise the objectives of the research: ***the main use of the system dynamics model is not to provide a tool enabling to forecast in detail product sales. Its main function is to help understanding the general behavior of a complex diffusion process and to identify the respective influences and patterns of all dynamics at play in an ecosystem based on a dense structure of feedback loops.***

11.4.2. Selection of calibration data

The choice of data sets used to perform this calibration was made to test the model in a wide range of configurations: in our research, we have developed the model mainly on a demand-based approach, focusing in particular on the role of socio-economic and cultural characteristics of the potential adopters' basis. It appeared therefore more relevant to use a set of diffusion data related to a limited number of products, but across a large number of countries, rather than analyzing sets of diffusion data in few countries but for a diversity of products.

The objective of the research being to study the diffusion dynamics in the telecommunications industry, we had to calibrate the model using an innovation the most similar characteristics: offering telecommunications solutions to individuals, and bringing a significant technological improvement or disruption, compared to previous existing products. In that perspective, diffusion data for 3G mobile phones were considered to be the most relevant. Historic sales data has been collected for 17 countries (Argentina, Belgium, Brazil, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Poland, Russia, Spain, Turkey and the United Kingdom) and used to calibrate the model.

11.5. Model analysis and policy recommendations

Once the model calibrated, the last phase consisted in:

- assessing the calibrated model's performance in terms of goodness-of-fit to the historical data, comparing it with the Bass reference model. Diffusion patterns conducive to improved goodness-of-fit will be identified, and the contribution of specific model components and variables to such improved calibration will be highlighted;
- exploring of the sensitivity of model behavior to major context parameters,

such as socio-economic or cultural characteristics. This analysis will be of particular interest to practitioners, to understand the sensitivity of product diffusion to such factors, and to promote taking into consideration such aspects by policy or business planners.

- identify specific policy recommendations to accelerate product diffusion, defining and running specific scenarios of potential policy or business strategies, and quantifying their impacts on product diffusion.

The following sections will unfold the research plan and methodological approach described above.

Theoretical Framework

12. THE REVIEWED STRANDS OF LITERATURE

Since a vast body of literature has been dedicated to extending the knowledge on the diffusion process, in this dissertation we will highlight some of the major works in the field of international diffusion of innovations and differences across countries in the time to take-off of new products.

In the attempt to summarize research in the field of diffusion of new products and innovations, we've reviewed the major works from the field of economics and marketing, with an emphasis on the latter, followed by an overview of relevant system thinking research. This exercise allowed revealing several interesting characteristics of the existing body of literature on the diffusion of technological innovations.

First of all, it is our understanding that there is a major emphasis in the economics literature on the *sources of innovations*. This is probably to be put into perspective with the economists' focus on the incentives policies. Second, it appears that the strategic marketing scholars dedicated so far most of their research to the study of innovation output, which seems consistent with their emphasis on the results framework (Gilbert, 2006; Arora and Gambardella, 2010).

The economists' work has been thoroughly studied by numerous scholars. There are several outstanding reviews of the economics literature with respect to the diffusion of innovations, performed by Gordon (1990) and more recently by Stoneman (2002) and Ahuja, Lampert and Tandon (2008). In order to highlight the key theoretical mechanisms that have been identified by the strategic marketing research on innovation, we've also relied on past reviews of the diffusion literature

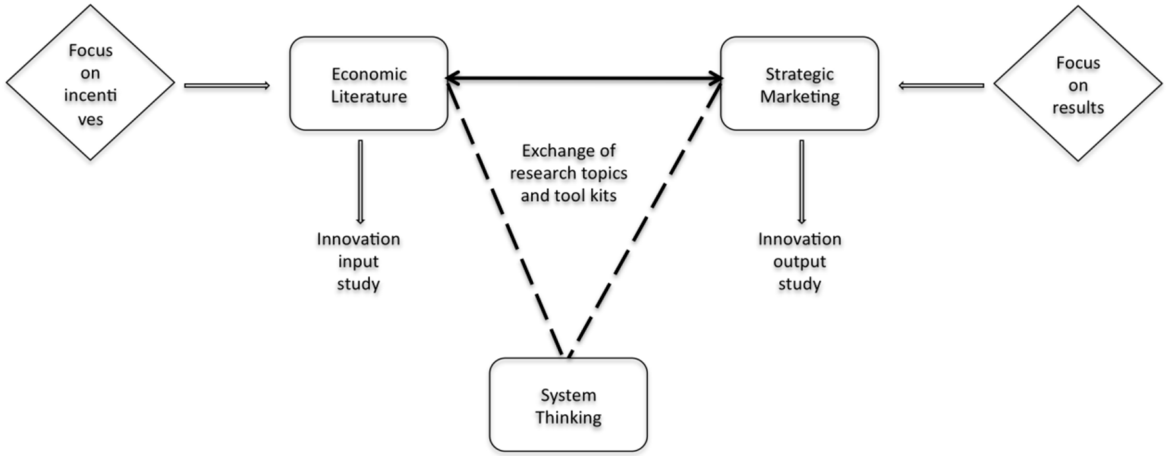
(Ahuja, Lampert and Tandon, 2008; Gilbert, 2006; Kamien and Schwartz, 1975).

In this literature review we were looking for both theoretical novelty and empirical validation of the concepts related to the diffusion of technological innovations in the telecommunications industry. We found that there was a preponderance of the former, due to a reduced availability of data sets regarding the diffusion process .This view is supported by a survey done by Ahuja, Lampert and Tandon (2008). Analyzing these two bodies of literature, they argue that "there may be cross pollination benefits" if a swap of both problems and toolkits could be achieved.

Going forward with these findings, we suggest that a more holistic approach to the diffusion process is to be taken and that it should include insights from both literature strands. The main reason for a holistic approach is that holism encourages the use of trans-disciplinary analogies, giving attention to "both structure and process" and enabling us to link "theory and practice in a learning cycle" (Sterman, 2000).

Because of growing popularity of holistic thinking, there is now a rich storehouse of different approaches, methodologies and models being designed for the circumstances of the highly complex era of technological innovations (Jackson, 2006). Organizational cybernetics, complexity theory, hard and soft systems thinking, evolutionary and postmodern systems methods have been developed among others.

Figure 16: Conceptualization of the literature review



In this research, we will primarily focus on the System Dynamics methodology that derived from the system thinking research stream. There are several reasons why this approach fits better the recent work objectives and we will review them in greater detail in a dedicated section of this research. For now, we argue that this approach proved its ability to enhance understanding of the dynamic behavior of complex systems, such as the diffusion environments of innovations and therefore this discipline sits somewhere on the crossroad between the economic and strategic marketing literature (as illustrated in Figure 2). The system thinking research work in this dissertation will be highlighted in more details in the Chapter dedicated to the system dynamics modeling.

13. Findings from Literature Review

In the process of literature review, we've been looking for research insights and, where possible, empirical evidence, on the major factors affecting the diffusion of technological innovations, as well as on the existing interdependencies among these factors. This implies that certain factors are probably not completely independent (for example industry and economic factors). However, since the objective of the research is not to perform a statistical analysis of product diffusion, but rather identify in the literature review and later from experts interviews the factors considered important, this question becomes less relevant. In fact, factors' interdependence do not undermine the relevance of the System Dynamics model behavior and its capacity to adequately respond to policy actions or business strategies (Sterman, 2000).

As a result, we've found a large number of factors and we've organized them in 7 major categories of factors, which are :

- Product-related factors
- Marketing factors
- Industry factors
- Economic factors
- Demographic factors
- Cultural factors
- Regulatory factors

The following section presents each category of factors and details the research insights and, where found, empirical evidence drawn from the literature review.

13.1. Review of factors identified in the literature review

Diffusion of innovations and new products in a given country or society is affected by a number of factors (Rogers, 1995; Tellis, Stremersch, Yin, 2003;). Initially, socio-contagion was believed to be the major phenomenon characterizing the diffusion process (Bass, 1969; Moore, 1991). Later on, factors like product price (Bass et al. 1994; Krishnan, Bass and Jain, 1999; Bass and Bultez, 2001), advertising and word-of-mouth (Bass, 1969; Horsky and Simon, 1983), distribution networks (Jones and Ritz, 1991) and others, have been found to play a critical role as well in the adoption of new products by the target market. Moreover, factors that go beyond the usual *marketing mix*, or the *4Ps*, have been highlighted in the specialized literature as being determinant in the successful diffusion of new products which rely extensively on a technological component (Dekimpe, Parker and Sarvary, 2000).

In the paragraphs to follow we'll briefly summarize the key findings from the literature review on major factors affecting the diffusion of innovations. There are many others of course, but these ones have been predominantly studied by both economists and marketing scholars and will therefore be reviewed below.

1) Product-related factors

- **Product advantage/value-added**

According to Rogers (2003), the relative advantage of a product and its value-added perceived by the consumer is the attribute that accounts most, out of five in total (the others being compatibility, complexity, trialability, and observability).

The relative superiority of the product and/or its differentiation over competitive offerings usually captures elements pertaining to the new product's value-added, and real fit with customers' expectations and needs. Research by Henard and Szymanski (2001) on determinants of new product success on the market also highlights a number of empirical studies that view this factor as being among the most relevant for augmenting new product success levels.

- **Product innovativeness**

The newness and originality of a product on the market, or what is determining the perception of its innovativeness in the eyes of a potential adopter, is something that has been identified as being a strategic driver in the of new product success (Henard and Szymanski, 2001). The empirical evidence supports conventional wisdom regarding the significance of this factor (Cooper and Kleinschmidt, 1987; Montoya-Weiss and Calantone, 1994), however its definition remains somewhat blurred and confusing. Robertson (1967) went some way towards addressing this complexity by defining different types of innovation, according to their degree of innovativeness. Innovation can be "continuous, dynamically continuous, or discontinuous" based on the level of disruptiveness (Robertson, 1967) with the perception of product innovativeness altering often times consumer adoption behavior (Worthing et al., 1973; Leavitt and Walton, 1975; Joshi and Sharma, 2004). The more the innovation is "discontinuous", or radical, disruptive even, the more its diffusion encounters exacerbated challenges, as adopters face uncertainty associated with the new product (Sheth, 1981; Weeheler, 2007).

2) Marketing factors

- **Price**

Price has always been seen as the fundamental driving factor of adoption and widening of the market potential (Mahajan and Peterson, 1978; Bass, 1980; Bass and Bultez, 1982; Kalish, 1985; Horsky, 1990). A decreased price can place the product within the budgetary limits of a larger portion of population, thus extending adoption opportunities (Mahajan and Peterson, 1978).

Improvements in old technologies may extend the lives of technologies making the move to new products/services on the market less attractive (Dattee, 2007). Moreover, before the product has clearly taken over the market, diffusion failure may occur at any time, leaving the early adopter with fees to pay over the remaining commitment period. Therefore, potential adopters often have to consider a *switching-back cost* in case the new technology/product embraced proves to be less efficient than the previous one. The literature on switching costs documented that switching cost is high in general (Klemperer, 1995) and in the mobile phone industry in particular (Tudela, Polo and Sese, 2009).

- **Advertising and interpersonal communication/word-of-mouth**

Rosenberg (1976) argued that new technologies are not perfect when they are introduced and "the existing information about the new technologies is not knowledgeably perceived by potential adopters". Even since, intensive communication about new products and the emphasis on the *word-of-mouth* has been a must and every marketer was praising its positive effects. It was not until the eighties, that the researchers started to question the positive effect of the information available about the new product on the actual product diffusion (Cestre, 1996). Research by Mahajan et al. (1984) and Sharif and Ramanathan (1982) brought to light situations where the impact of *word-of-mouth* can be neutral or even negative.

Distinct in nature from a formal corporate communication campaign or advertising, the word-of-mouth relies on the concept of interpersonal communication/influence from peers or recognized opinion leaders (Rogers and Shoemaker, 1971; Mahajan et al. 1984). Goldenberg, Libai and Muller (2002) showed that a lack of communication between the early adopters of a product and the remaining mass market could result in trough in sales of nearly 52% of the 32 consumer electronic products in the USA (Tellis, 2008). Either positive or negative, "information spreads like an epidemic and reduces the associated uncertainty" (Stoneman, 1983), thus increasing the acceptability of the new technology to potential adopters. Research approaches of both Mansfield (1968) and Stoneman (1983) demonstrate that *new product information*, *cost of adoption*, and *uncertainty* are key determinants of why the diffusion of new technological innovation does not take off immediately or even fails in a highly complex environment. Moreover, potential adopters may be dispersed geographically, driving downhill the *contact rate* and requiring increased efforts in *communication* (Steyer, 2005). The later is of paramount importance in the classical diffusion theories, where the main focus is on the flow of information within a social system, such as via mass media and word-of-mouth communications (Bohlmann, Calantone and Zhao, 2010).

In an attempt to answer why diffusion follows an S-shaped curve, Mansfield (1968) puts forth the idea of epidemic theory. Basically, Mansfield asserted that the process of technological diffusion can be likened to medical epidemics. In other words, diffusion occurs over time as more and more individuals or entities come in contact with those who have already adopted a new technology, determining the *contact rate* and speed of diffusion. With the advent of social networks and other online communities on the web, this factor becomes one that triggers additional research focus.

- **Distribution channels**

Few research efforts have been dedicated to factoring in the effects of distribution channels in the modeling exercise of innovations diffusion (Everdingen, Fok and Stremersch, 2009). Distribution channels are playing a critical role in heavily promoting a new product and making it widely available (or not) in a new country. In the matter of fact, in a highly globalized economy, the performance of distribution network in a given country/region, can have significant spillover effects on the diffusion of the new products in neighboring countries (Tellis, Stremersch and Yin, 2003; Everdingen, Fok and Stremersch, 2009).

Lately, researchers' focus shifted from variables in the so-called marketing mix to other, more complex, socioeconomic factors that are credited to affect the diffusion patterns of a new product.

3) Industry factors

- **Network Externalities**

While studying the consumption patterns of durable goods, researchers noticed that "the utility a user derives from consumption increases with the number of other users consuming the good" (Katz and Shapiro, 1985). This is particularly true in industries like the telecommunications, where "the value of a unit of the good increases with the number of units sold" (Economides, 1996). Because of this *positive demand/consumption externality* (Katz and Shapiro, 1985; Xie and Sirbu, 1995), a self-reinforcing mechanism is engaged, described more in detail by Shapiro and Varian (1999). To them "*network externalities* occur when the value of a good to one consumer depends on how many other consumers purchase it." This can trigger important network effects such as increasing returns, lock-in phenomena and "winner-takes-it-all" scenarios. Indeed, empirical evidence from the digital industry (Shaw, 2000) shows that network externalities can imply high switching costs for the actual network of users, the so-called "installed base", which represents the market share and capacity to take-over the market (Farrell and Saloner, 1986). With these dynamics in place, "the strong grows stronger and the weak grows weaker" (Safferstone, 1999). The drawback of this is that under specific circumstances the markets may adopt an inferior product or network in the place of some superior alternative (Farrell and Saloner, 1985; Arthur, 1994). This *lock-in* phenomenon has been studied by Arthur (1989) under the aspect of path dependency and overall this research stream sends the signal that markets may be inadequate for managing network effects (David 1985; Arthur 1989, 1990). However, this hypothesis is debated in a series of more recent studies by Liebowitz and Margolis (1994) for whom a great deal of "definitional issues" have altered the debate and that, in the end, network effects/network externalities tend to be endemic to new, high-tech industries, in which "the fundamental raison d'être is to connect people" (Lim, Choi and Park, 2003). Managing in a realistic way their expectations with respect to the new product to be launched on the market is something that can guarantee a pretty high level of success.

In the research they've pioneered on the subject, Le Nagard-Assayag and Manceau (2001) argue that the success in the durable goods industry is determined by customers' expectation, which can be triggered by preannouncement communication on new products. By developing a model to analyze how perceptions affect the new hardware product's penetration, Le Nagard-Assayag and Manceau (2001) show the strong impact of the prior-to-launch expectations of both consumers and providers of complementary products on the long-term market success of the new product. The managerial implication is that in order to achieve a rapid diffusion, a firm should try to create high prior-to-launch expectations amongst consumers *and* program providers, leveraging both direct and indirect network externalities. This conclusion is consistent with previous research (Katz and Shapiro, 1986; Gandal, 1995; Le Nagard Assayag, 1999) showing that positive network externalities drive adoption process and once the critical mass is reached, and due to a bandwagon effect, the growth of the network is self-sustaining (Rohlfs, 2001; Shapiro and Varian, 1999).

However, this conventional wisdom is being challenged in a recent research by Goldenberg, Libai and Muller (2010) argues that network externalities may also have a “chilling effect”, creating an initial slowdown in growth pace. This is primarily due to the fact that potential customers adopt a “wait-and-see” attitude (Farrell and Saloner, 1986) and do not adopt before a critical mass of early adopters are bringing in more utility, motivating them enough to adopt. In a striking comparison with a colony of penguins, this phenomenon is also described as a *penguin effect* or *herd behavior* (Choi, 1997). Hungry penguins on ice will wait and see until one penguin jumps into the ocean for food. If the penguin has not been attacked by sharks or sea lions, then the others will consider it safe too and will all follow into the ocean as a herd.

Back to telecommunications, a critical mass of early adopters are bringing in more utility for adopting a new product, motivating the skeptics to adopt and thus moving forward the product diffusion process. These *crossing the chasm* phenomena are not new either (Moore, 1991) and link back to the time it takes for an innovation to develop. If the growth of network goods follows the two-stage process described by Rogers (2003) which is, slow initial diffusion followed by a very fast growth stage, then this growth rate is of considerable managerial importance also due to the *time value of money* (Goldenberg, Libai and Muller, 2010). The later may become a sensitive issue for marketing practitioners and decision-makers, as the variability in the diffusion speed across markets can translate into a sizeable difference in the Net Present Value (NPV) of an innovation (Goldenberg, Libai and Muller, 2010).

4) Demographic factors

Numerous studies (Robertson, 1967; Marks and Hughes, 1976; LaBay & Kinnear, 1981) have attempted to understand the influence of demographic factors on the diffusion of innovations. Population growth and its heterogeneity have been presented as being determinant in the diffusion process (Stoneman, 2002).

- **Population growth**

Population growth has been increasingly taken into account while modeling demand for new products. For instance, Mahajan and Muller (1996) used the population growth models to forecast the demand for the IBM mainframe computers and come up with the optimal introduction timing. A similar objective was pursued by Kim et al. (2000) to study inter-generational substitution of telecommunications services.

- **Population heterogeneity**

Population heterogeneity translates systematic differences at individual level in the adoption style of new products (Chatterjee and Xu, 2004). There is an extensive theoretical and empirical literature on the extent to which population heterogeneity affects the diffusion process (Mahajan and Peterson, 1985; Mahajan, Muller, and Bass, 1990; Geroski, 2000; Stoneman, 2002). Key insights from this research stream are that population heterogeneity affects the sociocontagion phenomena (Mahajan, Muller, and Bass, 1990;) and is responsible for why agents adopt at different times, either by inertia, conformity, contagion or social learning (Young, 2006).Consumer segmentation can help marketing practitioners gain more understanding (Guibert and Dubois, 2006). Recently, the agent-based (AB) modeling emerged as a new approach to allow for better exploration of social interaction dynamics n the context of complex topology of populations of agents (Axtell, Axelrod, Epstein and Cohen, 1996;

Rahmandad and Sterman, 2008; Centola, 2010).

5) Cultural factors

The literature on cross-national diffusion models is gaining increased importance and triggers new research efforts on the question of cultural dimensions affecting the diffusion (Tellis, 2008). There is an understanding that cultural factors affect the time-to-takeoff (Agarwal and Bayus, 2002; Chandrasekaran and Tellis, 2007; Golder and Tellis, 1997; Tellis et al. 2003) and often-times lead to a very rough categorization of countries by degree of innovativeness. However, prior research focused on analyzing the effects of cultural factors on the diffusion of new products in United States and Western Europe (Chandrasekaran and Tellis, 2008). This calls for a broader sampling for gaining insights into the phenomena which is unfolding in many developing countries as well (Dekimpe et al. 2000; Hauser et al. 2006).

Research by Canepa and Stoneman (2004) shows that diffusion paths are technology specific: no country, whether in Europe or North America, can be said to exhibit faster, earlier or more extensive diffusion for all technologies than other countries. This contrasts with more recent research work by Van Everdingen, Fok and Stremersch (2009), who argue that national culture can explain inter-country differences in diffusion and particularly in the time to take-off. Adding developing countries to the sample is also a new direction in the research agenda on this topic.

While talking about critical dimensions of a *national culture*, the research pioneered by Hofstede (1980) is of paramount importance, being considered by many scholars as “ground-breaking” and “a major paradigm-shift” in the cross-cultural studies at that time (Eysenck, 1991; Triandis, 1994; Sorge, 1983). And as Kuhn (1970) has pointed out paradigm-shifts are most often met with strong initial resistance, which eventually fades away in the virtue of compelling evidence supporting that shift. Hofstede’s four cultural dimensions became a dominant influence and set a fruitful agenda for strategic marketing and management studies (Chapman, 1997). Although criticized for its initial sample - IBM employees, the data collection method – a questionnaire, and the time of research – about 30 years ago – Hofstede has been often imitated by many of his critics (Marcus, 2000; Holden, 2002; McSweeney, 2002). Researchers that have defended and endorsed Hofstede's results (Hortum and Muller, 1989; Jensen, White, and Singh, 1990; Kim, Park, and Suzuki, 1990; Brockner et al. 2001), validating and expounding on his initial insight, may not fully agree with the details of the study itself, but do find relevant the findings of his life-time research work.

The four cultural dimensions – uncertainty avoidance (UAI), individualism (IDV), power distance (PDI) and masculinity (MAS) indexes – relate to the four fundamental issues in human societies. Hofstede (1980, 1983, 1984) argues that they represent the basic elements of common structure in the cultural systems of the countries, thus providing an important framework not only for analyzing national culture itself, but also for considering the effects of cultural differences on phenomena like the diffusion of innovations. The role of PDI and MAS dimensions have not been specifically studied in previous researches on product diffusion, and in the present analysis of telecom products their analysis was not considered relevant.

Recent findings (Steenkamp, Ter Hofstede and Wedel, 1999; Tellis, Stremerch and Yin, 2003) stress the significant effects of UAI and IDV on the diffusion of innovations, and warns from the inclusion of all cultural dimensions as it may generate misleading collinearity (Van Everdingen, Fok and Stremersch, 2009).

- **Individualism (IDV)**

Tellis, Stremerch and Yin (2003) showed through statistical correlation that Hofstede's (1980) cultural Individualism index (IDV) was a significant predictive factor of the delay between telecom product commercialization and their diffusion take-off time, being defined by them as the moment when product diffusion reach a 2% penetration rate. Motives for imitative adoptions can relate to the individuals' need of identification and belonging to a social group. In this context, the cultural individualism index is a proxy to measure one's tendency to stay apart from this imitative process and therefore not be prone to its influence while considering adopting a new product.

- **Uncertainty avoidance (UAI)**

Since Bernouilli (1738), risk aversion lays as a fundamental concept in economy. Knight (1921) studied a common form of risk aversion, in which the risk involved is non-quantifiable - the *uncertainty avoidance*. In this frame of mind, a potential adopter will be much more deterred by a given loss possibility, than he will be attracted by a potential gain, even if the overall expectancy remains largely positive. In other words, the uncertainty adverse potential adopter is inclined to a more conservative stance, his demand for a product decreasing sharply as risk or uncertainty increase.

According to Hofstede (1980) the Uncertainty Avoidance Index (UAI) reflects the society's tolerance for uncertainty and risk taking. It indicates to what extent a culture programs its members to feel either uncomfortable or comfortable in unstructured situations, with limited access to information or little control over outcomes. Uncertainty avoiding cultures try to minimize the possibility of such situations by strict rules, safety and security measures, both at individual and collective levels. The opposite type – uncertainty accepting cultures – are more tolerant of opinions and approaches different from what they are used to.

Prior research argues that a country’s high uncertainty avoidance hinders innovativeness of its consumers and thus negatively affects the take-off of a new product (Tellis, Stremerch and Yin, 2003; Van Everdingen, Fok and Stremersch, 2009).

In the same order of ideas, the perception of product success/failure is a dynamic variable, clearly impacted by the observations the potential adopter makes in his environment, in particular by the current product success or market penetration rate. This perception is naturally driven by adopter’s cultural background. Mansfield (1968) argued that “the number of adopters of a new technology is a function of the adoption risk, the expected benefits associated with the acquisition, and the number of potential adopters". According to his research, greater *perception of adoption risk* is generally recognized to slow the diffusion process.

From this perspective, Jensen (1982) developed a conceptual model of diffusion to show that firms may delay adoption of an innovation if there is *uncertainty* with respect to the overall *attractiveness* of the new technology.

The perception of product failure (or of the risk associated with the adoption) is particularly capital in the purchase decision of technology-driven products and even more in the telecom sector. As suggested by Arthur (1989), the risk of adopting a product before the market is locked in by its technology is substantial. An unsuccessful industrial adventure may leave its pioneer consumers with obsolete and useless products, if the market base and the global infrastructure leveraging its utility remain "an unfulfilled promise". For the potential adopter, the *perceived risk of product failure* plays therefore a central role in his final decision making.

6) Economic factors

- **GDP level**

Previous research on global diffusion showed that a nation's standard of living and stage of economic development determines both the speed and extent of diffusion. For example, Dekimpe, Parker and Sarvary (2000) carried-out an extensive study on 184 countries and empirically validated the *breadth* and *depth* of adoption of cellular technologies. Their research concludes that wealthier countries (i.e. with highest GDP level) are the best adopters of innovations. These findings are consistent with research by Stremersch and Tellis (2004) and Chandrasekaran and Tellis (2008).

Such relationship between economic prosperity and innovations diffusion can actually be considered as a two-way interaction: according to a recent World Bank study (Qiang, Rossoto and Kimura, 2009), mobile penetration stimulates macroeconomic growth, measured through its GDP, at several levels: through the economic development of the mobile operators and of all actors along its value-chain (suppliers, distributors, infrastructure developers, etc.), the increased productivity in most economic sectors, and, in a less measurable way, through all the social transformations and welfare improvement following wireless communication development. This statistical study across 120 countries enabled to conclude that each 10 percentage-point increase in mobile phone penetration lead to an economic growth of 0.6 % high-income countries and of 0.81% in low and middle-income countries. The results are consistent with earlier findings of Fuss, Meschi and Waverman (2005) from London School of Economics, arguing that the "growth dividend" of increasing mobile phone penetration in emerging economies is substantial. Using data on 92 countries, both high- and low-income, from 1980 to 2003, the researchers tested whether the introduction of mobile phone networks added to growth. They demonstrated that mobile telephony has a positive and significant impact on economic growth, arguing that this impact may double in developing countries vs. the developed ones.

- **Income distribution - Gini index**

At this point it is important to mention that wealth is not necessarily equivalent to general welfare (Peres, Muller and Mahajan, 2010). There is a commonly used measure of income inequality, the Gini index, which captures the uneven income distribution within a country. Research by Van den Bulte and Stremersch (2004) found low Gini index being a significant predictor of a fast diffusion of innovations. In fact, Horsky (1990) has already stated that decrease in price is not the only option to increase the market potential and adoption likelihood. This could also be achieved with the reduction of the dispersion of the distribution of income, or simply the increased income. Section 20 of this dissertation addresses with more insights this approach, essential to the goals of our research work.

- **Budget available for telecoms**

While studying the budget available for mobile phone, Fuss et al. (2005) found that demand increases much more than in proportion to either increases in income or reductions in price. However, the debate continues on how to properly estimate that budget available. One answer is brought by economists at the World Bank who, in order to calculate the available amount of money for telecom expenditures, convened using the income distribution (Gini) curves. The same approach is used in management practice. For instance, Intelecon (2006) sizes the available Budget by applying an affordability estimate of 5% of household income against the income level of the population. In this research work we will adapt the same approach, recognizing that income, and more specifically, the available income/budget for the telecom expenditures is what in the end supports any new product's purchase. More detailed parameterization of this variable is given in 20.2.1.

7) Regulatory factors

- **Standardization**

Policymakers and other institutional actors and stakeholders in the mobile industry play an influential role in shaping up the diffusion of new products and innovations at different phases. With respect to the telecommunications sector, Saugstrup and Henten (2006) propose that regulatory and policy framework is an important factor affecting the deployment of the new 3G technology. Moreover, research by Gans, King, and Wright (2004) suggests that standardization mechanisms have significant impact on the successful deployment of wireless communication. Other findings (Gandal, 2002; David and Greenstein, 1990) suggest that standardization and compatibility policies may lead to efficient outcomes in the market. This is consistent with previous research (Teece, 1986; Utterback and

Abernathy, 1975; Utterback, 1994) on the emergence of the dominant design and leading technological standard on the market that decreases the uncertainty on the market.

A World Bank report (2006) offers a historical perspective on regulatory approaches to standardization with the intent to safeguard consumers, acknowledging that inflexible regulation can sometimes confine the development of new telecommunications services. Earlier research by Gandal et al. (2003) argued that the benefits of standardization on mobile markets are unclear. However, successful examples of GSM standardization, especially in the context of roaming agreements, justify by themselves a government mandated standard on the mobile market (Kioski and Kretschmer, 2002; Gans et al., 2004). In contrast, research by Rouvinen (2006) on the effects of standardization on diffusion of digital mobile telephony across developed and developing countries concluded that mandated standards actually hinder competition in both types of countries.

- **Financing schemes/incentives/subsidies**

A recent report by World Bank economists (Muente-Kunigami and Navas-Sabater, 2010) advises that countries do not see the incentives and other financing schemes as substitutes for regulatory reforms, aimed at making markets work in a competitive environment. The authors identified a set of twelve mechanisms that have been, or still are, used in different contexts to promote efficient markets for mobile services and extend the universal access.

The reverse auctions and output-based aid (OBA) approaches have been extensively used in the telecommunications sector, starting with tender mechanisms for rural payphones access in 1990s and continuing nowadays with these approaches to extend broadband connectivity. Complementary to them are the licensing obligations to roll-out nationwide and the institutional demand stimulation (Muente-Kunigami and Navas-Sabater, 2010). Although many of these mechanisms proved to be efficient, like for example in Korea, or Nicaragua, for enhanced broadband coverage, still the ability of end-users to pay for the service provided often remains an issue.

While there is still a challenge to do it in a sustainable manner, several approaches to ***end-user subsidies*** have been explored lately by a growing number of scholars and development agencies. For instance, InfoDev (2010) reports that the practice of "ensuring universality by using cross-subsidizing between the different services of an operator" has brought some results but largely insufficient and which have been severely strained by the introduction of competition. On the other hand, OECD report (2005) on Chile, illustrates that end-user subsidies, along with smart *cross-subsidization*, are powerful mechanisms to trigger the diffusion of innovations.

There is a call for wider array of models and best practices to build upon. The end-user subsidies, which is a mechanism under which government transfers are given directly to end users/consumers, emerges nowadays as one of the most promising solutions, although their implementation in practice is sometimes challenging (Booz, 2010).

The different schemes for allocating these end-user subsidies are often times hard choices like what segment of users should get the subsidy (e.g. percentile of low-income population or a specific category, like the students or elderly citizen), as well as what means of personal identification to use and what secure channels to distribute the subsidies (e.g. bank accounts, mobile phone accounts, top-up cards, etc.). It can make the practical implementation of these schemes quite difficult (Muente-Kunigami and Navas-Sabater, 2010), but there are several successful examples of the above schemes being deployed in Japan, South Korea, Singapore and other best-in-class digital economies (Booz, 2010). In contrast, direct cross-subsidization of services/products offered by the mobile operator, for example, offer in the end almost the same benefits and are easier to implement (Muente-Kunigami and Navas-Sabater, 2010). We will review this approach in the dedicated section of this dissertation on Policy Implications.

13.2. Summary of factors affecting the diffusion of

innovations

The literature review allowed identifying seven major categories of factors. These factors, along with the description, the effect on diffusion and the research references, are presented in Table 2.

In order to build a more realistic and robust diffusion model, the literature review has to be completed with a qualitative analysis, allowing to supplement and refine the list of factors/variables identified. In addition, taking an exploratory approach to the phenomena can help revealing other unknown connections among different variables being measured.

The next section presents both the rationale for and the findings from the interviews conducted with industry experts and practitioners.

Table 9: Factors affecting the diffusion of innovations, as identified in the literature review

	Factor	Effect	Selected Research
Product-related factors	Advantage/value-added	Positive	Jain, Mahajan and Muller, 1991; Henard and Szymanski, 2001;
	Innovativeness	Mixed	Robertson, 1967; Cooper and Kleinschmidt, 1987; Montoya-Weiss and Calantone, 1994; Joshi and Sharma, 2004;
Marketing factors	Price	Positive	Bass, 1980; Bass and Bultez, 1982; Kalish, 1985; Horsky, 1990;
	Word-of-mouth	Mixed	Bass, 1969;
	Advertising	Positive	Horsky and Simon, 1983; Kalish, 1985;
	Distribution	Positive	Jones and Ritz, 1991; Lilien, Rao and Kalish, 1981;
Industry factors	Network externalities	Mixed	Le Nagard-Assayag and Manceau, 2001; Rohlfs, 2001; Katz and Shapiro, 1985; Xie and Sirbu, 1995; Goldenberg, Libai and Muller, 2010;
Economic factors	GDP (high)	Positive	Golder and Tellis, 1998; Clarke and Wallsten, 2006;Qiang and Rossotto, 2009;
	Gini index (low)	Positive	Chandrasekaran and Tellis, 2009; Tellis, Stremersch, Yin, 2003;
	Budget available for telecoms (high)	Positive	Fuss et al., 2005;
Demographic factors	Population heterogeneity	Negative	Tellis, Stremersch, Yin, 2003;
	Population growth	Positive	Mahajan and Peterson, 1978; Sterman, 2000;
Cultural factors	Uncertainty avoidance	Positive	Hofstede, 1980; Ganesh, Kumar and Subramanian, 1997; Parker, 1997; Tellis, Stremersch, Yin, 2003;
	Individualism	Negative	
Regulatory factors	Financing Schemes/ Subsidies	Mixed	Kalish and Lilien, 1983; Laffont and Tirole, 2000; Estache et al. 2002; Navas-Sabater et al., 2002; Muente-Kunigami and Navas-Sabater, 2010;
	Standardization	Mixed	Saugstrup and Henten, 2004; Gans, King, and Wright, 2004; Rouvinen, 2006;

Exploratory Study

14. Interviews with Industry Experts

The literature review presented earlier is essentially grounded in the theories of diffusion of innovations and reviews of diffusion models. These had been developed based on available statistics and datasets on innovative products. Few allow exploring the perceptions of decision makers in the telecommunication industry and their opinions on factors affecting the diffusion of innovations.

It seemed necessary to confront the findings from the literature review in the previous chapters with those of practitioners. The aim is to improve our understanding of the diffusion process, taking into account industry experts' views on innovations in the telecom sector and major factors affecting their diffusion. Given the complexity of phenomena under study, a qualitative approach seems to be the most appropriate (Hart, 1987). Therefore, we chose to do the interviews in a semi-directive way, as well as in an open-ended format (Briggs, 1986). The questions were mainly addressing the identification of factors affecting the diffusion of technological innovations.

A total of 22 exploratory interviews have been conducted with industry experts, each representing a major player in the telecommunications and ICT industry. At the time of the interview, the interviewees were holding managing and executive positions in their companies and/or had a significant knowledge in the field of innovation.

This section presents the methodology used to conduct the exploratory study and discusses the findings from the interviews.

15. METHODOLOGY USED FOR THE EXPLORATORY STUDY

15.1. Objectives of the study

The overall objective of this study is to explore the perceptions of practitioners, industry experts and decision-makers in the telecommunication and ICT sector, on what are the major factors affecting the diffusion of innovations on the international arena. Once we've selected the qualitative methodology to explore their perceptions and opinions, we've established an interview guide and proceeded to gathering information by interviewing people/companies on the list we've put together beforehand. Specific choices of companies and people to be met are explained below.

15.2. Gathering information from innovation experts

15.2.1. Semi-structured interviews

In order to attain the objectives stated above, the interviews were semi-structured and conducted with a fairly open framework which allowed for conversational, although focused, two-way communication. The interview guide included a predefined set of open-ended questions, some phrased beforehand and others arising naturally during the interview, allowing for the flexibility to probe for details or discuss issues. Following the *saturation* principle, we stopped conducting interviews when the information gathered was getting too repetitive and bringing no/or few novel insights.

15.2.2. Interviews conducted

All the interviews started with a short presentation of the present research in the field of telecommunications and ICT and how does it fit into a broader research agenda on the international diffusion of innovations. Almost every interviewee started by recalling/identifying one or two technological innovations to discuss. Most of them came up with the most recent (and probably most revolutionary) one in the telecommunications industry: Apple's iPhone. Overall it seemed that it was easier for the interviewees to put a name on a technological innovation and/or new product they wanted to comment on. Other examples often discussed were: the GSM and 3G technologies, the RFID and NFC technologies, the e-ID, the i-mode, mobile banking and mobile payment services.

15.3. Interviewees' profile

Since this was meant to be an exploratory study, there was no ambition to target a specific group of people or firms and the final sample is not necessarily representative. However, the choice was guided by the idea of interviewing a variety of actors who are part of the value-chain in telecommunications. This industry is highly fragmented and contains a large number of market actors involved in offering end-to-end solutions to the final user. Table 10 below dresses a rapid overview of these different groups of actors and present their respective roles:

Table 10: Actors in the telecommunications/mobile services value-chain

Device Manufacturers:	Providing the actual device through which users can access the mobile services, the handset manufacturers are the ones concerned with developing a wider variety of functionalities, able to support new applications and services with innovative features.
Network Operators:	They provide and maintain the running telecom infrastructure and are administering services in it.
Service Operators or Access Providers:	Since often times they do not own spectrum and/or network infrastructure, the access providers have business arrangements with network operators to buy capacity which

	is then sold to their own customers. They also have control over the SIM card, branding, marketing, billing and customer care operations.
Content Providers and Aggregators:	They are responsible for providing the final users with data and information that creates the so-called mobile content. Content aggregators often create mobile portals that are accessible from mobile phone screens and allow navigating through different categories of information. Note that a simple two-way communication via SMS with a service provider implies as well the existence of a database with relevant content for the final user.
Service Providers:	Most of the time, they are offering services through software applications, but for older generations of mobile devices, some services can be accessed/used via SMS only. The service provider will make sure that the service can be used and can be used in a certain quality. A variety of different parties, not only for providing application services but also value-added services, such as mobile payment and mobile banking services, can be found.
Equipment Vendors:	Infrastructure equipment vendors provide the tools for delivering mobile services: platforms, gateways, routers, middleware and other necessary software for the delivery of the expected service functionalities.
Software Vendors:	Technology platform vendors include companies providing operating systems and/or specific enabling applications such as micro-browsers.
Government Agencies/Regulators:	These represent the central authority whose role is to regulate and facilitate the development of standards and technologies that are supporting the mobile services delivery to citizen customers.

Customers:	They are the final users - corporate or individual - and the target of all the telecom services and applications developed through the collaboration of all the actors involved in the value-chain.

15.3.1. Choice of companies to be studied / interviewed

As already mentioned, the telecommunications landscape is rapidly evolving and involving an increased number of actors, each playing complex roles that sometimes overlap. For the purpose of this exploratory study, we tried meeting at least one company representing the groups of actors in the value-chain described above. It seemed important to get a sense of what each group of players had to say about the international diffusion of innovations in the telecommunications industry.

A summary of the companies met and their belonging to a particular sector is presented in Table 11. However, this is just an illustrative mapping, as many companies nowadays have a versatile business positioning that can expand beyond one single sector.

Table 11: Mapping the companies interviewed during the exploratory study

Device manufacturers	Nokia Ericsson
Equipment vendors	Siemens Intel STMicroelectronics Gemalto Avery Dennison
Network and Service operators	Orange Vodafone Telecom Italia Telefonica
Software vendors	Microsoft

Content providers	NXP Google
Regulators	EU Commission The World Bank Forum SMSC ARCEP
Customers	Represented by Mercatel Association
Other actors: Consultants, think tanks, etc.	McKinsey Consulting Intelecon ITIF

15.3.2. Choice of persons to be met / interviewed

In each company, we tried to reach out to persons knowledgeable about innovation and, at the same time, holding a management position or a decision-making role. Since we wanted to explore practitioners' perceptions on the diffusion of innovations in the telecommunications industry, a prior experience/expertise in this area was a pre-requisite for the interview. Also, interviewees' exposure to international markets was privileged, in order for us to obtain a more accurate understanding on the topic. Given the research topic on international diffusion of innovations, the interviews have been conducted in several countries (and continents). In Europe, the interviewees were met in France, Italy, Belgium and UK. In Asia, companies have been interviewed in Singapore. The others have been met in the United States. No interviews have actually taken place in developing countries, since most frequently all of the senior managers and directors interviewed were actually based in their company's headquarters, in developed countries. However, often times they were in charge of a country, region or were even leading a global initiative.

Tableau 2 offers an overview of positions held by the representatives of each company interviewed.

Further we present key Findings that are based on the analysis of interviews made and the specific comments and examples brought by our interlocutors. At this point, we did not check back for the accuracy of the statements made, since our goal was to identify their actual perceptions of the reality and understand what makes sense to this community of decision-makers.

Table 12: Detailed listing of companies interviewed during the exploratory study

	Company name (in alphabetic order)	**Position held**	**Country/Region**
1.	ARCEP	Manager for Regulation on Interconnection and wholesale (fixed, broadband, mobile)	France
2.	Avery Dennison	RFID Market Development Manager	UK/USA
3.	Ericsson	Director of worldwide packet technologies research group	Global
4.	EU Commission	Director of Information Society and Media	Europe
5.	Forum SMSC	Managing Director	France
6.	Gemalto	Executive Vice-President (EVP) Operations	Global
7.	Google	Head of Global Development Initiatives	USA
8.	Intel	Manager for Intel World Ahead	USA
9.	Intelecon Consulting	Director of Consulting and Partner	Global
10.	ITIF	Foundation President	USA
11.	McKinsey Consulting	Manager	Europe
12.	Microsoft	Director for Humanitarian Systems	USA
13.	Nokia	Senior Manager for Emerging Markets	Finland
14.	NXP	Segment Marketing Manager RFID at NXP Semiconductors	Germany

	Company name (in alphabetic order)	Position held	Country/Region
15.	Orange	Marketing Manager	Europe
16.	Mercatel Association	Director	France
17.	Siemens	Innovation Manager	Germany
18.	STMicroelectronics	Secure mobile and NFC Marketing Manager	Switzerland
19.	Telecom Italia	Director, Future Center	Italy
20.	Telefonica	Manager	Latin America
21.	The World Bank	Manager of the Global ICT Unit	Global
22.	Vodafone	Manager	Latin America

16. Findings from the Exploratory Research

The following section is dedicated to the presentation of identified common points among the different interviews.

16.1. Converging Views on Innovations in the Telecommunications and ICT sector

There is a common understanding among the interviewees that innovation is being driven by the exponential growth in the reach of mobile phone networks and the new era in information and communication technologies fostering economic growth and citizen participation.

Mobile phones are extending outreach beyond just voice and represent today the leading means of internet access - providing for email, market or weather data, and service access – therefore expected to contribute to closing the digital divide. This is particularly important when speaking about the 3G mobile phones. 3G wireless is not only faster and more efficient, but is often considered a wireless version of the

Internet, encompassing Web browsing, media downloads and electronic credit/debit card. Knowledge of the user's location via 3G wireless takes this much farther, offering the ability to provide enhanced value-added services.

Mobile phones are thus no longer a luxury good but an essential utility for the poor including those in low-income countries. Despite the fact that the role of mobile technology in advancing economic development and alleviating poverty has been increasingly recognized, a striking heterogeneity persists in its diffusion patterns around the world. Interviewees agree that gaining more understanding on the factors affecting the diffusion process is a major step forward in extending reach and increasing access to mobile technology and ICT in general.

- **Diffusion process is a complex phenomenon and there is heterogeneity in the international diffusion patterns**

While in the developed world, mobile communications were introduced as a convenient way to complement access to fixed networks, their impact has been transformational in emerging economies, where the large majority of the population still has limited access to traditional telephone services.

Mobile technologies present a game changing opportunity for both developed and developing countries. Interviewees argued that the implications for transforming sector operations and service delivery were profound. The implications for how world economics may change as a result are only just coming to light. It is critical to unleash the power of innovation and find ways of speeding-up the international diffusion of mobile telephony. As for today, the majority of interviewees saw the diffusion process as a complex phenomenon, with the mobile technology exhibiting a striking heterogeneity in the international diffusion patterns.

Although each interviewee had an individual approach to innovation and diffusion in general, a pretty common vision on how things work within the ICT and telecom sector emerged.

- **Everything operates within an ecosystem**

Almost everyone we've interviewed argued that telecommunication industry operates as an ecosystem, with a large number of actors involved, each playing one or several roles in this highly interrelated environment. While the definition of a telecom ecosystem might have been blurry for some of the interviewees, it was clear that the concept is far from irrelevant. In the matter of fact, it helped clarify the dynamics needed along the value chain, as well as each player's role in maintaining a thriving industry. As they see it at Ericsson: "Telecom ecosystems aren't really about the survival of the fittest - it's about the survival of those who are best at adapting."

Indeed, in such a systemic industry as telecommunications, complex interactions within the ecosystem players may arise, leading to market failures and unsuccessful diffusion of new products, among other things. In the context of diffusion of innovations, seemingly unrelated components of the ecosystem, both at the market and country levels, interact with each other in unexpected ways. Mitigation measures and policy decisions made with a narrow focus on one part of the system can often produce unanticipated effects that ultimately feed back to make the original problem worse. For example, the European Commission's decision to regulate international roaming prices in 2007 is nowadays considered to have been counterproductive (GSMA, 2009). Partly driven by the belief that mobile markets are uncompetitive, the European Commission adopted the policy on European mobile operators' roaming prices regulation. Although it did provide immediate roaming minute price flattening across Europe, such price regulation is believed to have affected market dynamics in a counterproductive way, inhibiting the evolution of the market and potentially slowing down price reductions over the longer term.

Another example of inefficient Government intervention is the 1920 federal policy in the United States. Originally enacted to suppress the alcohol trade (and therefore reduce consumption), it instead drove many small alcohol suppliers out of business and consolidated the hold of large-scale organized crime over the illegal alcohol industry. The same is true for the "*war on drugs*" policy enacted in 1971 by President Nixon. Forty years later, the Global Commission on Drug Policy released a critical report on the illegal drugs situation, declaring that "the global war on drugs has failed, with devastating consequences for individuals and societies around the world".[8]

- **The network view on the value-chain**

At Telecom Italia they believe that as the world grows more complex, people, industries, economies as a whole, have to find a way of structuring all the activities around". Therefore it comes at no surprise that (Porter's original) value-chain assessment tool is used by most players in the telecom industry with the aim of understanding how they should position themselves strategically amongst their suppliers, buyers, and existing/future competitors. This is of vital importance at national as well as international level, where pressure for competition is greater and heavily regulated. For example, the EU regulation on international roaming tariffs urged the mobile operators in all 27 member states of the European Community to lower the charges for using mobile phones abroad. In the opinion of the EU Commission representative, it's the vertical integration of the value-chain where the suppliers work together, that is sustainable, versus the horizontal integration (involving competitors) that can rapidly reach limits and doesn't provide enough success stories, except for the GSM standardization.

- **Investments and the «chicken and egg » dilemma**

The complex dynamics at play in the process of diffusion of innovations often narrow down to the question of as to how best manage uncertainty related to bringing new products to market: different players may have difficulty determining the best

[8] www.globalcommissionondrugs.org accessed in June 2011.

use of their resources in kicking-off the diffusion process. The majority of interviewees recognize considering very carefully their investments in an environment characterized by such complexity.

According to Gemalto, major companies are still reluctant to pour investments into a market where players have dissimilar conceptions of the need for (or benefits brought by) that investment. At Nokia they acknowledge that there is a need to work together towards a shared understanding in addressing market needs and committing investment resources. Without that, the oft-cited « chicken and egg » problem will persist and thus delay the launch of truly innovative products.

At McKinsey, they think that « for the diffusion to become wide-spread, the chicken and egg problem has to be solved: it's when the suppliers impose a standard to a retailer, who imposes a standard to all other suppliers… » But who should start first ? « For now, there is a complexity in how to put things in place».

The most cited example is the Carte Vitale in France – a health insurance card allowing medical patients to be instantly identified as a beneficiary of entitlements to medical services and medication. It took less than five years to issue as many Carte Vitale as there were inhabitants in France, but beyond the simple plastic card (with an identification chip) there was a heavy administrative machine, processing the medical claims and issuing payments and patient reimbursements. It is believed that because the French Government asked all medical practitioners and pharmacies to comply with the new system and purchase the reading devices for the Carte Vitale, was it able to impose the later to all citizens and ensure its massive adoption. Ultimately, the never-ending "chicken and egg" dilemma has been resolved. Although somehow "imposed" by the French Government, the collaboration of all the players in this complex medical services value-chain was the key to successful diffusion of new smart-card technology.

This understanding is also shared by Telefonica and NXP who believe that there is an obvious hesitation from players on the market to commit investments in really new products, like NFC. In this context, one can refer to the *penguin effect* or the *herd effect* which as we've seen has been studied in the field literature as well.

The widespread diffusion of this standard will only become reality when one, or several, players will overcome the initial confidence barriers. Like in the example described above (Carte Vitale), but also in the context of GSM technology diffusion, Government intervention or industry consortia backing-up the new standard can be instrumental in fostering adoption.

16.2. Opinions on factors affecting the diffusion of innovations

- **Product attractiveness and the marketing mix**

During the interviews, a major emphasis was put on determining what enhances product attractiveness in the eyes of the final customers and how does this justify the new product cost. According to Forum SMS, « the terms of equation should include all the elements needed to trigger (and justify) the additional investments ». What will be the final benefit to the customer and will it be attractive enough for him to pay a premium price?

At ST Microelectronic they are concerned as well with the "real selling point" and understanding why would the customer be interested in buying their products. For instance, in the example of the personal computer (PC), since it's commercial launch the price customers agree to pay is more or less the same, year after year. However, the PC itself changed dramatically: it is faster, better performing and has many new features. "Beyond that it has to be really innovative for the customer to accept paying a premium price".

Going back to the mobile phones, the new mobile applications designed to enhance customer experience on the 3G technology should bring an additional value. At Google they believe that "the content you deliver has to be responsive to the audience that you serve: the technology on which you deliver it can very well be a useful one, an appropriate one, and there can be advantages to not having to rely on legacies, but … what's the content on top of technologies ? That's something we sometimes forget about."

It is the same approach taken by Telecom Italia, ensuring that the product that is getting out of the company is meeting some new market need: « Otherwise there is no reason to be on the market. » While the other telecom operators interviewed, Orange and Vodafone, support this view, Google pushes it further, arguing that: « Google for example targets not the average user, they target the power user. That's their model of diffusion. They want people who use their products a lot. They don't just want to go after somebody who once in a while uses Gmail. Instead, they want to go after people, who are using iGoogle, use Gmail, use Gcalendar, etc." It clearly touches upon the innovative adoption by early adopters, which may look like some niche strategy, but in the matter of fact this innovative adoption fuels mass adoption, through the word-of-mouth mechanism. "We did mobile phone for the rich people. But it ended up being adopted by a much broader class of people, but there is a whole range of reasons, very logical reasons why that has worked, and why other technologies don't spread nearly as fast in those contexts."

Meeting some real market need is of primary importance for the diffusion to occur, even in low-income countries. According to the World Bank (2011), in the context of developing countries, "innovation is being driven by a new era in collaborative communication using tools that empower citizens to directly participate in the development process and provide new means of holding governments accountable and tracking service delivery". Indeed, even the simplest mobile phones are apt for this use, as in the example of Tanzania, where Daraja is using mobile phones to track maintenance on existing water pumps. By providing residents with the official spending data on their district pumps and encouraging SMS (or "text") based responses, the NGO can sample – or crowdsource – the population and put pressure on government agencies to perform better. Another example cited by the World Bank, is the Map Kibera initiative, which has embraced a co-creation model to develop a detailed urban needs map of the Nairobi slum whereby local youth draw edits and comments on paper maps, and online community volunteers digitize and render such maps. This process gives voice to the urban service needs of Kibera's residents, under-served before, as official maps marked Kibera homes as a forest area. Mobile phones, combined with innovations such as geolocation technologies and social networks, have begun to show a significant development impact in the emerging economies, fuelling the diffusion of mobile technologies.

Along with the effect of advertising and standard marketing mix, the perceived affordability of the innovative product adoption and cultural aversion to risk-taking and innovation, are the major determinants of product attractiveness.

- **Perceived affordability of adopting an innovative product**

Global overview of diffusion patterns exhibited mobile networks reaching deeper into emerging markets. However, interviewees questioned the affordability of mobile services to low-income groups of the population, to the ones marginalized by social, demographic and geographic contingencies.

At Telecom Italia they believe that "Technologies do not succeed because they are faster, but because they are cheaper." For a technology to reach out to the mass-market « it has never been the functionality, it has been low-cost… The train has changed the world not because it was faster than the coach, but because it was cheaper".

Indeed, several interviewees stressed the fact that functionality and affordability are the two major factors driving massive adoption of innovations. It is believed that the prohibitively high upfront cost of mobile phones has slowed down the penetration rates in the developing countries. Despite a growing array of ultra low cost handsets, like Motorola (retailing for $15 in India and Africa), mobile handsets are still too expensive for many users. This might be the reason for the emergence of some very successful local initiatives, such as the Village Phone, created in 1996 around the idea of combining microfinance and mobile technology in order to micro-franchise access to mobile services. Its goal was to enable entrepreneurial women in Bangladesh to start a business through the purchase of a mobile phone with financing from the

Grameen Bank. Becoming "virtual operators", these Village Phone intermediaries would charge other villagers for using mobile services, generating revenue that enabled them to pay back the loan and often make a sustainable profit. Fifteen years later, the network has grown to over 270,000 Village Phone operators in 50,000 villages across three countries, demonstrating how mobile technology can benefit poor people at the bottom of the pyramid.

Donors like The World Bank and European Commission argue that the world is now well on the path to increasing accessibility and affordability. Opinions converge on the fact that gaps in accessing the newest mobile technologies make it difficult to reap the full benefits of a highly functional and effective ICT sector, preventing emerging economies from capitalizing on innovative applications to improve service delivery in both the public and private sectors. However, there is a shared understanding among development agencies that the innovative technologies and business models have the potential to drive down the cost of mobile ownership.

This should be possible not only for the existing 3G mobile phones, but also for the newest products based on emerging technologies, such as 4G, WiMax and others.

By lowering the upfront costs of handsets and by creating flexibility with pay-as-you-go airtime and phone sharing, players in the mobile value-chain can increase households' budget available for the mobile services and communication. This in turn can enhance the social and financial inclusion of the poor and will ultimately provide a powerful platform to bridge the gap between the developed and developing countries.

According to The World Bank, defining the affordability threshold for a certain income group or in a given geographic area is important for estimating the market efficiency frontier and thus for designing appropriate subsidy schemes. While many are concerned with how to make services available to a specific population or region (supply-side perspective), the issue of whether potential customers will be able to pay for services on a sustainable basis is rarely tackled and needs more focus from players in the ecosystem.

- **Perceived risk of failure and switching-back cost**

The perceived risk of failure can minimize firms' commitment to invest in the development of a totally new product. At ST Microelectronic, if an innovation does not yield a straightforward return on investment (ROI), then it is perceived as too risky and not worth the effort. « In today's capitalist world, one has to believe in the success of the enterprise » and expect that the investment made brings up more value to the customer than it costs him. To illustrate this purpose, several interviewees quoted the example of Wall Mart's « successful failure ».

In the matter of fact, in 2003 Wall Mart Stores Inc. required its top 100 suppliers to put radio-frequency identification tags on all shipping items, a move that was expected to spur broader adoption of the RFID technology because of Wal-Mart's market clout. The giant retailer envisioned the deployment of nearly 1 billion RFID tags for tracking and identifying items at the individual crate and pallet level, with the primary objective of improving its supply chain flows. Putting its faith in this new technology, Wall Marts requested its vendors to massively invest in RFID tags and supporting technology (i.e. reading devices all suppliers' factories, warehouses and stores). A vast majority of suppliers perceived this level of effort as too risky, as nothing at that time could guarantee a massive diffusion of the RFID standard. Three years later, due to a tremendous lack of value for suppliers and failure in rolling out the technology on the market, Wall Mart project was trimmed down and eventually aborted.

Changing existing systems for the RFID technology required from vendors improving and expanding (inter-company) infrastructure, covering the cost of tags and readers, changing or adapting corporate processes, etc. – all that with an apparent lack of ROI for Wall Mart's suppliers and high switching-back costs.

This echoes the comments made by Orange representative, who sees the switching-back costs as an important barrier to overcome, along with the lack of confidence in the new product's success.

Furthermore, NXP acknowledges this as an important obstacle to overcome, but it's « not the only bolt to be fixed in the system ». Other factors pertaining to social, economic and regulatory fields may play an important role too.

- **Existing legacies**

The barriers to the diffusion of new technologies can be those harvested from existing systems and legacy communication infrastructures. Several interviewees brought up the example of the successful mobile banking service in Kenya, where the absence of an established banking infrastructure favored the emergence of innovative payment and banking services delivered on the mobile network. This is of great importance for a country where safe, reliable traditional banking has historically been limited, and often available only to the wealthy.

Meanwhile, in the developed countries, mobile banking hasn't gained much traction yet. For instance, many argue that in the United States, people will continue to use checks, credit cards and cash rather than adopting yet another system for their mobile devices. It may also be the case in France, according to Mercatel, who believes that countries with less technology legacy can actually leapfrog to the next generation of communication infrastructure and services. Gemalto cited the example of telecommunications in India, where several states passed from no telephone line at all, to mobile coverage accessible to everyone.

- **Monopoly / dominant position**

At Orange they watch closely the case of the Japanese NTT DoCoMo's successful mobile wallet service, called *FeliCa*. Months after its commercial launch in 2004, this highly innovative, technological service encountered a huge popularity among Japanese users, with a total subscribers' base in 2010 reaching 126 millions.

But FeliCa has a huge advantage in being owned, end to end, by DoCoMo who developed FeliCa in conjunction with Sony, and delivered FeliCa handsets pre-installed with the EDY stored-payment system from BitWallet (also developed by

DoCoMo). Later on DoCoMo offered its own plastic credit card, exhibiting strong links to the banking system. Operator's profits rose instantly and justified the investments made in the new technology. Owning every part of the value chain is the best way to make profits out of it. Indeed, if NTT DoCoMo managed to launch *FeliCa* on the market under extremely favorable conditions to every adopter's segment (free for the less rich, etc.), it could afford this because of a strong vertical integration and dominant position on the market. The other players had to accept these game rules or lag behind. This example of classic telecommunications monopoly, but also market dominance and commercial power over suppliers and providers, made the diffusion of *FeliCa* service among the fastest known to date. As a result, we have a situation in Japan where DoCoMo has, for reasons partly of its technological and strategic foresight and partly of its sheer size, achieved a re-monopolizing of the communications environment.

Minitel in France had a similar success story. Launched in the'80s by France Telecom – a Government-owned telephone company – the service replaced telephone books, containing every telephone listing in France. Besides, *Minitel* featured on its screen transportation schedules, as well as other practical information and daily news. The early terminals featured a (tiny by today's means) black-and-white screen, a fold-up keyboard and a 1,200 bps modem. Despite these low-key features, *Minitel* penetration rates in France were impressive and the service was still in use in the mid-'90s. It's not until the competitive and innovative features of the Internet eclipsed the ones of *Minitel*, that the market dynamics could regain a healthy competitive boost.

- **Cultural characteristics of a country**

Like FeliCa, the *i-mode* is another innovative Japanese product that has been often cited by the interviewees. The *i-mode* was launched in 1999 and stands for a wireless portal, that can be accessed just like an Yahoo or Hotmail portals on the web, except that here it is wireless. In the matter of fact, the American operator Sprint was the first in the world to offer a wireless internet portal. However, the extent of *i-mode* popularity, at least in its early days, had nothing comparable to either Sprint, or Yahoo and Hotmail mobile portals.

Mercatel believes that in this case what made a real difference were the cultural characteristics of the country where the diffusion of innovations was to take place.

A number of very innovative products, such as Digital TV and LED lighting technology, took off more rapidly in a country than in another. For instance, in the telecommunications sector, the usage of mobile data and wap portals on high speed mobile networks became very popular in Japan, with services such as *i-mode* and *e-wallet* hitting dozens of millions of customers in less than two years after their commercial launch.

Even a decade later, these figures on mobile users sound unrealistic for many European countries. Mercatel believes such scale of usage may never happen in France, or other countries in the region.

Telecom Italia explains these phenomena by a « cultural difference », by simply acknowledging that « Japan is more « geeky ». The same view is shared by ST Microelectronics and Microsoft who see Japanese customers much more prone to adopt really innovative products.

Although it is probably the most difficult to isolate and measure, cultural factor is recognized to play a critical role in the diffusion process. At Gemalto they believe that « cultural differences have a significant impact on behaviors and attitudes towards using technological applications ».

- **Uncertainty avoidance**

One important cultural aspect mentioned by the interviewees is linked to the ability to embrace uncertainty and risk and to adopt a new product with confidence. This is something that « lacks » in many European countries like France. Interviewees brought up the example of the French pass *Navigo*, used primarily in the metro system in Paris. The diffusion of this smart card faced exacerbated challenges due to negative media coverage and consumers' rather irrational worries about « being tracked and spied on ». Speaking about this service, Orange argues that these fears were unjustified, since no data gathered had had a nominative value, and that the whole national paranoia was based on cultural characteristics, such as risk aversion.

- **Cultural individualism**

This is a factor that had been cited most of all in the context of imitative adoption and influence by peer adopters.

Another interesting interpretation of this cultural dimension was given by the Vice-President of Gemalto who sees in the cultural individualism a national determinant of the capacity to work together in a team. Indeed, cultural individualism is the opposite of the collectivism which, according to the initial definition by Hofstede (1980), is the degree to which individuals are integrated into groups. Therefore, Gemalto believes that this cultural factor plays a significant role in the ability to form constructive working groups and create efficient consortia. The latest being instrumental in setting up the innovation ecosystem and thus kick-starting the diffusion process.

- **Income inequalities and purchase power parity**

The definition of low income below US$1/day was established as a metric of poverty by the World Bank already decades ago. But assessing poverty level proved not to be that simple, since this notion has to also encompass other measures, such as access to health, education, employment, and recently, ICTs. Moreover, the United Nations Development Programme (UNDP) provides compiled a list of over 200 indicators for defining the Human Development Index, that every year ranks countries on a multi-dimensional scale according to their level of poverty. With respect to the mass adoption of the ICTs, income level and sustained financial ability to pay for both the technology/device and the service charges are critical. In the matter of fact, these factors have been repeatedly cited as essential in the diffusion of innovations, since they are directly related to the budget available for telecommunications services.

While significant progress has been made in the mobile sector in the recent years in terms of access (network coverage), price of the mobile device and affordability of mobile services, much remains to be done in order to extend the **fraction of population financially able to adopt.**

According to Gemalto, the imminent launch of new low-cost 3G handsets, that integrate mobile web and media functionalities (live TV and FM radio reception) with basic voice and SMS services, will encourage mass market uptake in emerging markets. For instance, Nokia is keen at addressing the price-sensitive consumer segments in developed economies and launching low-cost TV handsets for the World Cup in South Africa and the Cricket World Cup tournament milestones in 2011, believing this can put 3G phones and mobile TV in reach of consumers around the world. Ironically, the 3G was for long considered not to have a direct impact on the poor due to the high costs. However, these times changed and now the majority of companies interviewed believe that innovations around broadband mobile access is likely to have a significant impact for both development workers and poor people themselves.

The World Bank reports cases of community-run networks that provide mobile voice telephony and low cost data networking to local villagers, offering opportunities for employment, self-reliance and improved access to communication. These networks do not only enhance entrepreneurship, but also help to retain the income and profit within communities. Nevertheless, governments and local authorities should take the lead and work together with the private sector in delivering affordable access to the population. Most interviewees stressed the fact that both accessibility and affordability mobile communications should be a priority policy action in developing countries. And that this has to be done with the concourse of the private sector (local and international operators, other SMEs in the value chain, individual entrepreneurs, etc.)

- **Access to knowledge : consortia, working groups and self-organized networks of experts**

Another factor that was highlighted during the interviews was the access to global knowledge and expertise. Although it is more likely to impact the innovation sources (as discussed in the first part of this dissertation), the emergence of consortia, working groups and self-organized networks of experts has been judged by the interviewees as critical in the diffusion of innovations.

For example, Google believes that today, knowledge is dispersed, it's decentralized, it's de-concentrated, it's inherently spread out. There are clusters of knowledge in lots of different places. The question is how to reach out to those communities and clusters of experts and gain access to that tremendous amount of knowledge?

At Google they believe that in order to benefit from that large experience slash knowledge repositories one has to leverage the so called *self-organizing networks*. In this context, these networks consist of interconnected organizations, such as commercial firms, universities and government agencies, which create and integrate diverse knowledge and skills required to for innovation.

Moreover, as the demand for such innovations is growing rapidly around the world and for some of them so does the potential developmental impact, efforts are needed to bring these new ideas and projects to scale. While this is consistent with the role of the development agencies, their internal capacity is limited. For instance, at The World Bank the internal capacity may have difficulty keeping pace with the speed at which innovations are created by the private sector and individual social entrepreneurs. There is therefore a critical need to bridge the fast growing demand for innovations, with the vast amount of willing external expertise available globally to advance knowledge and develop innovative technologies and services to benefit both developed and developing countries. However, often times the expertise is scattered and is not being leveraged in a systematic way that developing countries can benefit from.

Companies like Intel, Google and Microsoft believe that collaborative social networks today have turned information consumers the world over into information providers; creators of content in continuous feedback with the world around them. Ideas and people are coming together to deliver public goods from unexpected sources; from the creation and free dissemination of Wikipedia on internet to the self-organized networks and communities supporting Open Street Map software in Afghanistan, Haiti and other challenging areas around the globe. Therefore, knowledge and tools are genuinely becoming democratized: beginning to be accessed, co-created and shared in entirely new ways.

This understanding is also shared by development agencies, such as The World Bank and the EU, in the sense that collaborative networks can play a catalytic role in enabling stakeholders to share, comment and provide feedback on development services and to contribute to the design of their own interventions.

- **Consortia**

Most of the time consisting of industry groups and regulatory entities, a consortium aims at supporting a technology or a specific standard. The most well-known example is the GSM Association – a global body encompassing the leading wireless communications standard in Europe. While promoting the GSM platform for digital communications around the world, the consortia represents the interests of over 400 GSM, Satellite and 3rd Generation networks operators, regulator and administrative bodies. This is probably one of the most successful examples known to date on the effective collaboration among industry partners and their competitors. At ST Microelectronics they see consortia as the most effective way of bridging towards otherwise distant areas in the value-chain. Potential conflict of interests among the competitors can be neutralized by signing an MOU (i.e. *memorandum of understanding*) between two companies that are on the same market and business niche.

At Siemens they find this approach quite surprising: "it needs to be a partner, not a competitor, since only a partner brings in the competence and the value one needs to work. And the partner needs to harvest as much as the others from that value chain. Otherwise the chain will break".

Rather, actors like Siemens, Nokia and NXP see the future of collaboration towards effective results, in setting up the so-called *working groups*. This is also something claimed by Mercatel who believes that working groups are instrumental in the emergence of technology standards and realistic business models.

The representatives from Forum SMS and ARCEP stressed the importance of following a set of rules and codes defined by the members of the working group, who should all be able to apply their own business logic to the emergent technology. In this circumstances, government's role is to make sure that the end users' interests and rights are well-understood and respected (e.g. customer privacy, access to personal information, etc.)

On mobile operators' end, Orange supported the idea of working groups because they can facilitate the emergence of a sustainable ecosystem. The example of *Pegasus*, *Ergo Sum* and *Ulysses* working groups in France is the most often cited. These have been established in order to advance the consolidation of the NFC contactless technology in France and the emergence of several innovative applications in the area of mobile payment, mobile ticketing and electronic identification. While their initial focus was on the definition of functional and technical specifications, thanks to government back-up (e.g. Luc Chatel initiative), the working group open to representatives from the civil society and customers' associations, taking the debate to the next level.

Another objective for these working groups is to facilitate the emergence of a sustainable business model and affordable prices for the end users.

- **Collaboration with the academia**

While talking broadly about innovation, interviewees mentioned the need for closer ties between national agencies and universities/research centers. This collaboration is seen as extremely fruitful in the early stage of product development, proof of concept, prototyping, and more generally R&D&D (research & development & demonstration). However, the main objective is to foster increased partnerships and collaboration among academic, public and private sectors in the area of next generation products and services. Most companies interviewed have established such type of partnerships.

For example, Intel recently announced its support of U.S. President Barack Obama's "Change the Equation" campaign, which focuses on improving science, technology, engineering, and math (STEM) education in the U.S. The company is funding national research efforts jointly with other companies, such as IBM, Micron, Texas Instruments. Intel's $2M/Year cash contribution is chartered to invent at American universities, and transfer to the private sector, the next generation of computing technology so that transistors manufactured in the year 2020 are dramatically smaller and use less power than today's.

- **Regulation and well-targeted policy levers can have a tremendous impact on the diffusion of innovations**

In a strikingly large number of countries, the policy and regulatory provisions do not respond to the challenges and the potentials of ICTs discussed above. According to ARCEP, Government agencies either fail to recognize the potential of mobile technologies or are unable to design appropriate policy mechanisms. McKinsey reports that as for today, a significant share of developing countries still have local authorities in control of incumbent operators, thus preventing healthy competition. Inversely, in some other countries, few operators collude on prices and services thus distorting market dynamics. Governments and regulators are expected to step in and restore confidence by leading the way towards increased accessibility and affordability of mobile services in emerging economies.

○ Subsidies/Resource Allocation

The question of whether Governments should support the diffusion of innovations through any policy mechanism did not make unanimity among the interviewees. Old perceptions on public resource allocation and subsidy schemes continue to alert against potential market distortion scenarios. However, recent developments in the telecommunications industry around the world call for a revival of public policy actions, especially in the domain of universal access and universal service extension. For example, Government of France recently engaged into a sector-wide operation aimed to provide the lower-income population with access to mobile services at a *social tariff* (i.e. affordable prices for mobile communications targeting France's 1.2 million homes on basic state benefits).

Nokia acknowledges that the combination of prepaid subscriptions and regulatory policies favoring service take-off has boosted penetration in a series of emerging countries. On the other hand, it is clear that « prepaid services are generally priced far above the ability to pay of the average poor », inducing cost-cutting strategies such as beeping or SMS-ing, or avoiding mobile outgoing calls altogether. Mobile operators like Orange and Telefonica, with a large subscribers' base in developing countries, are aware of these practices. But regulators insist on the need for a sustainable approach favoring pro-poor access to mobile telephony in its full capacity, encompassing the broad opportunities offered by the 3G technology for instance.

At the EU Commission, the understanding is that governments should make policies focusing on affordability a national priority, as reducing tariffs will stimulating the introduction of commercial innovations for low-income groups and extend the reach of mobile services to the poor.

Government interventions have been also mentioned in domains other than subsidy mechanisms. Siemens recall the case of Korean government who put in place the enabling regulatory and institutional environment for the roll-out of its ambitious fiber-to-the-home (FTTH) programme : "they decided that FTTH is a must have and they are the first country in the world that started countrywide roll-out".

Citing the example of the biometric passport, ST Microelectronics calls it a « force-by-law business ». There is a belief that if the Department of Homeland Security in the USA didn't require a biometric passport for entering the American territory, the e-passport might have never known such an impressive diffusion rate. Like in the case of FTTH in Korea, Carte Vitale in France, the biometric passport system introduction in the USA illustrates the efficiency of public interventions under specific circumstances. This is a well identified phenomenon where public procurement is used to allow access to a large market, laying the foundation for an innovation to become economically viable and generate economies of scale that will lower the prices of subsequent deployment of the technology.

17. Conclusion on the Exploratory Research

In conclusion, the exploratory research allowed identifying industry experts' views on innovations in the telecom sector and major factors affecting their diffusion, thus improving our initial understanding of the diffusion process.

Overall, the results of the exploratory study are pretty much convergent with the findings from the literature review, and sometimes even complementary, adding new evidence or dimensions to look at. Tableau 3 below details this idea and presents a summary of findings from the exploratory research.

Table 13: Summary of findings from the exploratory study

	Description	Estimated impact on diffusion	Compared to the literature review
Product attractiveness and the marketing mix	This includes the features and value worth the cost and effort to adopt;	***Positive*** when the perception of product attractiveness is high;	convergent
Affordability and economic ease to purchase	Determines the sustainable level of price to bear for accessing the service;	***Positive*** when the perception of product affordability is high;	convergent
Perceived risk of failure and switching-back cost	Relates to the probability of the new product/innovation to fail on the market and the associated cost to switch-back to the initial product/service;	***Negative*** when the risk or of the switching-back cost should the product fail is perceived to be too high;	convergent
Cultural propensity for risk taking	Defines the ease to embrace innovations and take risks as opposed to uncertainty avoidance	***Positive*** when the uncertainty avoidance is low;	convergent
Government interventions and policy actions	Includes different financing schemes, public procurement and interventions such as imposed standardization	***Mixed*** impact as the effect of each policy has to be evaluated in complex and interconnected systems;	convergent

Network externalities, penguin/herd effect	Includes mechanisms that can potentially trigger the diffusion process with direct and indirect externalities fueling the adoption and/or the herd effect taking place and solves the "chicken and egg" problem	***Positive*** impact in the presence of direct/indirect externalities and penguin effects that fuel the adoption;	convergent
Access to knowledge	Relates to the benefits from interacting with consortia, working groups and self-organized networks of experts;	***Positive*** if the value from these interactions can be specifically identified and leveraged;	complementary
Existing legacy and market conditions (e.g. monopoly)	Describes the market characteristics at the time when diffusion of innovations occur;	***Mixed*** effects as this type of characteristic/context is country specific and can trigger both positive or negative outcome;	complementary

System Dynamics Model Building

18. CONCEPTUAL MODEL

Several important variables have been identified from the literature review and interviews with industry experts. While their impact on the diffusion of innovations is difficult to quantify and even more difficult to predict, valuable insights could however be drawn from this exercise. This section presents the conceptual and quantitative model developed, discussing at each stage the approach taken and presenting the assumptions made, with references to the findings from both literature review and the experts' interviews. Of course, not all the factors cited by the industry experts or identified in the literature could be taken into account and actually embedded into the model. More precisely, the last two categories specified in the previous section – the **Access to Knowledge** and the **Existing Legacy and Market conditions** – are the ones that have been cited by the industry and come in addition to the findings from the literature review. Integrating these dimensions into the quantitative System Dynamics model would push this research work in wholly different directions, urging to develop new sub-models and extensions in areas which are not of immediate interest in this dissertation work and for which data is very difficult to collect. They will however be highlighted in the Future Research directions of this research.

We used a system thinking approach to develop a System Dynamics model, aiming for both simple and holistic representation of diffusion phenomena in the specific context of this research. The variables which are ultimately integrated into the model are the ones that make most sense to help understanding the dynamics at play in which we are interested. The developed System Dynamics model philosophy and principles are described in the sections below.

18.1. Model Philosophy and Principles

In this research, we follow the System Dynamics approach to explore the complexity of product diffusion mechanisms. This describes very well the approach taken by System Dynamics modelers. Designed at M.I.T. in the 1960s and originally applied to engineering science, this systems modeling technique enables to assess the implications of policy strategies in complex and highly integrated environments. System Dynamics has repeatedly been demonstrated to be an effective analytical tool in a wide variety of situations, both academic and managerial, and applies best in situations where it is critical to understand the behavior of a system being impacted by some decisions and policy actions.

This type of approach is based on the identification of feedback loops as drivers of complex systems behavior. In this research, our analysis is based on a System Dynamics representation of the product diffusion model proposed by Bass (1969), incorporating two major types of adoption mechanisms: innovative and imitative adoption. Each mechanism contributes in a specific and decisive way to the overall diffusion pattern: the occurrence, timing and speed of a product take-off are entirely linked to innovative adoption dynamics, which later triggers the massive spreading of imitative behaviors. While a majority of adopters eventually base their decision on peers' example, the innovative adoption phase plays a defining moment in the diffusion cycle of the product.

Following the findings by Tellis et at. (2003) on the influence of socio-economic and cultural factors on product take-off, we have focused in this research on the analysis of early diffusion dynamics. Through System Dynamics modeling, we unpack the innovative adoption mechanism, exploring the role of various dimensions (such as income inequality, product affordability, uncertainty avoidance, etc.) in its development. Through literature review and interviews, we have identified and chosen to develop 4 key aspects of diffusion dynamics. The Core diffusion system dynamics model based on Bass diffusion model is therefore extended through 4 new feedback loops (components) reflecting these key dimensions:

Model component 1: **Core diffusion model** (paragraph 19)
Model component 2: **Product accessibility** (paragraph 20)
Model component 3: **Product affordability** (paragraph 21)
Model component 4: **Confidence effect** (paragraph 22)
Model component 5: **Economic leverage** (paragraph 23)
Complement to Model component 1: **Imitation dynamics** (paragraph 24)

19. MODEL COMPONENT 1: CORE DIFFUSION MODEL

19.1. Component 1 rationale

As mentioned previously, the model described by Bass (1969) for technology/product diffusion combines two distinct mechanisms:

- The **innovative adoption process**, in which the potential adopter's interest for the product results primarily from the effect of advertising or from individual investigation on the product characteristics.
- An **imitative adoption process**, concerning potential adopters whose perception of the product characteristics through advertising or direct investigation was not sufficient to motivate the purchase. In their case, adoption behavior was primarily driven by the wish/need to conform to peers' practice.

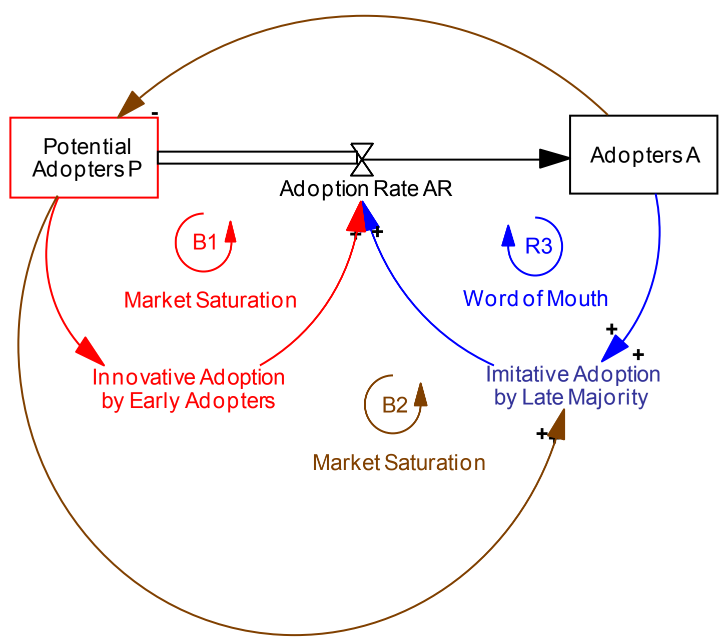
This elementary diffusion component of the model can be considered as its "core", as it lays at the base of consumers dynamics and conceptualizes the major diffusion mechanisms (adoption as a personal choice, which we will call *innovative adoption*, or part of a collective trend, which we will call *imitative adoption*).

The S-curve pattern related to this basic modeling of diffusion has been at the core of many concepts in strategic marketing science for more than five decades. Actually, the logistic shape may be considered as "the quintessence of pattern recognition in many social sciences" (Dattée, 2007).

Although this representation is consistent with the adapted Bass model, it entails the same critics addressed to the classical representation of the diffusion models. For instance, it does not take into account a large number of significant variables in the design of innovations diffusion.

Sterman (2000) insisted on the necessity of integrating and quantifying other diffusion determinants to understand diffusion dynamics. As he explained, simulation is essential to understand complex, nonlinear real-world systems, which cannot be realistically and reliably described by closed solutions or by qualitative discussions.

Figure 17: Bass diffusion model represented with System Dynamics



The Bass diffusion model, used as our model core component, contains three feedback loops:

Loop B1: this balancing feedback loop describes the market saturation process, limiting the innovative adoption process to the actual market capacity: the more potential adopters ➔ the greater innovative adoption rate ➔ the more adopters ➔ the less potential adopters ;

Loop B2: this balancing feedback loop describes the market saturation process, limiting the imitative adoption process to the actual market capacity: the more potential adopters ➔ the greater imitative adoption rate ➔ the more adopters ➔ the less potential adopters ;

Loop R3: this reinforcing feedback loop fuels the imitative adoption dynamics, as the number of adopters potentially spreading the word of mouth keeps increasing.

19.2. Quantitative inputs and parameterization

The core model is a representation of the Bass (1969) diffusion model using the system dynamics based on the following relationship:

$$x_t = p \cdot (N - X_t) + \frac{q}{N} X_t \cdot (N - X_t)$$

Where:

x_t is the amount of sales to potential adopters at time t (“Adoption Rate” variable),

X_t shows the cumulated sales to potential adopters from period 1 to t-1 (“Adopters” variable)

N represents the total market potential, and thus N-X_t represents the number of “Potential Adopters” at time t.

Here p is called the innovation coefficient and q is the imitator coefficient. Their development is discussed in the paragraph 19.3.

Resolution of the Bass dynamics equation yields the general S-shaped function:

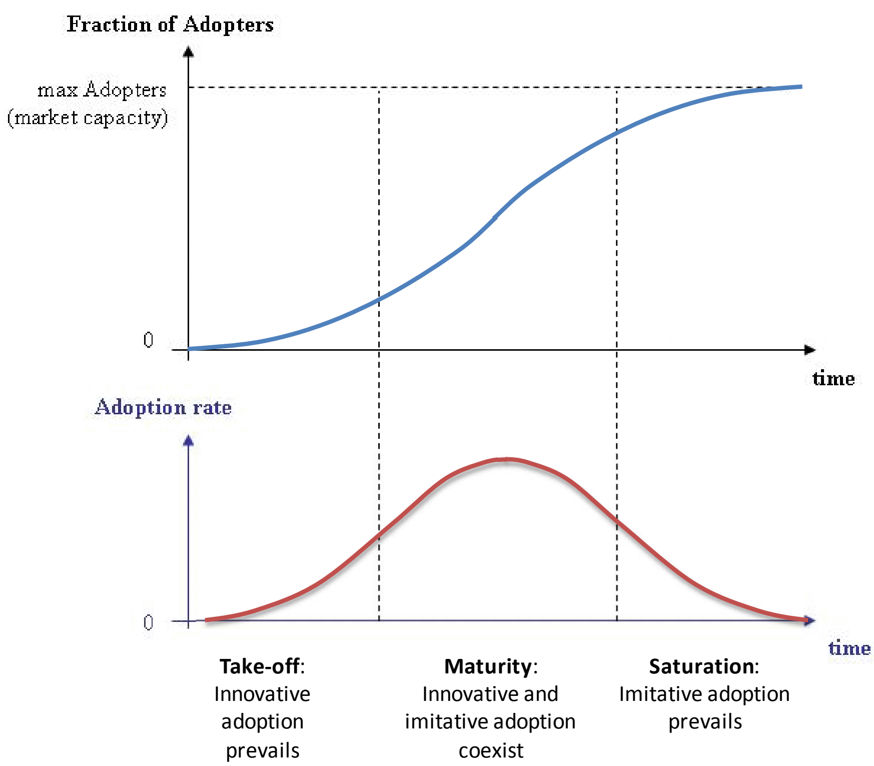
$$\text{Adopters at time t : } X_t = N \times \frac{1-e^{-(p+q).t}}{1+\frac{p}{q}e^{-(p+q).t}}$$

and,

$$\text{Adopters rate a time t : } \dot{X}_t = N \times \frac{(p+q)^2}{p} \frac{e^{-(p+q).t}}{\left(1+\frac{p}{q}e^{-(p+q).t}\right)^2}$$

The standard S-shaped diffusion curve and bell-shaped adoption rate curve associated to these equations illustrate the succession of three main diffusion phases: product take-off phase, market maturity and saturation phases, as shown on the graphs below:

Figure 18: Bass model standard diffusion patterns



Using this system dynamics approach, numerous adaptations of the Bass (1969) model have been proposed (Milling and Maier, 1996; Maier, 1998; Sterman, 2000; Morecroft, 2006).

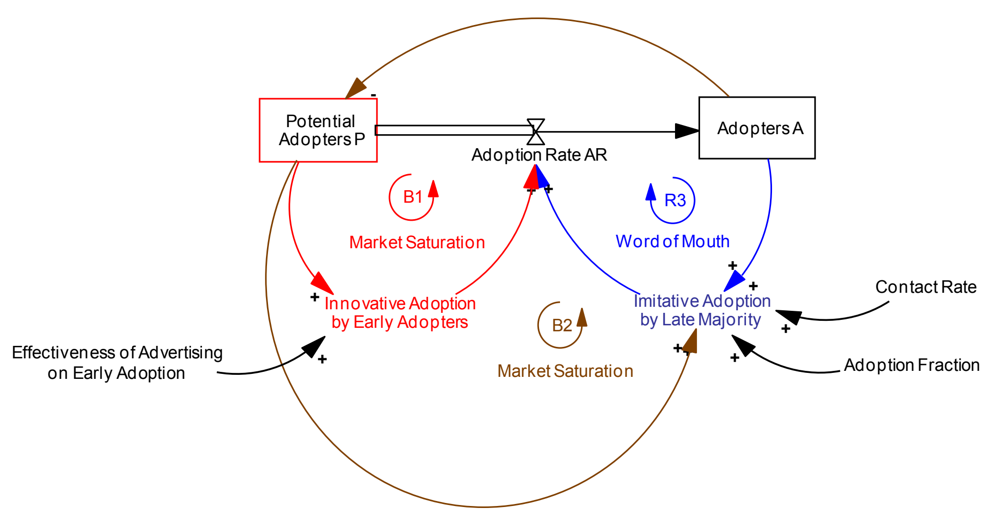
Note: this set of equations would not exactly apply to model described below, in which demographic growths have been taken into account to reflect the natural evolution of market size.

19.3. Bridging towards the other components

In Sterman's (2000) adaptation of the Bass model to system dynamics, the model introduces three factors to parameterize the adoption mechanisms:

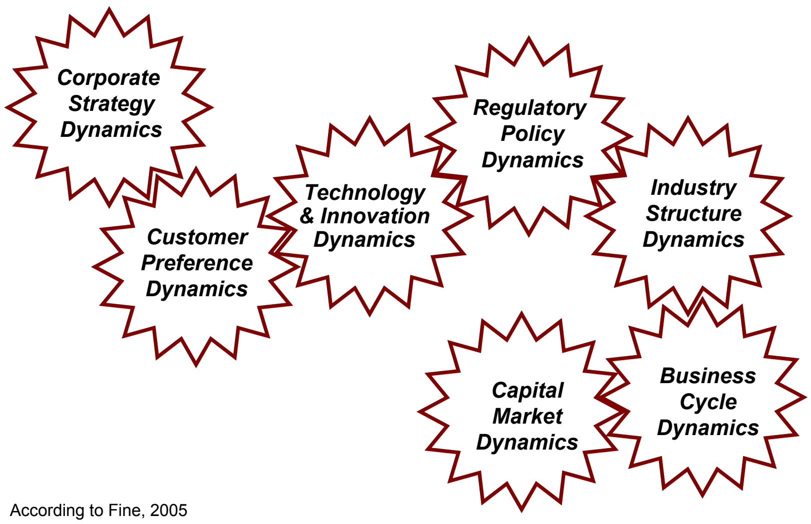
- At Early Adoption level: the Effectiveness of Advertising on Early Adoption (in the mathematical formulation proposed earlier, this variable stands for α);
- At Imitative Adoption level: the *Contact Rate* and the *Adoption Fraction* (in the mathematical formulation proposed earlier, the product *Contact Rate* × *Adoption Fraction* stands for β).

Figure 19: Variables bridging to the core reference model



To develop the model while keeping the focus on demand-based dynamics, we have analyzed the underlying nature of each of its inputs, considering Fine's (2005), representation of product diffusion ecosystem as a set of sector models, or diffusion "gears", articulated as illustrated in the figure below.

Figure 20: "Gears" in the product diffusion system



The Table below identifies the main diffusion "gear" related to each of these variables:

	Supply-based dynamics	**Demand-based dynamics**
Effectiveness of Advertising on Early Adoption	- Corporate Strategy Dynamics - Technology and Innovation Dynamics	- Customers Preference Dynamics
Adoption Fraction		- Customers Preference Dynamics
Contact Rate	*Not product-related*	*Not product-related*

Extensions from the core model have thus been made by exploring the *Effectiveness of Advertising* and the *Adoption Fraction* effects. All connections to the core model have been made at these two levels, as described in the following sections.

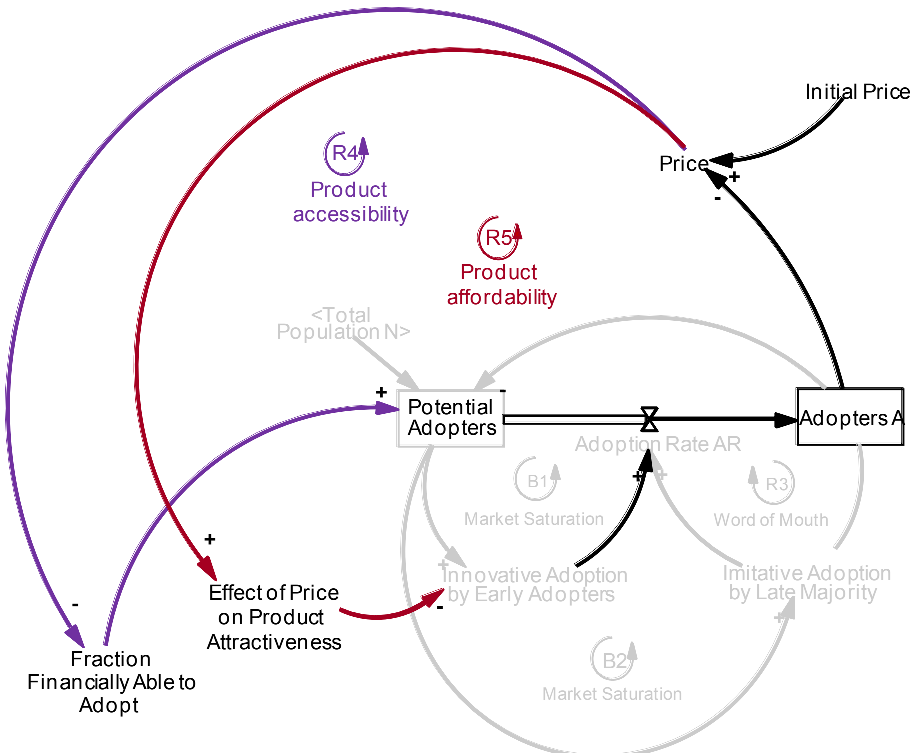
20. Model Component 2: Product Accessibility

As explained in the previous paragraph, we have chosen to focus this marketing research mainly on the demand aspects of product diffusion rather than on supply related dynamics. We focused the analysis mainly on initial product diffusion phases, during which product performance is supposed unchanged. However, the role of "experience" accumulation is significant during these early diffusion stages, in particular as they impact on product price. Production experience leads, through economies of scale (Sterman, 2000), to lower prices, stimulating product diffusion through two closely related mechanisms. These two mechanisms are captured into the model components 2 and 3:

Model component 2: product **accessibility** (impact of economies of scale on the size of the potential adopters base);

Model component 3: product **affordability** (impact of economies of scale on product attractiveness, among potential adopters).

Figure 21: Corporate dynamics feedback loops



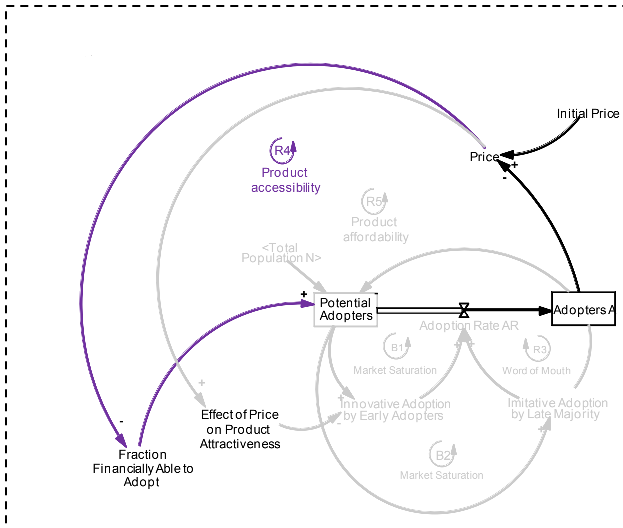
In this research, we have thus put a strong focus on the relationship between price reduction and adoption, by modeling the purchase power patterns across consumers markets. This path was undertaken following the conclusions of Tellis, Stremerch and Yin (2003) on the importance of socioeconomic inequality in the takeoff dynamics of technologically innovative products.

Our general understanding of this correlation property is that a relatively flatter purchase power profile enables to market products for larger audiences (accessibility increase) and it induces more reactive responses (affordability increase) to price variations. This systems dynamics based research gives the opportunity to test this hypothesis through the modeling of the accessibility and affordability components.

The current paragraph 20 focuses on the description of the product accessibility model component, while paragraph 21 discusses the product affordability component.

20.1. Component 2 rationale

This component inputs into the core component 1 at the level of the number of Potential Adopters. The main rationale of this component is to consider that the most significant factor discriminating potential from non-potential adopters is the product accessibility. Product price is itself a dynamic variable, most often declining over time as economies of scale enable companies to reduce production costs. Subsequently, the proportion of potential adopters, to whom the product is affordable, is expected to increase overtime, stimulating sales, and reinforcing economies of scale. This second model component is articulated around this positive feedback loop, named here R4.



20.2. Quantitative inputs and parameterization

Two variables have to be parameterized in this component: *Fraction financially able to adopt* and *Price.*

20.2.1. "Fraction financially able to adopt" variable

This variable is determined as the fraction of population to whom adoption cost is affordable. This is calculated by comparing household available budget for mobile phone expenditures, with the price of the considered product, at a given time. Such data was directly available from the French National Statistics Institute (INSEE) for

France, but in the absence of such detailed data for other countries, a more systematic econometric approach had to be developed and applied for the other countries.

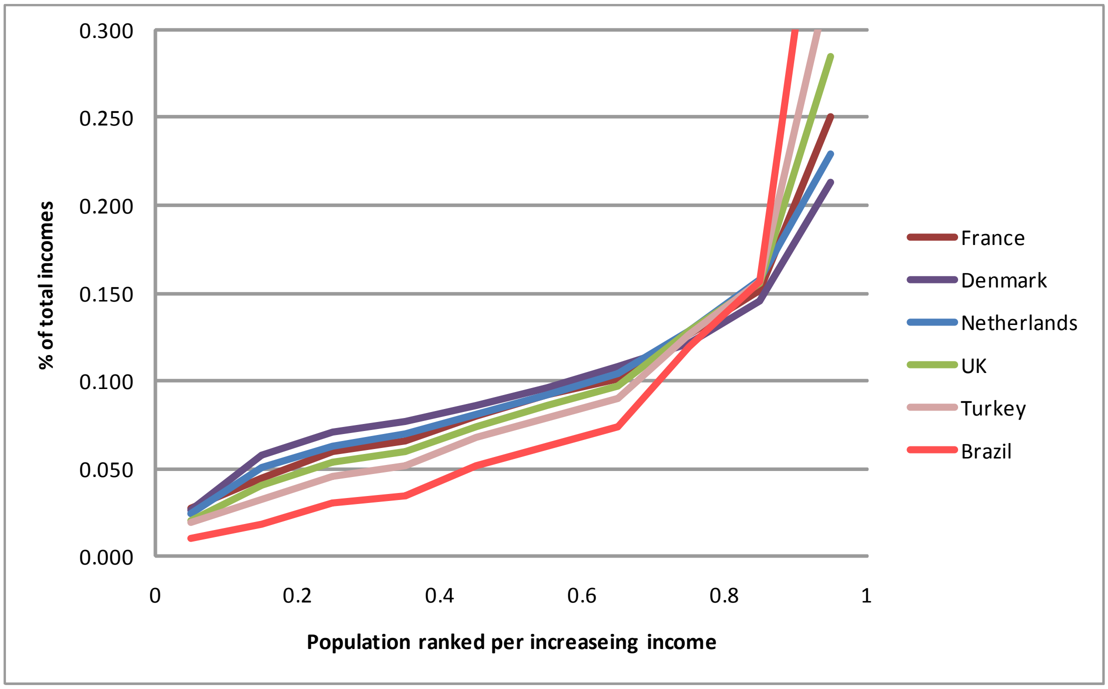
Following GSMA universal access report (2008), we have considered that in average, expenditures for telecommunication represent 5% of households' available budget. The model sensitivity to this assumption is discussed in section 0.

For each country, data from the World Bank and the International Comparison Program (ICP)[9] have been used to determine the population net income profile. Available data provided net values of the five income quintiles, as well as of the first and last deciles. The extrapolation of these discrete values to a continuous income profile curve is necessary to expand under System Dynamics a market hyper-segmentation based on income inequalities. It has been performed by fitting an exponential law to the income share distribution statistics and then inverting the fitted function to extrapolate between income-share values. The steepest curves, in particular in the fourth and fifth deciles, illustrate the most economically unequal societies (Latin America), while the flattest relate to the most egalitarian countries (Northern and Eastern Europe).

Across the middle-range income groups (second to fourth decile), income vary 2-fold in the countries with less inequities (Denmark), up to 4-fold in the countries with highest socioeconomic inequities (such as Brazil). This first observation suggests the potential importance of the elasticity of price on the size of potential adopters' base, as a relevant parameter in cross-country comparison.

[9] This program, spearheaded by the OECD and the World Bank, produces internationally comparable price levels, economic aggregates in real terms, and Purchasing Power Parity estimates for about 150 benchmark countries. The principal outputs of the ICP are estimates of Purchasing Power Parities (PPPs) benchmarked to the year 2005. These estimates are derived from PPPs based upon national surveys that priced nearly 1,000 products and services.

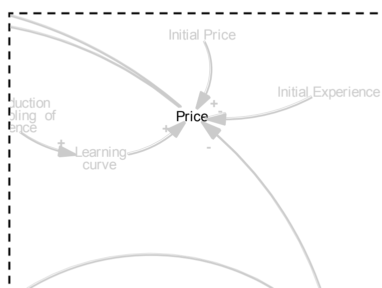
Figure 22 : Income distribution across several of the 17 countries in 2005 – extrapolated curve from cumulated income data per decile/quintile



20.2.2. "Price" variable

20.2.2.1. Initial adoption cost

The total cost of ownership of the mobile phone depends on three main components: the device purchased, the mobile tariff plan taken and the length of the contract. This definition entailed two specific difficulties in the framework of this study:



- First, it combines investment and recurrent costs. The perceived adoption cost therefore depends on a discount rate allocating respective weights to each of the two cost components. This allocation varies significantly across population, and cannot be captured in this research. Our assumption was that adoption decisions were to be mostly driven by the anticipation of recurrent costs, and that investment costs (connection fee, handset purchase when not subsidized) have been spread over 12 months of recurrent costs.

- Due to the diversity of proposed plans a specific methodology had to be developed to calculate adoption costs that would be representative of entry costs for mass consumers and represent comparable levels of service expectations across countries.

Tarifica[10] database have been used to assess adoption costs, combining:

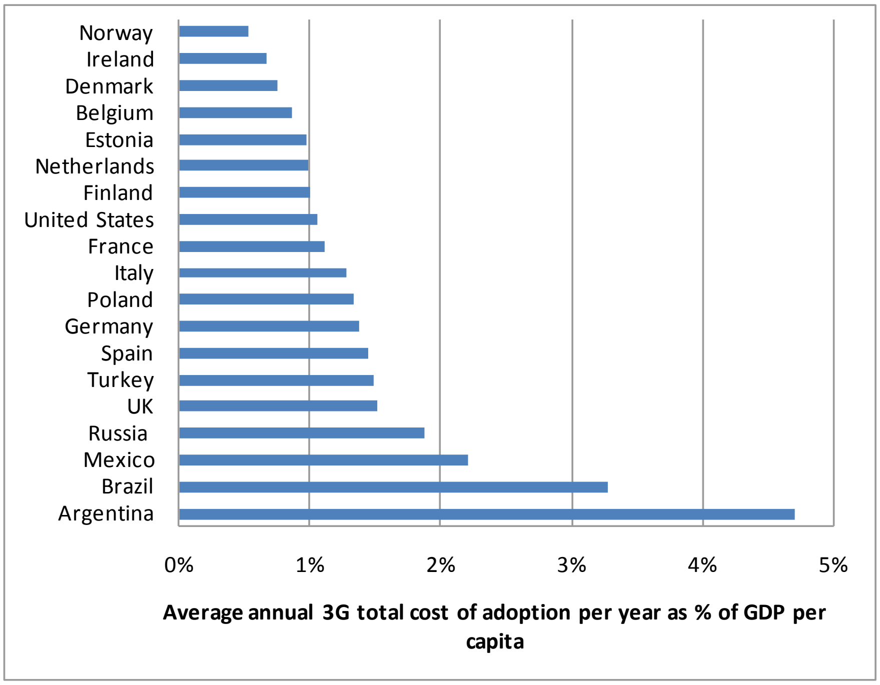
- the cost of the most affordable postpaid plan;
- the cost of the minimum available 3G data package;
- the connection fee (handset purchase cost), spread over 12 months.

Although major adoption cost variations can be observed between countries this has to be put in perspective with the reality of local financial means and purchase power. Such relationship has been reflected in our modeling approach, by taking into consideration both local adoption costs and population levels of revenues.

Despite the adjustment of product costs to local purchase power reality, a certain disparity still prevails across countries. The following figure shows the initial adoption cost of 3G mobile phones, calculated for each country the year of 3G commercialization. This figure puts the costs in perspective with GDP per capita :

[10] Tarifica – Worldwide Telecommunications Tariffs, The Philips Group

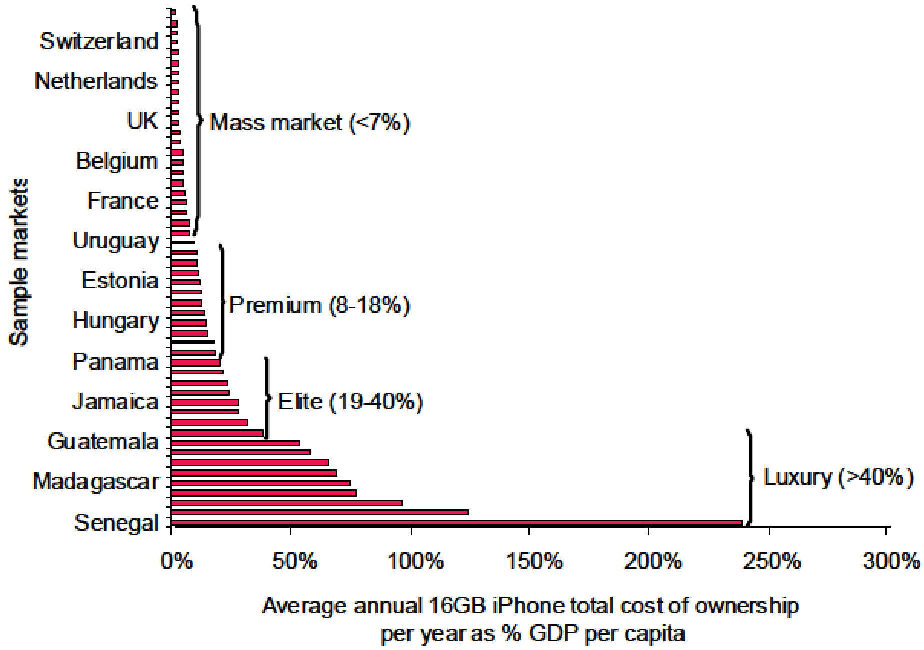
Figure 23: Average annual cost of 3G mobile adoption across countries, as % of GDP per capita



The share for the 3G total cost of ownership falls below 7%. Therefore, according to Hartley (2009) classification (see below the OVUM analysis for iPhone), this pricing qualified from the beginning the 3G products as mass-market products.

In the case of the iPhone, the total cost of ownership indicates whether the mobile phone is priced to be a mass-market device or a more exclusive proposition:

Figure 24: Average annual 16GB iPhone total cost of ownership per year as % of GDP per capita (source OVUM)



20.2.2.2. Adoption cost evolution

Whenever possible, historical data for price have been collected. Specific data and studies have been retrieved for the French market. As reported by INSEE[11] (Arthaud, 2006), the unit value of mobile phone have remained constant since 2001, due to the combined strong decline of prices, and to the improvement (quality and diversity of functions and services) of proposed products and services. In other words, for a monthly subscription to 3G services in 2008, the users were getting a much higher amount of service (voice, data) as in 2003 for the same price. Operators' strategies have enabled consumers to constantly improve the adoption value-for-money.

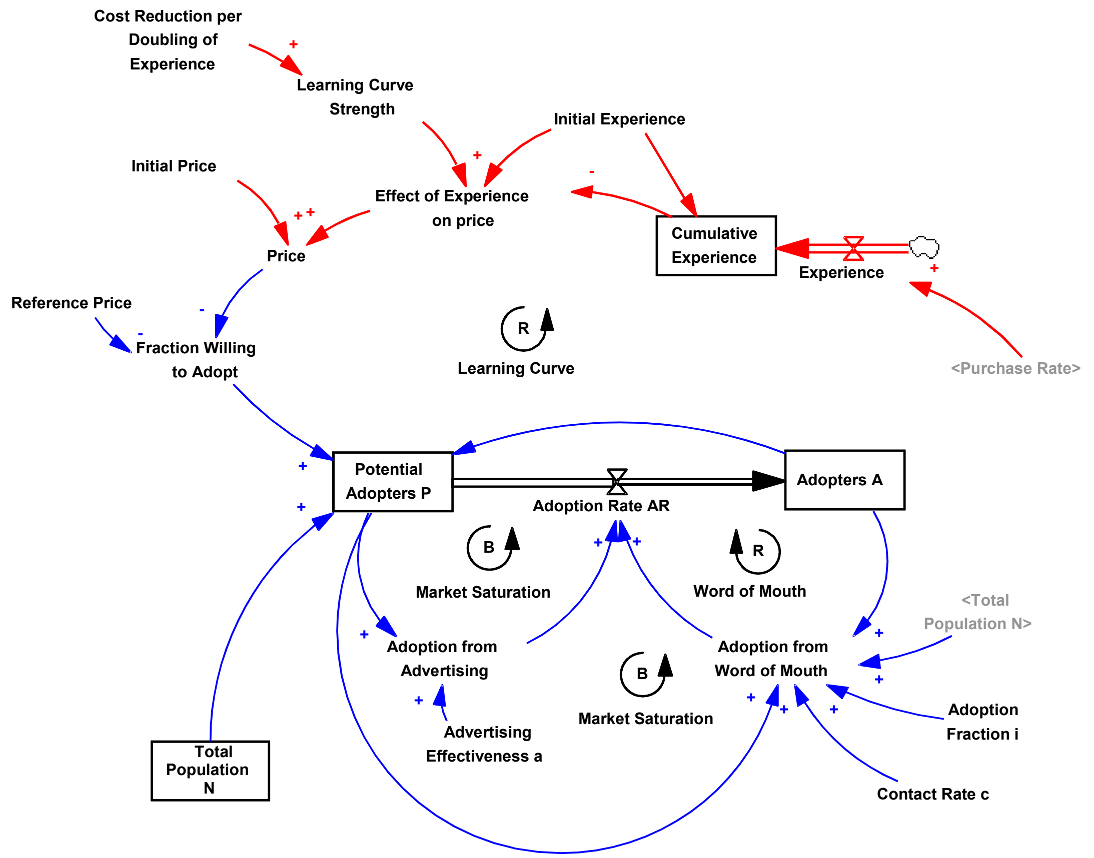
For this study, we have analyzed the evolution of comparable offers: the minimum required entry costs to 3G services (connection fee, minimum voice and

[11] Arthaud R. 2006, La consommation des ménages en TIC depuis 45 ans, in INSEE Premiere N° 1101

data plans). Since we do not focus on operators' strategies and margins made, in this research we will not explicitly differentiate between cost and price, assuming there is a logical relationship between the two.

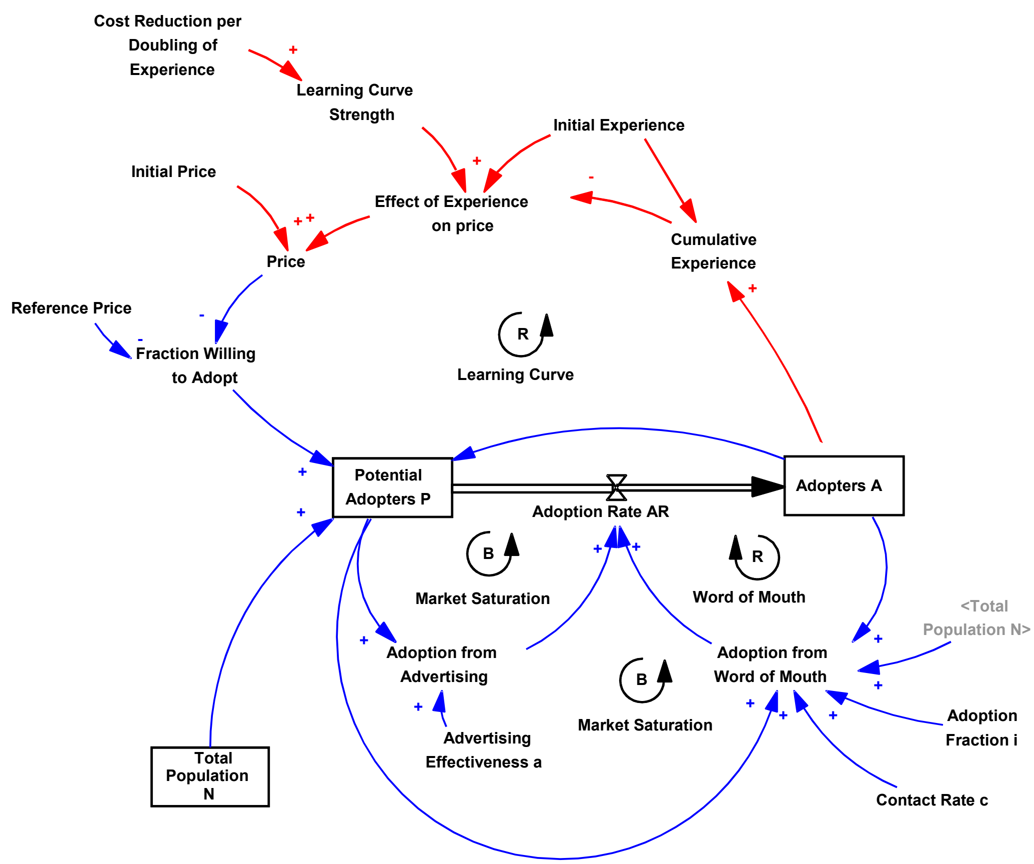
Because of the lack of detailed historical data on mobile phone tariffs, which would have been necessary to study trends of comparable services, a general price evolution pattern had to be modeled, to illustrate the progressive costs reduction enabled in particular by economies of scale. Such approach was anyway necessary to engage prospective study. We used for that purpose the observation made by Sterman (2000), that unit costs typically fall by a fixed percentage with every doubling of experience. His assumption was confirmed by insights from Teplitz (1991), Gruber (1992) and Argote and Epple (1990), who had observed cost reductions of 10% to 30% every time the company's cumulative experience was doubled. Sterman (2000) proposed a System Dynamics update of the Bass model, incorporating this relationship between experience and price:

Figure 25 : Revised Bass (1969) model incorporating a learning curve and price (Sterman, 2000)



In this model, the *effect of experience* captures the way actors of the diffusion value chain learn to produce and distribute at a lower cost as they gain experience. We have furthermore considered the assumption that in a highly competitive market such as the telecoms industry, competition drives the translation of cost reduction into price reduction, enabling to relate the Cumulative Experience directly to the Adopters base size. A new positive feedback loop can then be identified, as illustrated on the figure below: experience leads to lower prices, expanding the size of the market and stimulating further adoption, sales, and therefore experience.

Figure 26: Revised Bass (1969) model incorporating a learning curve and price (Sterman, 2000) - emergence of a new feedback loop



The *Effect of Experience on price* is defined as:

$$Price = Initial\_Price \times \left(\frac{Cumulative\_experience}{Initial\_experience} \right)^{Learning\_curve\_Strength}$$, where:

- the *Initial experience* is the initial experience level at the start of commercialization (production and distribution means). For 3G products, local operators already had a comparable production/distribution experience of 2G handsets. The semester has been considered as the elementary supply chain time frame (from corporate strategy to handset sale), and therefore for each country, the *initial experience* was defined as the last 6-month sales of 2G mobile phones, before 3G mobiles commercialization.

- the *cumulative experience* for 3G products then integrates the history of production - distribution experience:

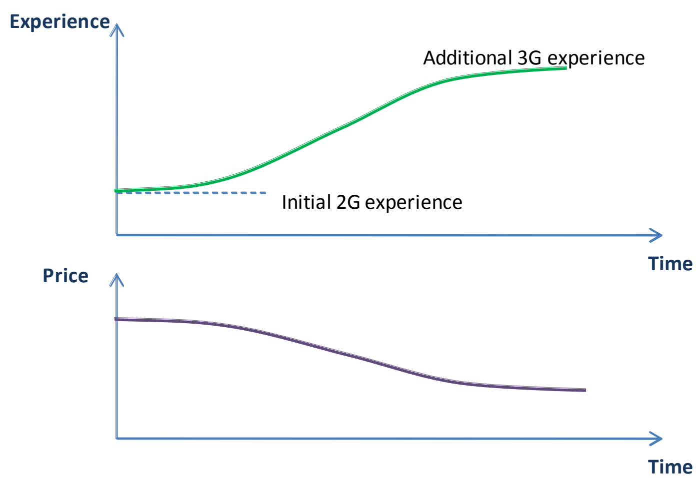
$$Cumulative\_experience = \int_{t_0}^{t} Adoption\_Rate + Initial\_experience$$

In this model, this experience is measured against the *Sales rate.* To simplify our research which mainly explores product diffusion on a limited time range, we have not distinguished *adoption rate* and *sales rate* (therefore, ignoring any *discard rate*). Price then decreases over time according to the equation below:

$$Price = Price_{Release}\left(\frac{Adopters\_A + Initial\_experience}{Initial\_experience}\right)^{Learning\_curve}$$

Experience and *Price* therefore show the following trends with time:

Figure 27: Reference mode – Experience and Price



- the *Learning curve* is a constant adjusted to calibrate the speed of price reduction. It is related to the more intuitive *Cost reduction per doubling of experience* by the equation:

$$Learning\_curve = \frac{\ln(1 - Cost\_reduction\_per\_doubling\_of\_experience)}{\ln(2)}$$

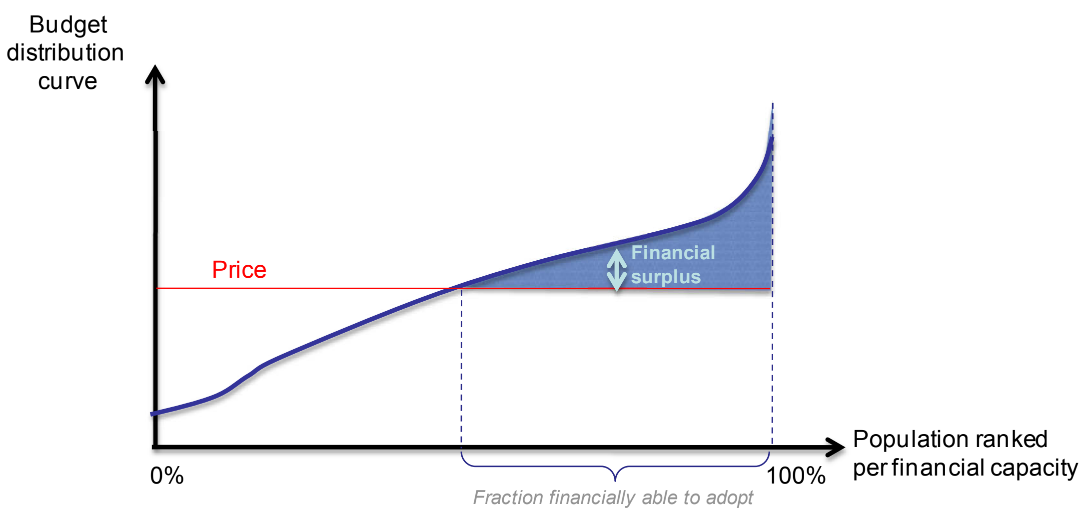
A general assumption had to be made in the framework of this research to set the learning curve parameter, in order to apply the model proposed by Sterman (2000). Preliminary analysis of Tarifica database was carried out, and suggested to assign a value of 0.08 to the *Cost reduction per doubling of experience* parameter. In other words, in average, every time the adopters' base doubles in size, the adoption cost decreases by 8% (beyond a base level defined as the "initial experience").

As commented by Sterman (2000), the main drawback of this model is that it assumes a perfect and continuous fit of demand (adoption) and supply (production and distribution). In the real world, planning and developing capacity takes time. During the sales jump phases, this capacity is likely to become temporarily inadequate, which may lead to shortages, long and unreliable delivery times, and possibly exaggerated prices. Other limits of that model are discussed in section 0.

20.2.3. "Fraction financially able to adopt" variable

This variable is calculated as the proportion of population whose financial capacity for telecom-related expenditure exceeds the product price, as illustrated on the graph below.

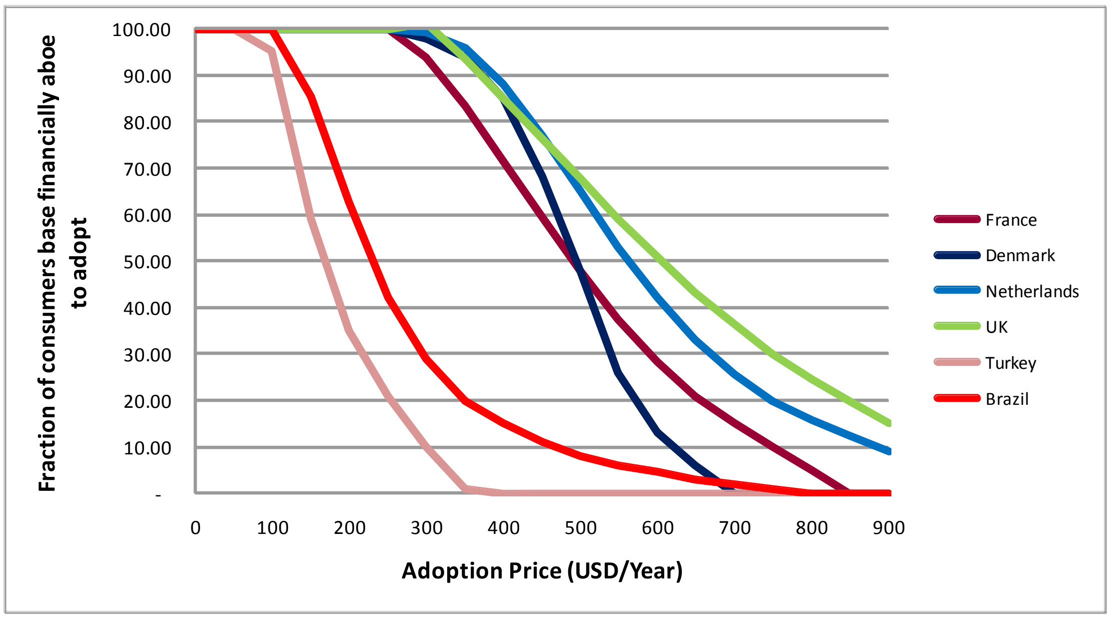
Figure 28 : Definition principles of the fraction financially able to adopt



Based on the socio-economic data gathered in this research, this variable has been calculated as a function of the product price. The following Figure 29 not only illustrates:

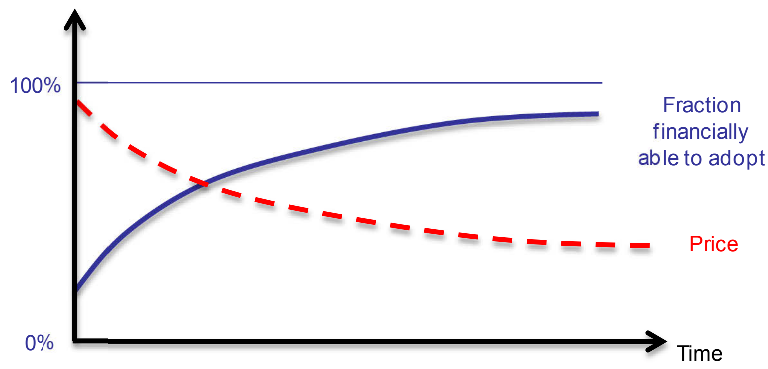
- the unequal financial capabilities of consumers in various countries (about 100% of the consumers base can afford a 200 USD product in France or Germany, but close to 3% in Ukraine),
- the sensitivity the size of potential adopters base to price change. In the case of Italy, where 3G price dropped from about 500 to around 320 USD/unit the potential adopters base has grown over about a year from 50% to 92%. This methodology therefore enables to illustrates and quantify the powerful effect of the accessibility feedback loop on the diffusion process.

Figure 29: Size of the potential adopters base depending on adoption cost, for several countries included in the study (2005)



Considering price reduction over time (with the strongest drop in the early diffusion phase), linked to *experience accumulation*, the fraction of potential adopters having access to the product is expected to follow the type of pattern illustrated in Figure 30:

Figure 30: Reference mode – Fraction of financially able to adopt

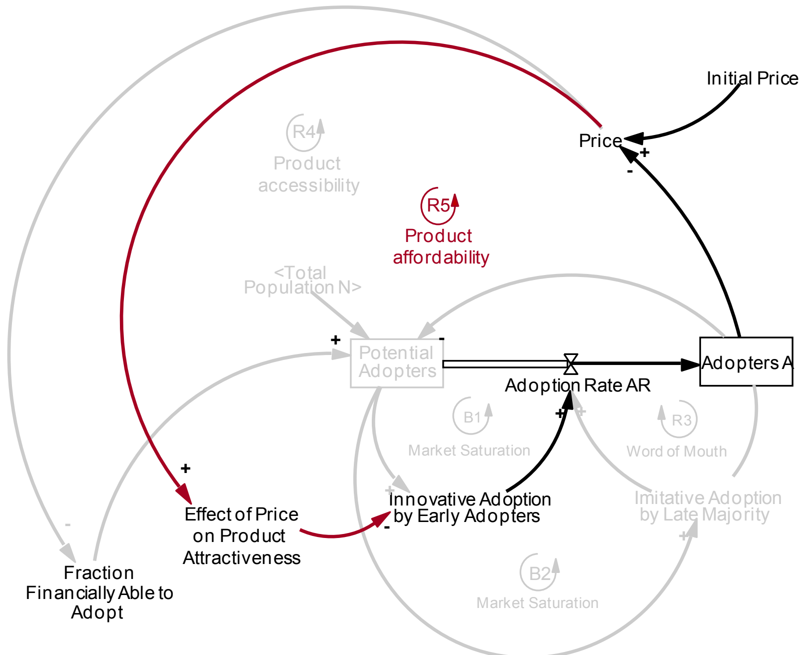


21. Model Component 3: Product Affordability

21.1. Component rationale

Economies of scale at the product production level trigger a second positive effect on sales, as price reduction boost the product attractiveness. To capture the related dynamics on product diffusion in the model, it is necessary to describe in detail the composition of the attractiveness function, and the way it simulates the *innovative adoption by early adopters*.

Figure 31: Overview of Model component 2

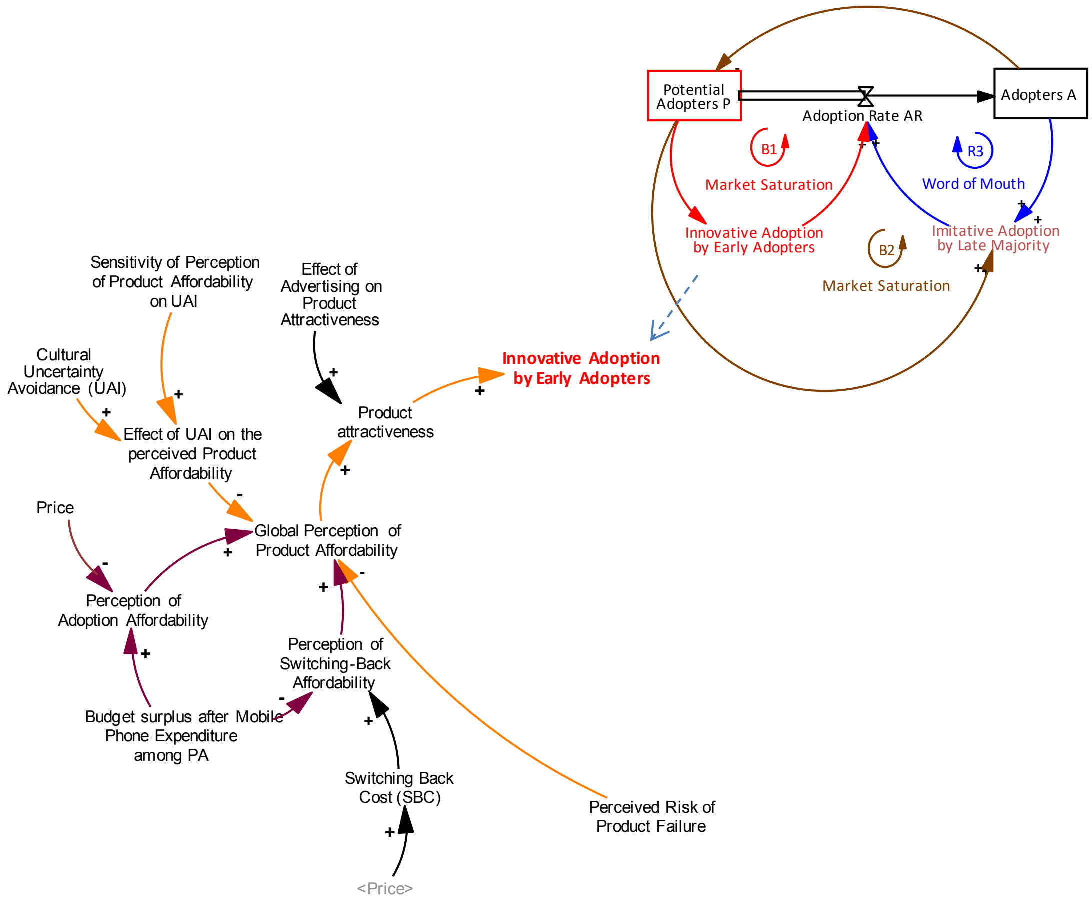


In this component, we have focused on the definition of the *Innovative Adoption by Early Adopters* variable, one of the two main diffusion mechanisms described in the Bass core model (below in red). In Sterman's reference version of the model, the adoption intensity among early adopters is directly and entirely driven by the efficiency of advertising on product attractiveness. In our research, we chose to explore and describe more in detail the factors driving the adoption decision, among the early adopters. In addition to the effect of advertising, the following aspects have been taken into account, as described more in details further in this section:

- the product adoption price,
- the cost of switching-back to the previous product, and the perceived risk of eventually having to switch-back, if the product fails on the market, and
- the cultural propensity to risk-taking (level of uncertainty avoidance).

These aspects have been reflected in the research preliminary investigations as major factors driving the early adopters' rationale, which have been modeled as shown of the following graph:

Figure 32: Inputs into Product Attractiveness



The *innovative adoption* rationale is built upon the following components, as shown of the graph above:

1. A cognitive/affective process through which the potential adopter builds his own perception of the product global *potential attractiveness* (defined as the *effect of <u>advertising</u> on product attractiveness* variable), corresponding to the product's perceived intrinsic added-value (functional, aesthetic, etc.) -> (Note: in this research we will use the term "advertising" as substitute to "marketing", since this is the initial terminology used in the System dynamics literature);
2. A cognitive/affective process through which the potential adopter builds his/her own perception of the global affordability associated to the product adoption. It integrates the perception of adoption cost (price) and of switching-back cost (put in perspective with the potential adopter's purchase power) that would occur if the

products diffusion fails, and the early adopter has to readopt an equipment of the previous generation. The subjective magnitude of these costs is related to the potential adopter's purchase power, as described in paragraph 21.2.1.3.

3. A risk evaluation process, through which the potential adopters assesses the probability that the product will fail on the market (the Perceived risk of product failure). According to the commercial outcome of the product, different costs would incur to the adopter. This variable is detailed in the description of model component 4.
4. The impact of *uncertainty avoidance* in the adoption decision making, considering the set of risks and their associated costs.

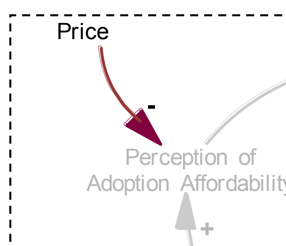
Product affordability lies in the center of the positive feedback mechanism, named R5, where: product adoption fuels economies of scale at production and distribution, which in turn bring down the product price, improves the product affordability and attractiveness, and therefore intensify adoption process.

21.2. Quantitative inputs and parameterization

To fully describe this model component, eight variables shown in Figure 32 have to be parameterized in this component:

21.2.1. Product Adoption Affordability branch

The two inputs influencing this variable are the product price and its affordability, as measured against the available budget of households.

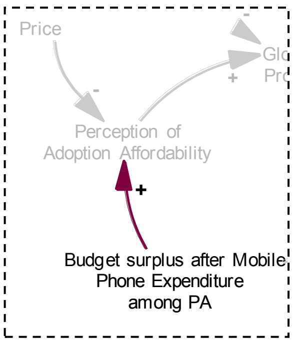


21.2.1.1. Price

See paragraph 20.2.2.

21.2.1.2. Budget surplus after Mobile Phone among Potential Adopters

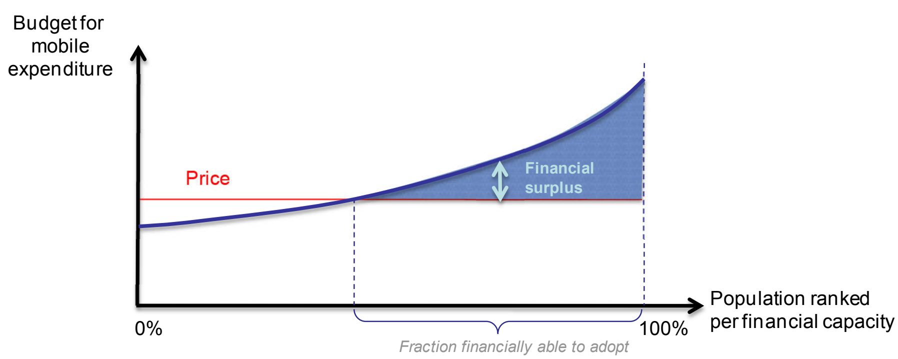
The fraction of consumers market, financially able to adopt, has been defined as a function of adoption Price (paragraph 20.2.1). Inside that market segment, a variable has been defined to reflect a representative purchase power related to mobile telephony: the *available budget surplus after mobile phone expenditures*, as illustrated on the figure below.



This variable was calculated as the remaining budget after a possible adoption of the product.

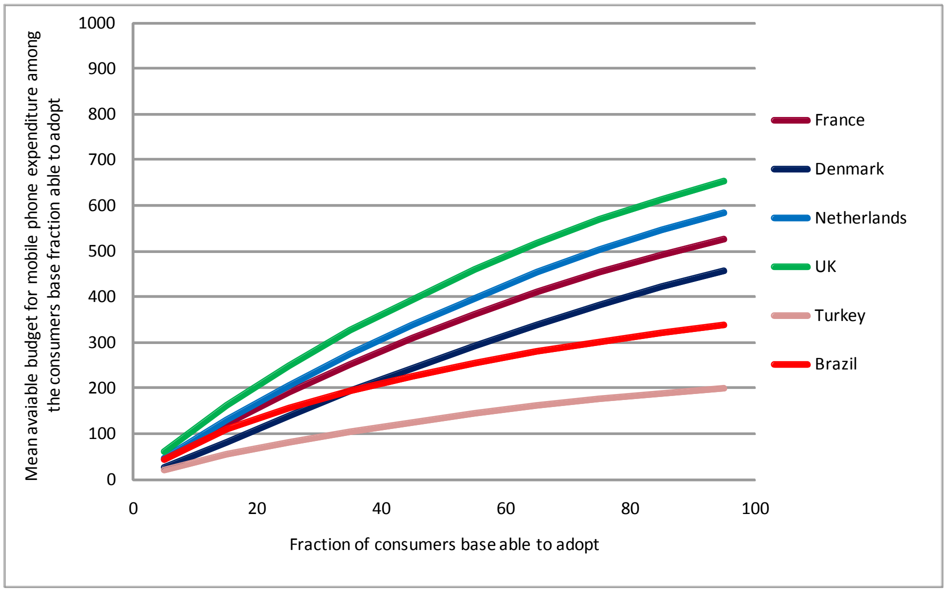
Rather than using an "Available budget for mobile expenditure" variable, that would include the adoption price, we considered a budget surplus among potential adopters, whose characteristics (=0 when adoption =0; increasing with the adoption fraction), made easier the definition of the *Perception of Adoption affordability* variable (see next paragraph).

Figure 33: Available budget surplus after mobile phone expenditure among the fraction of population to whom the product is affordable



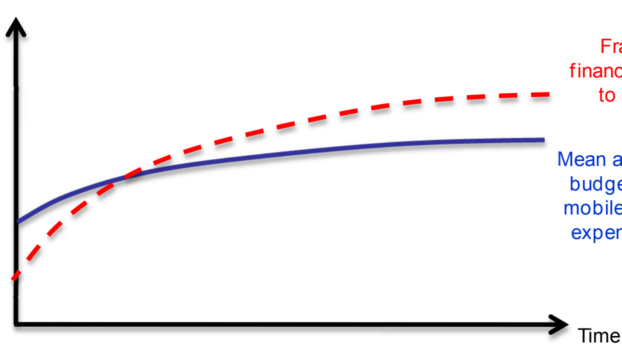
The following graph illustrates the budget surplus increase as the fraction of consumers base financially capable to adopt widens (as a result of price diminution).

Figure 34: Available budget surplus after mobile phone expenditure, for several countries studied (2005)



As product popularization decelerates with time (see Figure 30), so does the *budget surplus*. Therefore, the global purchase power is overall expected to follow an increasing but decelerating pattern, similarly to the *fraction able to adopt* variable. Due to the concavity of the *Budget surplus* variable (see the figure above), the deceleration is expected to be not as sharp though as for the *fraction able to adopt* variable.

Figure 35: Reference mode – Available budget surplus after mobile phone expenditure

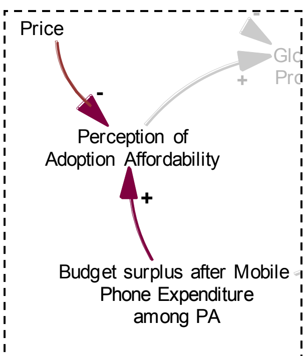


21.2.1.3. Perception of Adoption Affordability

Within the fraction of potential adopters (PA) able to adopt, the *Perception of Adoption Affordability* has been parameterized as a dimensionless variable reflecting the subjective effort mobilized for product adoption considering the adopter's financial surplus.

No metric variable representing such subjective perception of price is available. It was therefore necessary to construct a relationship between the *Price* and the *Budget surplus after mobile phone expenditure,* respecting the following basic properties:

- When the budget surplus is null, the perception of affordability is minimal (set at 0).
- The perception of affordability increases as the budget surplus to price ratio increases
- The affordability equals to 1 when the budget surplus equals the price.
- Beyond a certain budget to price ratio threshold, the perception affordability remains constant at its highest level (adoption price is not a significant factor anymore in the decision-making). We have furthermore assumed that when the budget surplus after mobile phone expenditure exceeds two times the product cost, the effect of price on attractiveness becomes insignificant and insensitive to the price. Beyond that threshold, product adoption does not limit any other customer's option, including in the worst case scenario: switching-back to the initial service while keeping the possibility to switch to another new technology in the short-term.



The following relationship was therefore considered:

1. If Surplus $< 2 \times$ Price:

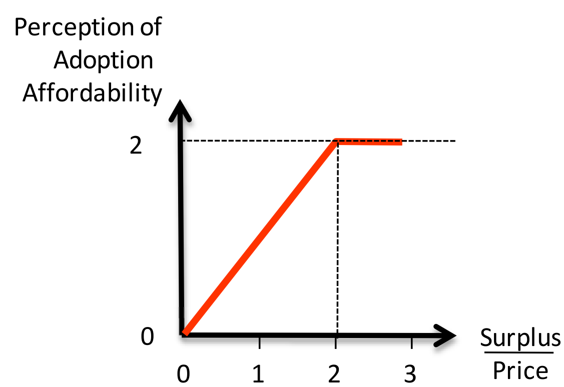
$$Perception\_Adoption\_Affordability = \frac{Surplus}{Price}$$

2. If Surplus $> 2 \times$ Price:

$$Perception\_Adoption\_Affordability = 2$$

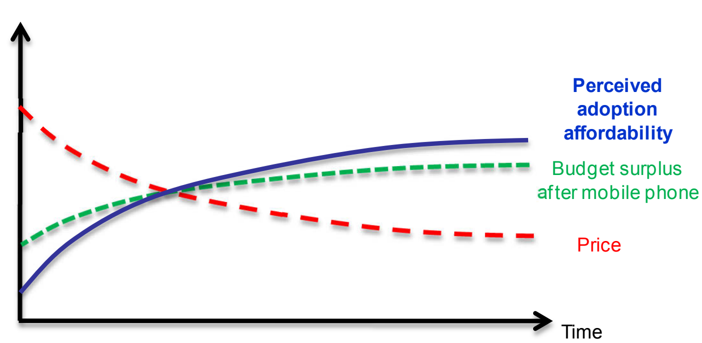
The following figure illustrates the proposed function:

Figure 36: Perceived Product Affordability, considering the adopters' purchase power



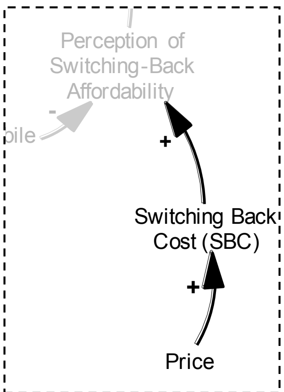
With time, price reduction and the subsequent increase of budget surplus among potential adopters will drive a significant increase of the product affordability. This trend will decelerate with time, following the dynamics of its two input factors.

Figure 37: Reference mode – Perceived adoption affordability



21.2.2. Switching-back Affordability branch

21.2.2.1. Switching-back Cost



The switching-back cost combines all the costs incurred to the consumer by the abandonment of the new product and the adoption costs of replacement solutions from previous generation. The most typical switching-back cost is linked to the commitment periods of 12 or 24 months sold with most mobile product packages. We can suppose that the adopter will conserve the previous handset / telecommunication device, preventing any necessary purchase in case of switching-back.

Early adopters may feel that before the product as clearly taken the market over, diffusion failure may occur at any time, leaving him with fees to pay over the remaining commitment period. We have considered that this remaining commitment period would be in the adopter's perception long enough to lead him to verify his capacity to pay on the long run both for the previous service – was he forced to switch-back to it – and for the committed fees.

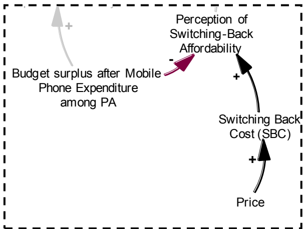
The switching-back cost is therefore entered as the full service monthly fee, contracted with the new product. As a consequence, the switching-back cost is directly indexed on the product price.

21.2.2.2. Budget surplus after Mobile Phone among Potential Adopters

See paragraph 0.

21.2.2.3. Perception of Switching-back cost Affordability

The parameterization of this variable is similar to the one adopted



for the *Perception of Adoption Affordability* variable. The Perception of Switching-back Affordability has therefore been defined as a dimensionless variable, comparing the necessary switching-back cost in case of product failure, with the adopter's financial surplus.

We have furthermore assumed, as previously for the adoption cost, that when the available surplus for mobile phone expenditure exceeds twice times the switching-back cost (SBC), perception of affordability is maximum and becomes insensitive to further cost decrease:

1. If Surplus $< 2 \times$ Switching-Back cost:

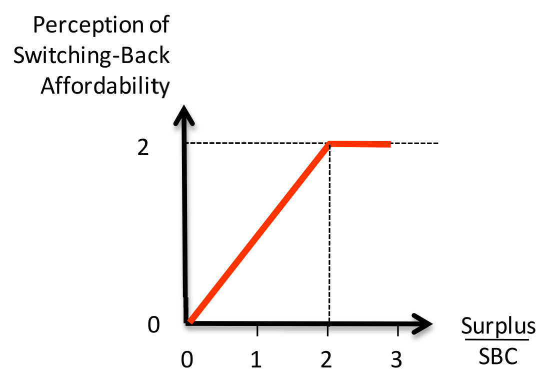
$$Perception\_Adoption\_Affordability = \frac{Surplus}{SBC}$$

2. If Surplus $> 2 \times$ Switching-Back cost:

$$Perception\_Adoption\_Affordability = 2$$

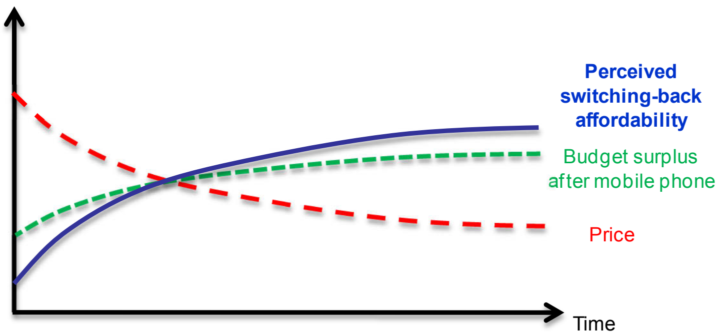
The following figure illustrates the proposed function:

Figure 38: Effect of switching-back cost on product perceived affordability, considering the adopters' purchase power

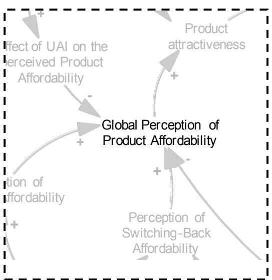


With time, switching-back cost reduction and the subsequent increase of budget surplus among potential adopters will drive a significant increase of the switching-back affordability.

Figure 39: Reference mode – Perceived switching-back affordability



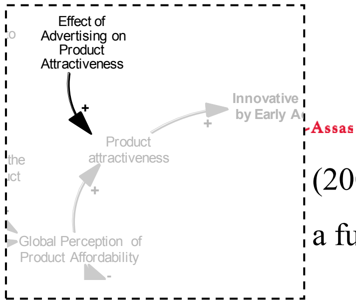
21.2.3. Calculation of the Global Perception Affordability



The complete description of this variable, integrating the *Adoption affordability*, the *Switching-back costs affordability*, the *Perceived Risk of Product Failure* and the *Uncertainty Avoidance Index* is given in the presentation of the model component 4.

21.2.4. "Effect of Advertising on Product Attractiveness" variable

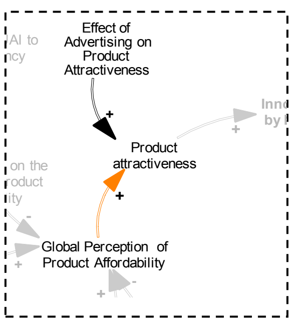
The core model dynamics and Sterman's (2000) adaptation of the Bass (1969) diffusion model described the *innovative adoption rate* as the product of the *Potential Adopters base* by the *Effect of Advertising on Product Attractiveness*. In other words, the *Effect of Advertising on Product Attractiveness* (expressed in 1/Year) would simply describe the fraction of targeted population convinced by advertisement to purchase the product, over a year. In our research, we have refined the conceptualization of the innovation adoption process, introducing the economic factors (price and switching-back costs) as well as cultural and psychological aspects (perception of the product success potential and uncertainty avoidance). The impact of advertising on adoption was therefore given a more specific and bounded role than in Sterman's



(2000) model, limited to the perception of the product added-value (from a functional, social, aesthetic, etc., point of view).

Such aspect of the product attractiveness was not quantified and parameterized in the present research, and the variable was subsequently left as calibration variable. In further research, a further exploration of this variable could be envisaged on the basis of available corporate data and of market surveys enabling to measure the intensity and efficiency of marketing campaigns. This point is highlighted in 0.

21.2.5. "Product Attractiveness" variable



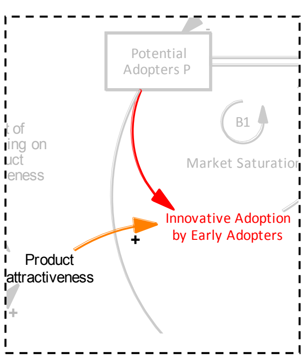
This variable describes the perception of the product value-for-money by its potential adopters. It combines the effects of advertising and of affordability:

Product Attractiveness = *Effect of Advertising on Product Attractiveness*

× *Global Perception of Product Cost*

The variable reference mode is presented in Model component 4.

21.2.6. "Innovative adoption by early adopters" variable



As per Sterman (2000) reference diffusion model, the innovative adoption is defined as:

Adoption from advertising = *Potential Adopters*

× *Product Attractiveness*

After completing here the representation of advertising effect with financial and psychological considerations, we have used a similar modeling approach to calculate the early adoption process:

Innovative Adoption = Potential Adopters × Product Attractiveness

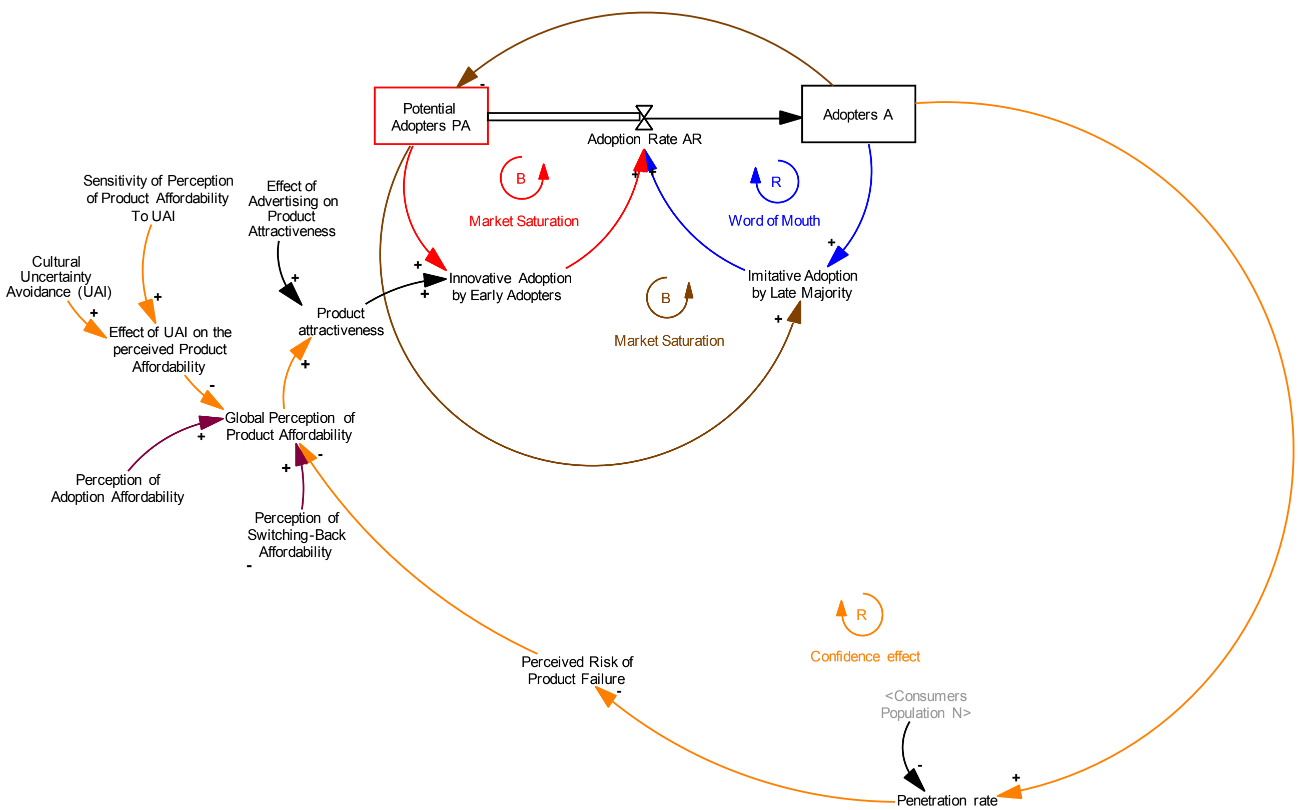
The variable reference mode is presented in Model component 4.

22. Model Component 4: Confidence Effect

22.1. Component rationale

As mentioned previously, the perception of the product cost depends not only on its objective costs related to the adopter's purchase power, but also on the two following aspects:

Figure 40: Overview of the confidence effect component



1. A risk evaluation process, through which the potential adopters assesses the probability that the product will fail to spread across the market (the *Perceived risk of product failure*). This consideration is particularly capital in the purchase decision of technological products and even more in the telecom sector. As suggested by Arthur (1989), the risk of adopting a product before the market is locked in by its technology is substantial. An

unsuccessful industrial adventure may leave its pioneer consumers with obsolete and useless products, if the market base and the global infrastructure leveraging its utility remain "an unfulfilled promise". For the potential adopter, the *perceived risk of product failure* plays therefore a central role in his final decision making.

If the potential adopter was a purely rational player, he would assess the overall affordability related to product adoption by simply weighting the factors according to their probability of occurrence:

$$GPPA = \underbrace{(PAA) \times (1 - PRPF)}_{\substack{\text{Affordability} \\ \text{expectancy if product} \\ \text{succeeds}}} + \underbrace{(PAA + PSBA) \times (PRPF)}_{\substack{\text{Affordability} \\ \text{expectancy if product} \\ \text{fails}}}$$

With:

- GPPA : Global Perception of Product Affordability
- PAA: Perception of Adoption Affordability
- PSBA: Perception of Switching-Back Affordability
- PRPF **:** Perceived Risk of Product Failure

However, we did not consider this parameterization of the GPPA in our model, considering the importance of a common psychological distortion involved in risk assessment rationale, which affects its perception of the global product affordability. This aspect is introduced in point 2 below and the adjusted parameterization in paragraph 22.2.3.

2. The impact of uncertainty avoidance on the perception of the cost associated to product adoption, as explained more in detail in the presentation of model component 4.

Due to *uncertainty avoidance*, a potential adopter will be much more deterred by a given loss possibility, than he will be attracted by a potential gain, even if the overall expectancy remains largely positive. In other words, the uncertainty adverse potential adopter is inclined to a more conservative stance, his demand for a product decreasing sharply as risk or uncertainty increase.

Therefore, to integrate the effect of uncertainty avoidance into the adoption *global affordability*, the relative weight of the perceived affordability related to a negative outcome - should the product fail or the product turn out disappointing - have been modulated depending on uncertainty avoidance levels.

The perception of the risk of product failure is a dynamic variable, clearly impacted by the observations the potential adopter can make in his environment, in particular by the current product success, estimated through its market penetration rate.

The model component feedback loop R6 captures the reinforcing effect structured on these relationships: product diffusion increases the consumer's confidence that the product will not fail. This in its turn increases the product attractiveness, and therefore stimulates its diffusion.

22.2. Quantitative inputs and parameterization

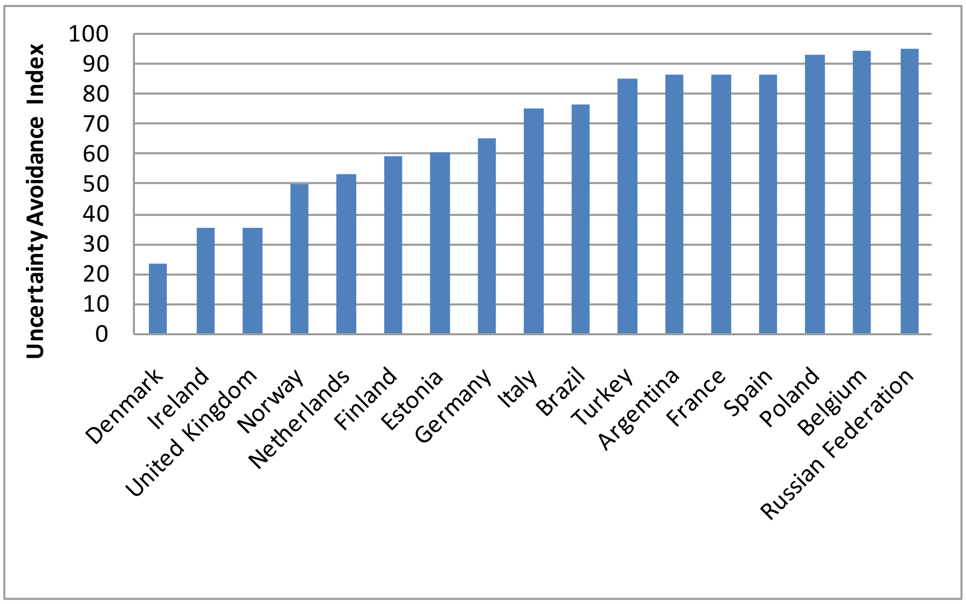
22.2.1. "Effect of UAI on the perception of affordability" variable

22.2.1.1. Cultural Uncertainty Avoidance Index

To modulate the magnitude of the cognitive distortion in product affordability perception, a quantitative variable representing the level of uncertainty avoidance was added to the model. As our research was primarily market-based, we had to use a factor that would capture at an aggregated, national level, this uncertainty avoidance dimension. In that perspective, we used for each country the culture Uncertainty Avoidance Index (UAI) established by Hofstede (1980). Although the Hofstede index is not a universally recognized approach and tool to compare cultural features between countries, this metric offered a unique possibility to incorporate cultural aspects into the quantitative model. The values used for each country was retrieved from the updated Hofstede website[12].

In this research, data have been analyzed across countries showing a wide range of UAI values:

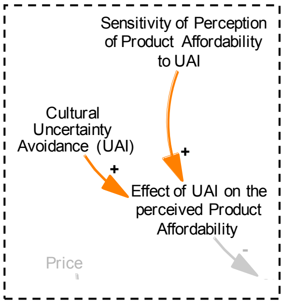
Figure 41: Uncertainty Avoidance Index across studied countries included in the study



22.2.1.2. Effect of UAI on the Perceived Product Affordability

The reference study used to parameterize this variable Tellis, Stremerch and Yin (2003) established the statistical correlation between uncertainty avoidance index across countries, and the delay between

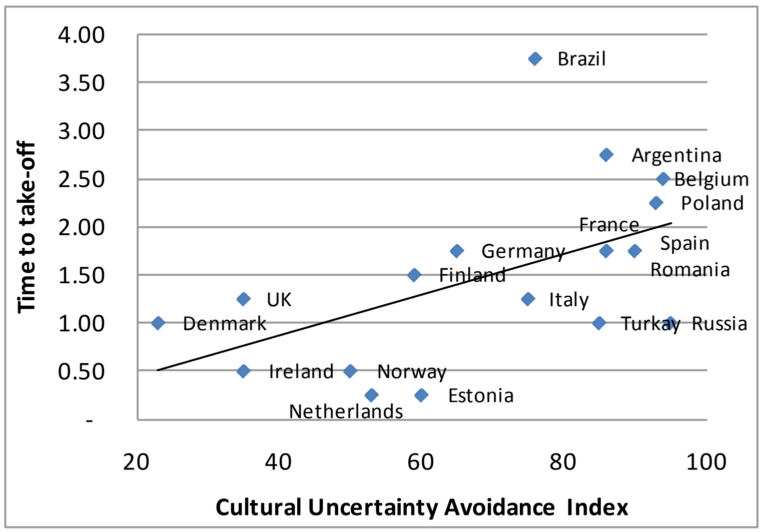
12 http://www.geert-hofstede.com/



telecom product commercialization and their diffusion take-off. Take-off tipping points are defined here as the moment when product diffusion reaches a 2% penetration rate.

This correlation is observed as well in our case, between UAI levels and takeoff dynamics of 3G mobile phones across the 17 studied countries:

Figure 42: Time to take-off, according to UAI levels (3G data processed across the 17 countries)



	Variable UAI	R^2
Parameter	0.022	0.272
T-Student	2.37	
p-value	0.03	

A bivariate regression involving the UAI and IDV (presented in paragraph 24.2.1) parameters confirms the correlation between UAI and the time to take-off variable:

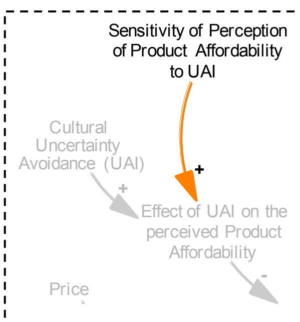
	Variable UAI	Variable IDV	R^2
Parameter	0.019	-0.007	0.032
T-Student	1.65	-0.40	
p-value	0.06	0.69	

This preliminary statistical analysis confirms that the effect of UAI on product diffusion should be positive (higher UAI lead to slower diffusion).

Therefore the *effect of UAI on the perceived product affordability* is defined by the application to the UAI variable to its scaling factor, considering that the *perception of affordability* function should be decreasing with the UAI level:

$$\textit{Effect of UAI on the Perceived Product Affordability} =$$
$$(UAI_{max} - UAI) \times (\textit{Sensitivity of Perception of Product Affordability to UAI}).$$

22.2.1.3. Sensitivity of perceived product affordability to UAI



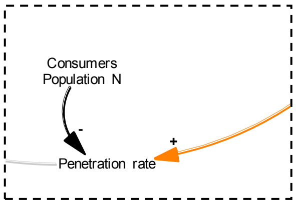
The *Sensitivity of perceived product affordability to UAI* is a parameter defined once for all countries, and which enables to rescale the UAI variable (defined by Hofstede on a 0 to 100 scale), so that the *effect of UAI on affordability* inserts into the definition of the *Global perception of affordability* (see definition in paragraph 22.2.3) with a weight consistent with the other components' metrics (magnitude of 1, and not 100). This approach is consistent with the methodology suggested by Sterman (2000) and yields Effect of UAI values ranging on a scale from:

- 0 : no effect of switching-back cost on perceived affordability UAI when uncertain avoidance is minimal, to
- 1 : switching-back cost taken into consideration as an expected reality in the perception of affordability.

The Effect of UAI can therefore be interpreted as playing the role of a discount rate on the potential switching-back cost component of the perceived affordability equation (see paragraph 22.2.3).

22.2.2. "Perceived risk of product failure" variable

22.2.2.1. Penetration rate



The penetration rate is calculated as the rate between the cumulated number of sold products (Adopters base) and the consumers base in the country. The total consumers base was considered as the fraction of population following the rules detailed in paragraph 20.2.1

22.2.2.2. Perceived risk of product failure

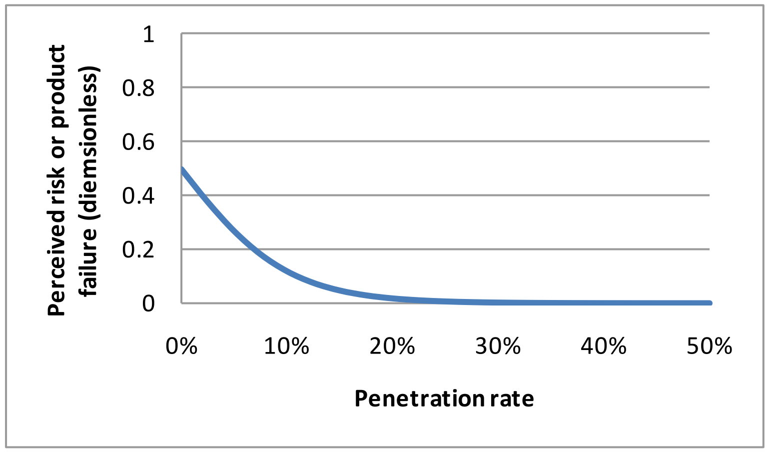
This subjective variable required a mathematical construction, as no specific metric is available to characterize it. We have constructed it considering the following principles:

- It is, logically, a continuous, decreasing function of market penetration.
- The perceived risk of product failure linked to the intrinsic qualities of the product is considered already integrated into the *Product Attractiveness* variable. In the *Perceived risk of product failure*, we model the dynamic component of that phenomenon, linked to the observation of the on-going product diffusion.
- Its initial value, at the time of product commercialization, reflects the belief *a priori* in the product's risk of failure, and can therefore be seen as inversely proportional to the number of "Innovators", "Early Adopters" and "Early Majority" in a population group: 50 %, according to Rogers (1962).
- Beyond a certain penetration rate threshold, market takeover appears guaranteed (*perceived risk* = 0). A reference penetration threshold of 20% has been used, but given the lack of control over that variable, its value is discussed in the sensitivity analysis.

The most appropriate type of function satisfying these properties is a sigmoid function:

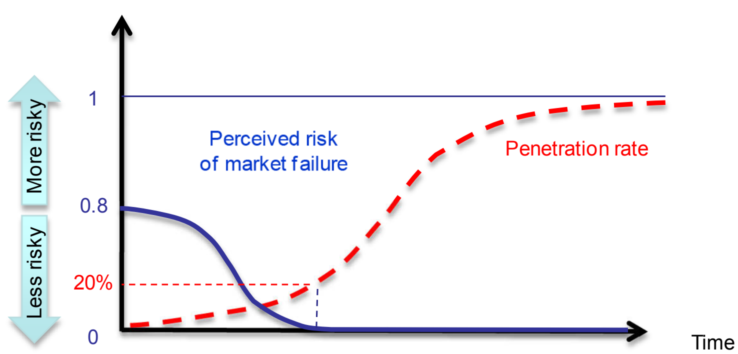
$$Perceived\_risk = 1 - \frac{1}{1+\exp\left(-b \times Penetration\_Rate\right)}$$

Figure 43: Perceived risk of product failure function with b = 20:



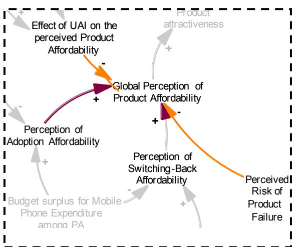
As the penetration rate is expected to increase with time following a general S-shaped diffusion pattern, the perceived risk of product failure is expected to decrease according as follows:

Figure 44: Reference mode – Perceived risk of product failure



22.2.3. "Global Perception of Product Affordability" variable

As explained in paragraph 22.1, the global perception function is built on the basis of an expectancy function ($\sum_i p_i . u_i$), in which an uncertainty avoidance component is introduced to distort decision-making process. The effect of uncertainty avoidance weights on the cost associated with a product failure scenario, as shown in the equation:



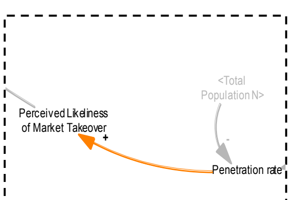
$$GPPA = \underbrace{(PAA) \times (1 - PRPF)}_{\substack{\textit{Affordability expectancy} \\ \textit{if product succeeds}}} + \underbrace{(PAA + PSBA) \times (PRPF)}_{\substack{\textit{Affordability expectancy} \\ \textit{if product fails}}} \times \underbrace{EUAI}_{\substack{\textit{Effect} \\ \textit{of UAI}}}$$

With:

- GPPA : Global Perception of Product Affordability
- PAA: Perception of Adoption Affordability
- PSBA: Perception of Switching-Back Affordability
- PRPF **:** Perceived Risk of Product Failure
- EUAI: Effect of UAI on Perceived Product Affordability

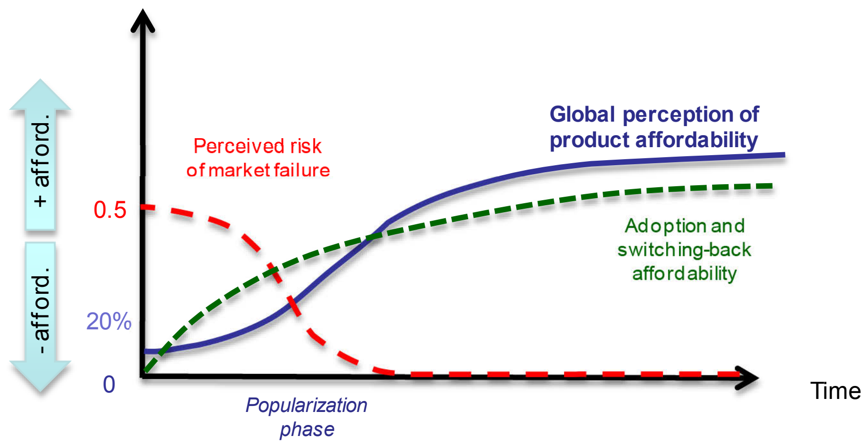
The effect of the UAI factor can be seen as one of a discount rate, which undermines future (and therefore uncertain) events, here specifically switching-back costs.

All factors contribute to a continuous increase of the global perception of product affordability: both the adoption and switching-back affordability perceptions decrease (along with product price).



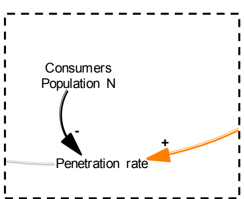
As the innovative product becomes a popularized commodity, the global perception of adoption risk drops significantly, simulating subsequently the perception of its affordability.

Figure 45: Reference mode – Global perception of product affordability



23. Model Component 5: Economic Leverage

23.1. Component rationale



This component has been developed to capture the long-term interactive dynamics between mobile phones diffusion and economic growth.

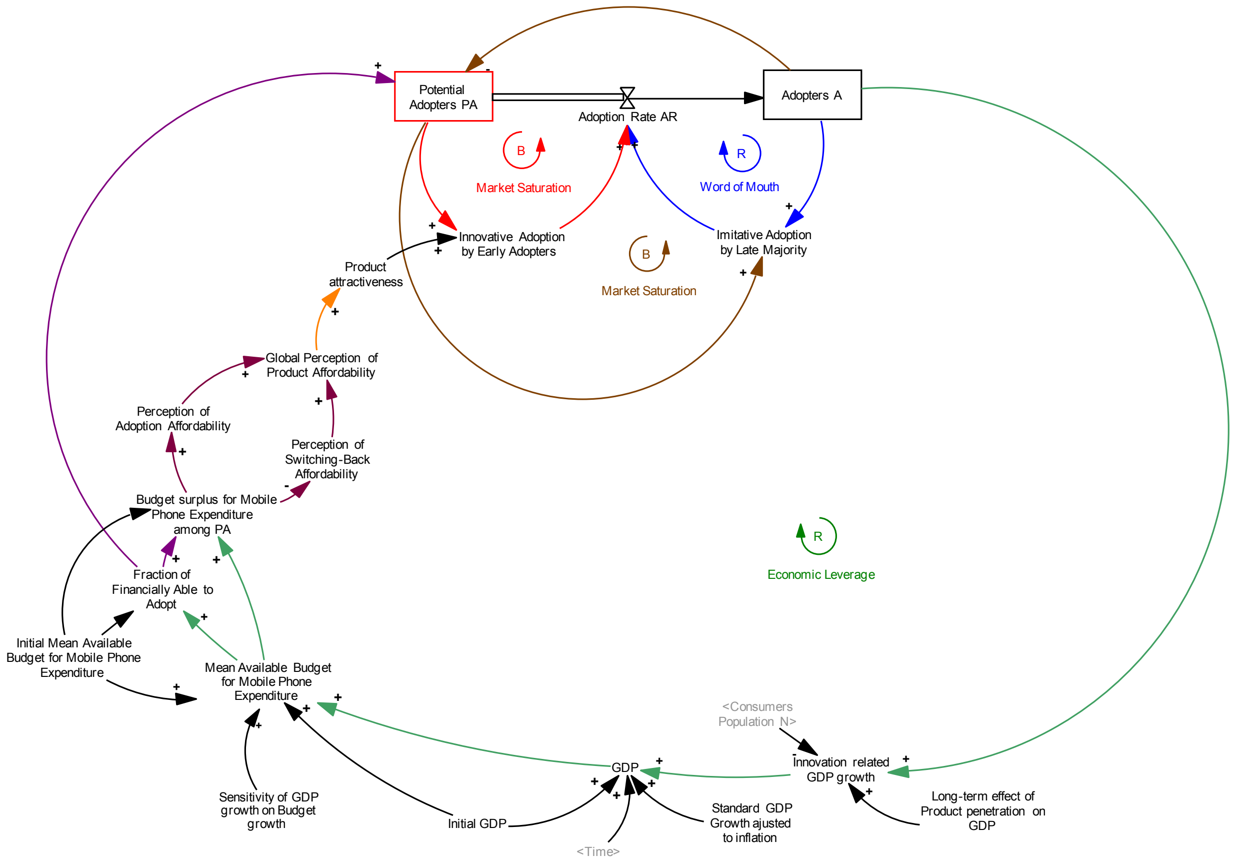
According to a recent World Bank study (Qiang, Rossoto & Kimura 2009), mobile penetration stimulates macroeconomic growth, measured through its GDP, at several levels: through the economic development of the mobile operators and of all actors along its value-chain (suppliers, distributors, infrastructure developers, etc.), the increased productivity in most economic sectors, and, in a less measurable way, through all the social transformations and welfare improvement following wireless communication development. Several statistical studies across a large number of countries enabled to conclude that each 10 percentage-point increase in mobile phone penetration lead to an economic growth of 0.6 % high-income countries and of 0.81% in low and middle-income countries.

This impact of penetration rate on economy drives the model feedback loop R7: the GDP growth in its turn impacts income levels, and, connecting to the model Component 2, reinforces the product accessibility and affordability, and subsequently increases product sales and penetration rate.

The relevance of integrating this economical dynamics into the model is however limited for two reasons:

- While previous studies focused on the major impact of wireless voice-based telecommunication, we have calibrated and applied our model to a younger generation of innovations – the 3G. It is not clear to which extent the impact on the economy and, more particularly, on the productivity, will benefit as significantly on the long-term.
- Our case study time-frames are limited to short diffusion periods, usually 5 to 8 years, while economic feedback effects would probably be relevant on a longer time scale. Neither of the two reference studies used to build this component quantify a typical lag time characterizing the effects delay between penetration rate and economy growth.

Figure 46: Model component 5



23.2. Quantitative inputs and parameterization

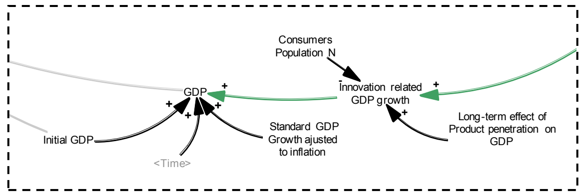
23.2.1. Long-term effect of product penetration on GDP

The long-term effect of product penetration on GDP has been incorporated at the level reported in the literature: = 0.006 in high-income countries and 0.081 in low and middle-income countries.

On the time scale considered for these calibration exercises, this model component was found to have too little impact on the overall diffusion to enable the adjustment of these values to each country, as calibration variables.

23.2.2. "GDP" variable

Following the observation of Qiang, Rossoto and Kimura (2009) and McKinsey (2006), we have considered a simple linear relationship between *GDP* Growth and *penetration rate*. The technological innovation induced economic growth has to be added to standard GDP growths (adjusted to inflation) observed before product commercialization. Besides, we have supposed that there was a 3 year lag-time between penetration rate levels and any induced impact on the economy. The *GDP* variable was therefore modeled as the sum of:



- The innovation related growth:

$$Initial\_GDP \times \left[Penetration\_rate_{t-3} \times \frac{\partial.GDP}{\partial.Penetration\_rate} \right]$$

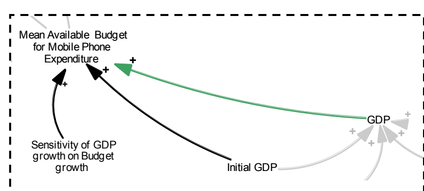
with $\frac{\partial.GDP}{\partial.Penetration\_rate}$ corresponding to the *long term effect of penetration rate on GDP* variable.

- The standard, inflation adjusted growth:

$$Standard\_GDP\_Growth\_inflation\_adjusted \times (t - t_0)$$

23.2.3. "Mean available budget for mobile phone expenditure" variable

An assumption had to be made on the impact of GDP growth on available income growth. Such relationship depends of course significantly on the macroeconomic policy and situation at each country level, in particular on the evolution of trade balance, and to a lesser extent on any change in public expenditures.



A detailed modeling of such relationship would have pushed the scope of this research far beyond its core purpose, so a simplified approach was used. Using World Bank yearly macroeconomic data, recorded for each country between 2000 and 2008, we have looked for correlations between yearly GDP growth and yearly consumption growth. In most cases, significant correlations were found, with most usually:

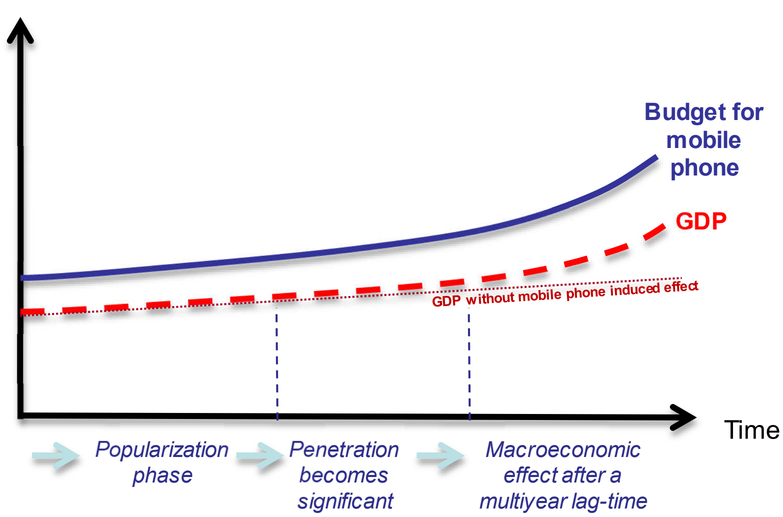
$$0.5 \leq \frac{\partial Consumption\_growth}{\partial GDP\_growth} \leq 1$$

Assuming that the increase in consumption reflects proportionally to the increase in mobile phone budget, we have:

$$Budget\_mobile_t = Budget\_mobile_{t_0} + \Delta GDP_{t_0 \to t} \times \frac{\partial Consumption\_growth}{\partial GDP\_growth}$$

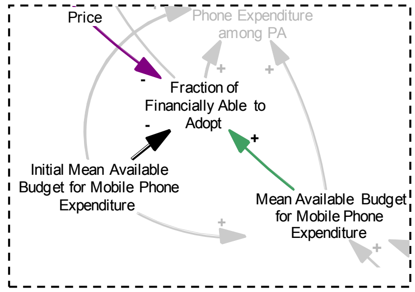
In addition to the income increase linked to the natural growth (or drop in exceptional cases) of GDP, the micro and macroeconomic effects of mobile phone technology diffusion is expected to become visible years after the penetration rate has become significant: at least 30%, to impact overall by more than 2% on the country GDP.

Figure 47: Reference mode – Global perception of product affordability



23.2.4. "Fraction of financially able to adopt" variable (completing paragraph 2.3.1.3)

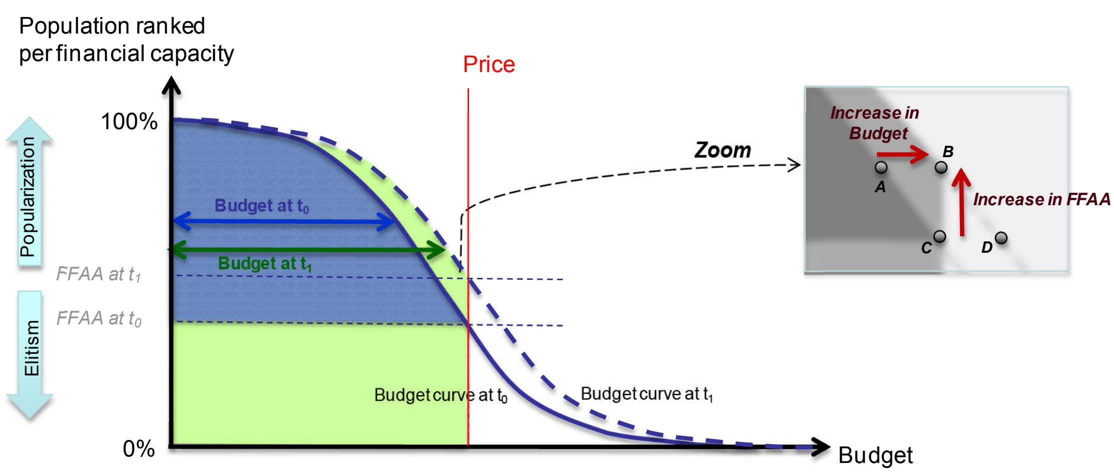
The main assumption made while connecting the Economic leverage component to this variable was that income distribution profile across population remain unchanged as GDP grows. In other words, that the incremental wealth generated by economic growth is redistributed to the population, proportionally to each agent's income. The normalized income profile remains therefore unchanged.



In addition to the widening of the potential adopters' base related to price drop, the GDP increase also contributes to the product diffusion. The following figure illustrates the impact of GDP increase on both the fraction of financially able to adopt and the budgets for mobile phone expenditures, hence leveraging the reinforcing feedback loops of components 2 (product accessibility) and 3 (product affordability).

This figure suggests that for small budget curves increases (acceptable hypothesis considering the small increases in GDP over the short simulation periods):

Figure 48: Impact of GDP increase on FFAA (Fraction of financially able to adopt) and the available budget for mobile expenditure



This can be translated into the following equations (Points A, B, C and D) are defined on the right part of the figure above).

$$FFAA_{Budget\_curve\_t_1}(Price) = FFAA_{Point\_B} = FFAA_{Point\_A} = FFAA_{Budget\_curve\_t_0}(Price_{point\_A})$$

With, geometrically:

$$Price_{Point\_A} \approx Current\_Price \times \frac{Current\_Price}{Price_{Point\_D}} = Price \times \frac{Current\_Mean\_Budget}{Initial\_Mean\_Budget}$$

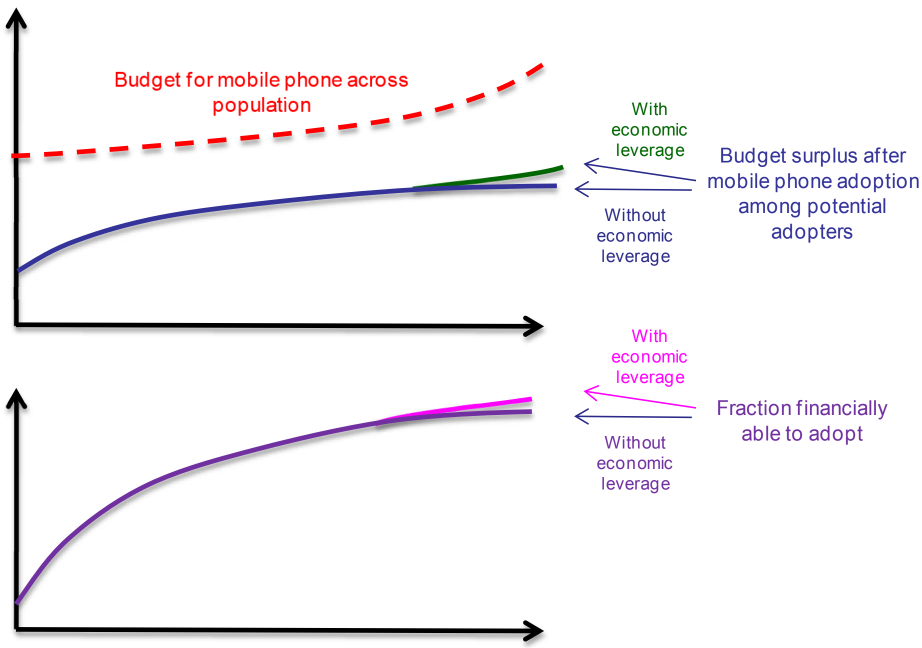
Therefore, the following equation integrates both the direct impact of price reduction and the impact of GDP (and budget) increase on the *Fraction of financially able to adopt variable*:

$$FFAA_{(Budget\_curve\_t_1)}(Price) = FFAA_{(Budget\_curve\_t_0)}\left(Price \times \frac{Current\_Mean\_Budget}{Initial\_Mean\_Budget}\right)$$

$$= FFAA_{(Budget\_curve\_t_0)}\left(Price \times \frac{Current\_GDP}{Initial\_GDP}\right)$$

As explained in the previous paragraph, the economic leverage effect induced effects of marginal magnitude, years after the diffusion reaches its maturity. The expected impact is a slight stimulation of the accessibility (*fraction financially able to adopt*) and affordability (*budget surplus after adoption among potential adopters*) levels.

Figure 49: Reference mode – Accessibility and affordability variables



24. Complement to Model Component 1: Imitation Dynamics

24.1. Complement rationale

Following the same logic as for the uncertainty avoidance index (UAI), Tellis, Stremersch and Yin (2003) showed the statistical correlation between Hofstede's (1980) cultural individualism index (IDV) and the delay between telecom product commercialization and their diffusion take-off.

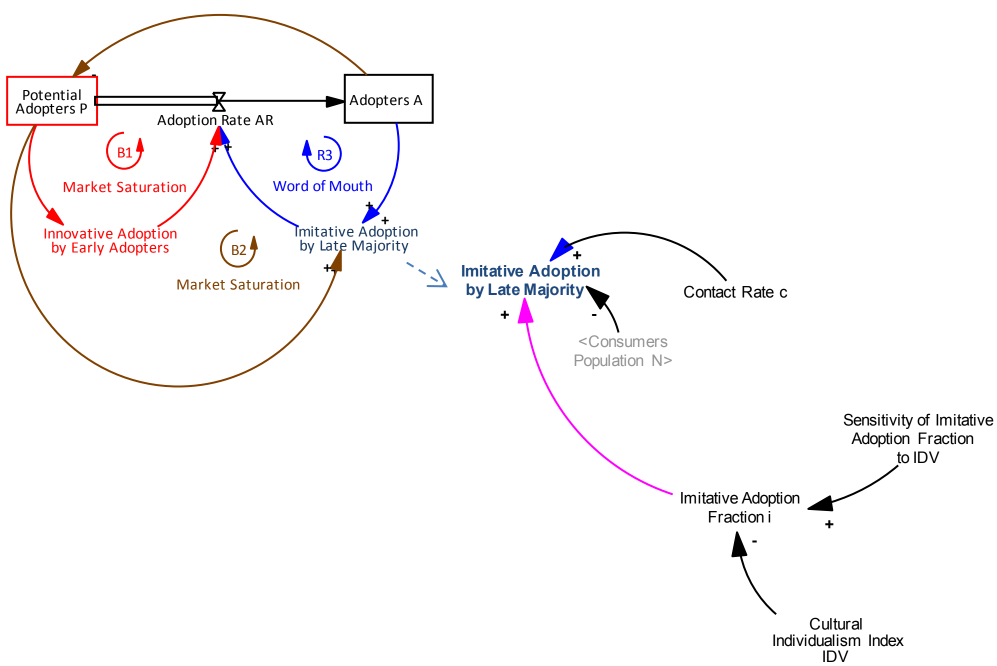
Motives for imitative adoptions can relate to the individuals' need of identification and belonging to a social group (Rogers, 1983). In this context, the cultural individualism index is a proxy to measure one's tendency to stay apart from this imitative process and therefore not be prone to its influence while considering adopting a new product.

As explained in paragraph 19.3, the main input variables of the Sterman (2000) adaptation of the Bass (1969) model related to customers preference dynamics are:

- the *effectiveness of advertising on early adoption*, detailed in the presentation of model component 3, and
- the *adoption fraction*.

The *adoption fraction*, reflecting the frequency of imitative adoption combines with the *contact rate* to yield the imitative adoption rate through word of mouth. IDV factor is most likely to play a role at this imitative adoption level, and more specifically, its connection to the core diffusion model is most relevant though the *adoption fraction* variable.

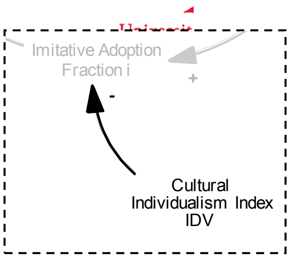
Figure 50: Complement to Model component 1 – Adoption fraction



24.2. Quantitative inputs and parameterization

24.2.1. Cultural Individualism Index IDV

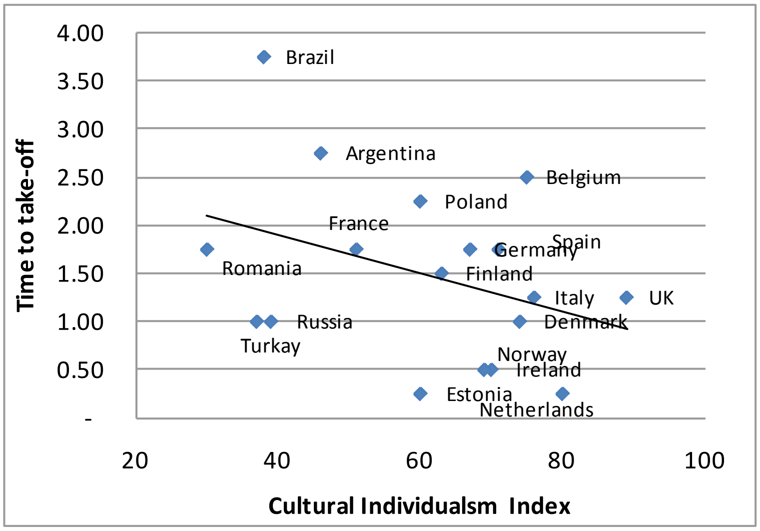
This factor is calculated using the Hofstede (1980) IDV index of the country's trend towards individualism. Its common values range



24.2.2. “Imitative Adoption fraction” variable

The type of relationship between IDV levels and takeoff dynamics of 3G mobile phones observed across the 17 studied countries is consistent with the correlation established by Tellis, Stremersch et Yin (2003), although the correlation is not statistically significant. They both suggest that the effect of IDV on product diffusion should be negative (higher IDV lead to longer diffusion).

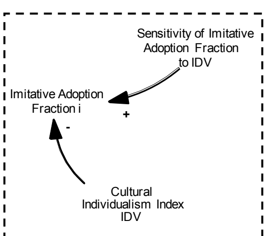
Figure 42: Time to take-off, according to IDV levels (3G diffusion data acrss the 17 countries)



	Variable IDV	R^2
Parameter	-0.022	0.140
T-Student	-1.57	
p-value	0.14	

Neither the univariate nor the bivariate regression involving the UAI and IDV (presented in paragraph 24.2.1) parameters confirms a significant correlation between IDV and the time to take-off variable:

	Variable UAI	Variable IDV	R^2
Parameter	0.019	-0.007	0.032
T-Student	1.65	-0.40	
p-value	0.06	0.69	



The statistical significance identified by Tellis and al. (2003) cannot be confirmed here on the basis of this 17 countries sample. The influence of individualism in imitation dynamics is logically less clearly reflected in the analysis of early diffusion through the time to takeoff measure.

The *imitative adoption fraction* is defined by the application to the IDV variable to its sensitivity factor, considering that the *imitative adoption* function should be decreasing with the IDV level:

$$\textit{Imitative adoption fraction} = \textit{Contact rate} \times (\textit{IDVmax} - \textit{IDV}) \times \textit{Sensitivity of Imitative adoption fraction to IDV}$$

24.2.3. "Sensitivity of Imitative Adoption fraction to IDV" variable

The *Sensitivity of imitative adoption fraction to IDV* is a variable defined once for all countries, and which enables rescale to the IDV variable (defined by Hofstede on a 0 to 100 scale), so that the effect of IDV on Imitative Adoption Fraction inserts into the definition of the Imitative Adoption by Late Majority with a weight consistent with the other components' metrics. However, it is the Contact Rate degree of freedom that already plays that scaling role in this subcomponent of the model.

25. Model Overview

The complete system dynamics model incorporating these six components, is presented on Figure 3. The model combines four main types of variables:

1. At the most upstream level of all calculation chains:

- Input data variables incorporating available hard historical data, *specific to each country*. There are **12** such variables:
    - Consumers base initial size
    - Fractional net increase population rate
    - Income share of xxth decile/quintile
    - Initial GDP
    - Standard GDP Growth
    - Long-term effect of telecom penetration on GDP
    - Cultural Uncertainty Avoidance Index (UAI)
    - Cultural Individualism Index (IDV)
    - Initial Mean available Budget for Telecom Expenditure

- Initial Price
- Initial Experience
- Cost reduction per doubling of experience

- Scaling parameters have values directly and once and for all assigned by the modeller (see paragraphs 22.2.1.3 and 24.2.3). Their values are identical *for all countries* for these **2** scaling parameters:
    - Sensitivity of Perception of Product Affordability to UAI
    - Sensitivity of Imitation Adoption Fraction to IDV
- Calibration variables are the degrees of freedom of the model and are adjusted for *each country* to bring the model to the most realistic representation of observed reality. **Our model has 2 calibration variables**, one for each of the core model diffusion loops (innovative and imitative diffusion). The implicit function of these variables - Effect of Advertising and Contact Rate - is to integrate all the aspects (corporate dynamics, sociological, etc.) that have not been developed in the model.

2. The other type of variables – the calculation variable – is defined as a set of relationships with other model variables, as described throughout this section. Our model contains **21** calculation variables. One of the calculation variables, *Penetration Rate* serves as the benchmark variable during the calibration phase.

   Among these 19 calculation variables, **2** present equations with *country specific coefficients*, whose values result from the econometric methodology described in paragraph 20.2.1.

To summarize:

⇨ "Upstream" variables (not defined as relationship of other model variables):

	Nb of variables		Value		Reflecting historical data	Defined by the modeller
Input data	11		...specific per each country		X	
Calibration variable	2		...specific per each country			X
Scaling parameters	2		...identical for all countries			X

⇨ "Downstream" variables (defined as relationship of other model variables):

	Nb of variables		Value...		Equation terms...
Calculation variable:	21				
With identical equation coefficients	19		calculated from other variables		... specific per country
With country-specific coefficients	2		calculated from other variables		...identical for all countries

The classification of each variable is described in Figure 4.

Figure 52: Overview of the diffusion model

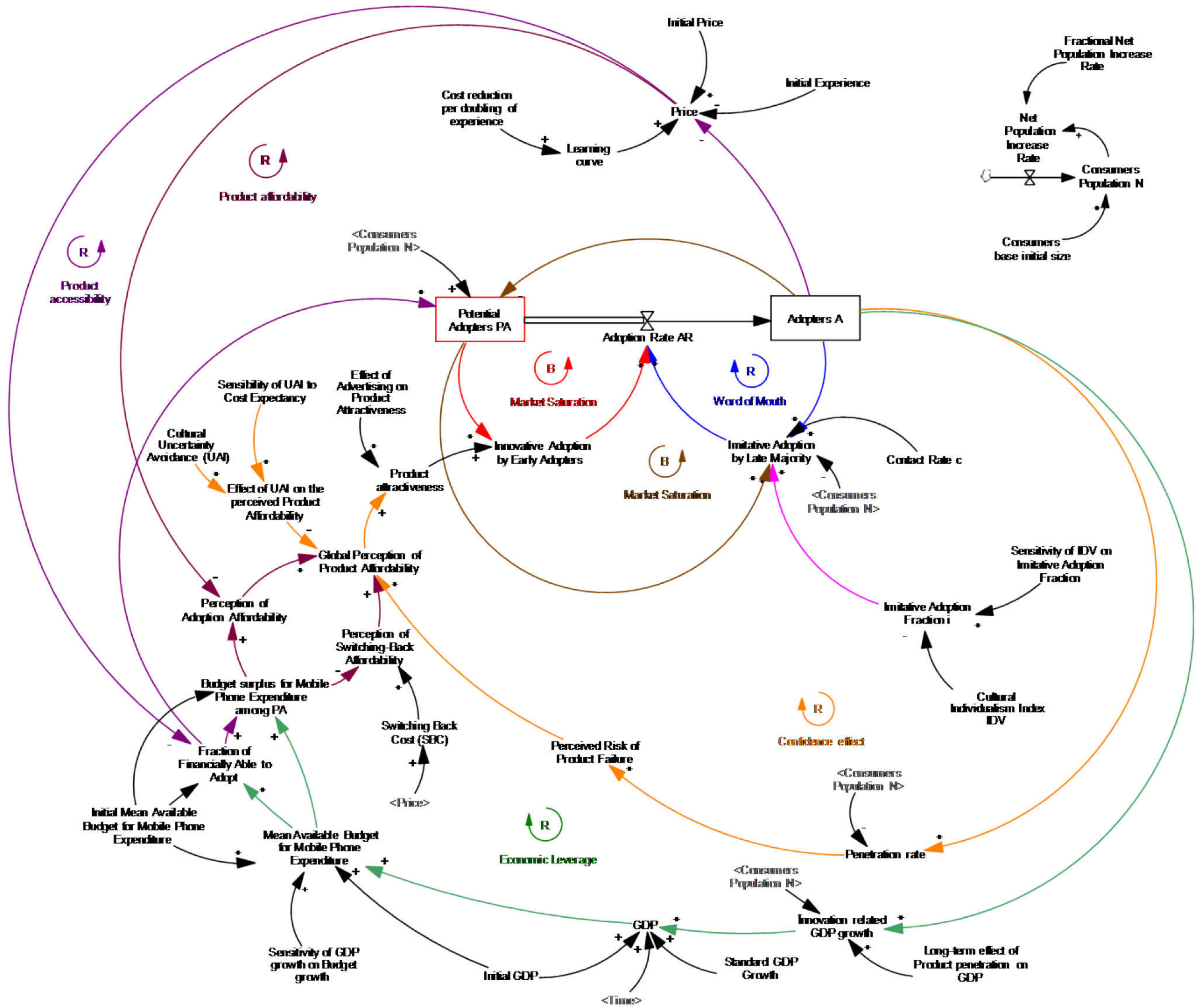


Figure 53 : Model overview with variables outlines by type

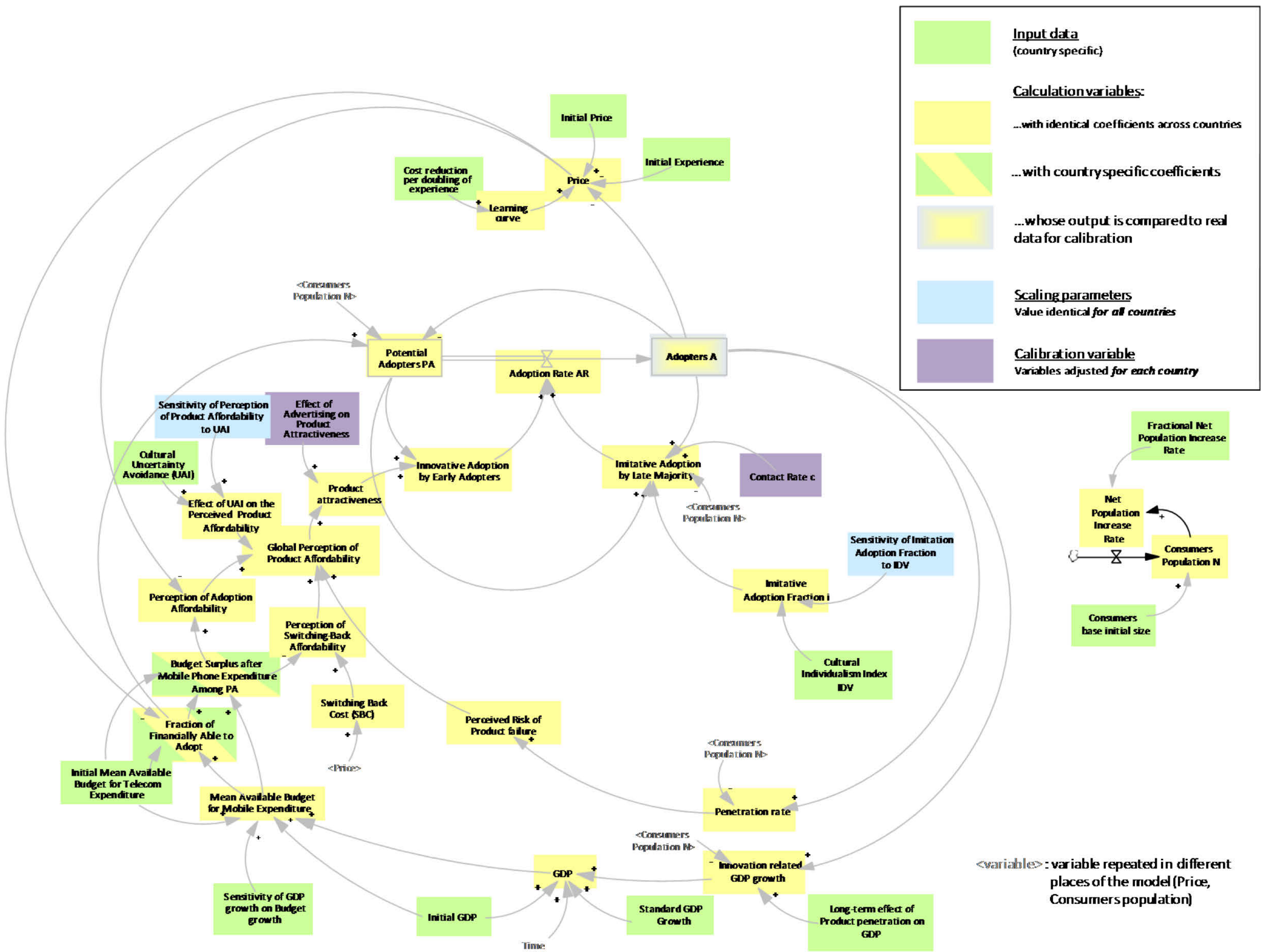

Input data
(country specific)
Calculation variables:
...with identical coefficients across countries
...with country specific coefficients
...whose output is compared to real data for calibration
Scaling parameters
Value identical for all countries
Calibration variable
Variables adjusted for each country
Initial Price
Initial Experience
Cost reduction per doubling of experience
Learning curve
Price
<Consumers Population N>
Potential Adopters PA
Adoption Rate AR
Adopters A
Sensitivity of Perception of Product Affordability to UAI
Effect of Advertising on Product Attractiveness
Cultural Uncertainty Avoidance (UAI)
Effect of UAI on the Perceived Product Affordability
Product attractiveness
Innovative Adoption by Early Adopters
Imitative Adoption by Late Majority
Contact Rate c
Global Perception of Product Affordability
Perception of Adoption Affordability
Perception of Switching-Back Affordability
Budget Surplus after Mobile Phone Expenditure Among PA
Switching Back Cost (SBC)
<Price>
Perceived Risk of Product failure
Fraction of Financially Able to Adopt
Initial Mean Available Budget for Telecom Expenditure
Mean Available Budget for Mobile Expenditure
Sensitivity of GDP growth on Budget growth
Initial GDP
GDP
Time
Standard GDP Growth
Innovation related GDP growth
Long-term effect of Product penetration on GDP
Penetration rate
Sensitivity of Imitation Adoption Fraction to IDV
Imitative Adoption Fraction i
Cultural Individualism Index IDV
Fractional Net Population Increase Rate
Net Population Increase Rate
Consumers Population N
Consumers base initial size
<variable>: variable repeated in different places of the model (Price, Consumers population)

Table 14: The complete inventory of model's variables and data sources

Variable	Type	Source / Methodology
Population		
Consumers base initial size	Input variable	World Bank Database
Fractional net population increase rate	Input variable	World Bank Database
Net population increase rate	Calculation	See paragraph 19.2
Consumers population N	Calculation	See paragraph 19.2
Econometrics		
Initial mean available budget for telecom expenditure (initial)	Input variable	International Comparison Program (2005)
Mean available budget for telecom expenditure	Calculation	See paragraph 23.2.3
Fraction of financially able to adopt	Calculation variable / Statistical data	World Bank Database See paragraph 20.2.1
Budget surplus after telecom expenditure among Potential Adopters	Calculation variable / Statistical data	World Bank Database See paragraph 0
Economy		
Initial GDP	Input variable	World Bank Database
Standard GDP growth	Input variable	World Bank Database
Innovation related GDP growth	Calculation	See paragraph 23.2.1
Long-term effect of telecom penetration of GDP	Input variable	Qiang, Rossoto and Kimura (2009)
Sensitivity of budget growth to GDP growth	Input variable	See paragraph 23.2.1
Adoption model (« innovative » component)		
Effect of advertising on product attractiveness	Calibration variable	
Product attractiveness	Calculation	See paragraphs 21.1 and 21.2.5
Cultural Uncertainty Avoidance Index (UAI)	Input variable	Hofstede scale (1980)
Sensitivity of Perception of Product Affordability to UAI	Scaling parameter	See paragraph 22.2.1.3
Effect of UAI on the Perceived Product Affordability	Calculation	See paragraph 22.2.1.2
Global Perception of Product Affordability	Calculation	See paragraph 22.2.3
Perception of Adoption Affordability	Calculation	See paragraph 21.2.1.3
Perception of Switching-Back Affordability	Calculation	See paragraph 21.2.2.3
Budget Surplus for Mobile Phone Expenditure	Calculation	See paragraphs 0 an 21.2.2.2

Variable	Type	Source / Methodology
among potential adopters		
Fraction of Financially Able to Adopt	Calculation	See paragraph 20.2.3
Perceived risk of product failure	Calculation	See paragraph 22.2.2.2
Innovative adoption by early adopters	Calculation	See paragraph 22.1
Adoption model (« imitative » component)		
Contact rate	Calibration variable	
Cultural Individualism (IDV)	Input variable	From Hofstede scale (1980)
Sensitivity of Imitative Adoption Fraction to IDV	Scaling parameter	See paragraph 24.2.3
Imitative Adoption Fraction	Calculation	See paragraph 24.2.2
Imitative Adoption by Late Majority	Calculation	See paragraph 23.1
Price		
Initial price	Input variable	Tarifica database (2008)
Initial experience	Input variable	Dataxis - Broadband Mobile Digital Data
Cost reduction per doubling of experience	Input variable	See paragraph 20.2.2
Learning curve	Calculation	See paragraph 20.2.2
Price	Calculation	See paragraph 20.2.2
Switching back cost	Calculation	See paragraph 20.2.2
General		
Penetration rate	Calculation	See paragraph 19.2
Potential adopters	Calculation	See paragraph 19.2
Adopters	Calculation	See paragraph 19.2
Adoption rate	Calculation	See paragraph 19.2

26. SYSTEM DYNAMICS MODEL CALIBRATION

26.1. Selection of sales data

The calibration exercise has been performed on 3G mobile phones diffusion records from 17 countries:

Table 15: List of countries used for model calibration

Group	Country	
OECD Countries	France	Germany
	Spain	Italy
	Denmark	Finland
	Ireland	Netherlands
	Norway	UK
	Belgium	
Eastern Europe	Poland	Estonia
	Russia	
Middle-East	Turkey	
Latin America	Argentina	Brazil

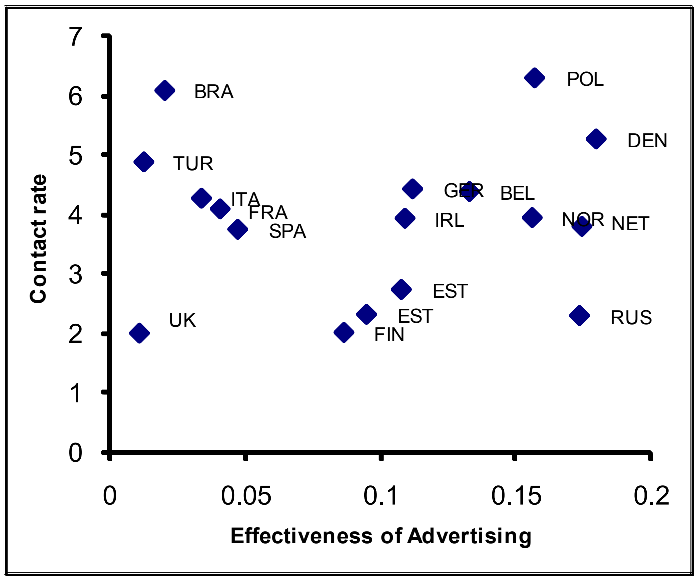
Quarterly observations (Dataxis - Market data and forecasts – Broadband Mobile Digital) were available from 2003 to 2006, and after 2006 yearly data (Yankee Group Market forecast database) were used to calibrate the model.

26.2. Calibration results

The model calibration across 17 countries on the two degrees of freedom (contact rate and attractiveness of advertising) has been carried out using the calibration module available on Vensim DSS® software which minimizes the weight squared residuals using a variant version of Powell conjugate gradient search method, with multiple random starts. The software's optimizing algorithm automatically adjusts the calibration variables to offer the best fit with observed data.

The quality of calibration to 3G diffusion data is very satisfactory for all 17 countries, as illustrated on the Figure 5, Figure 6 and Figure 7 below.

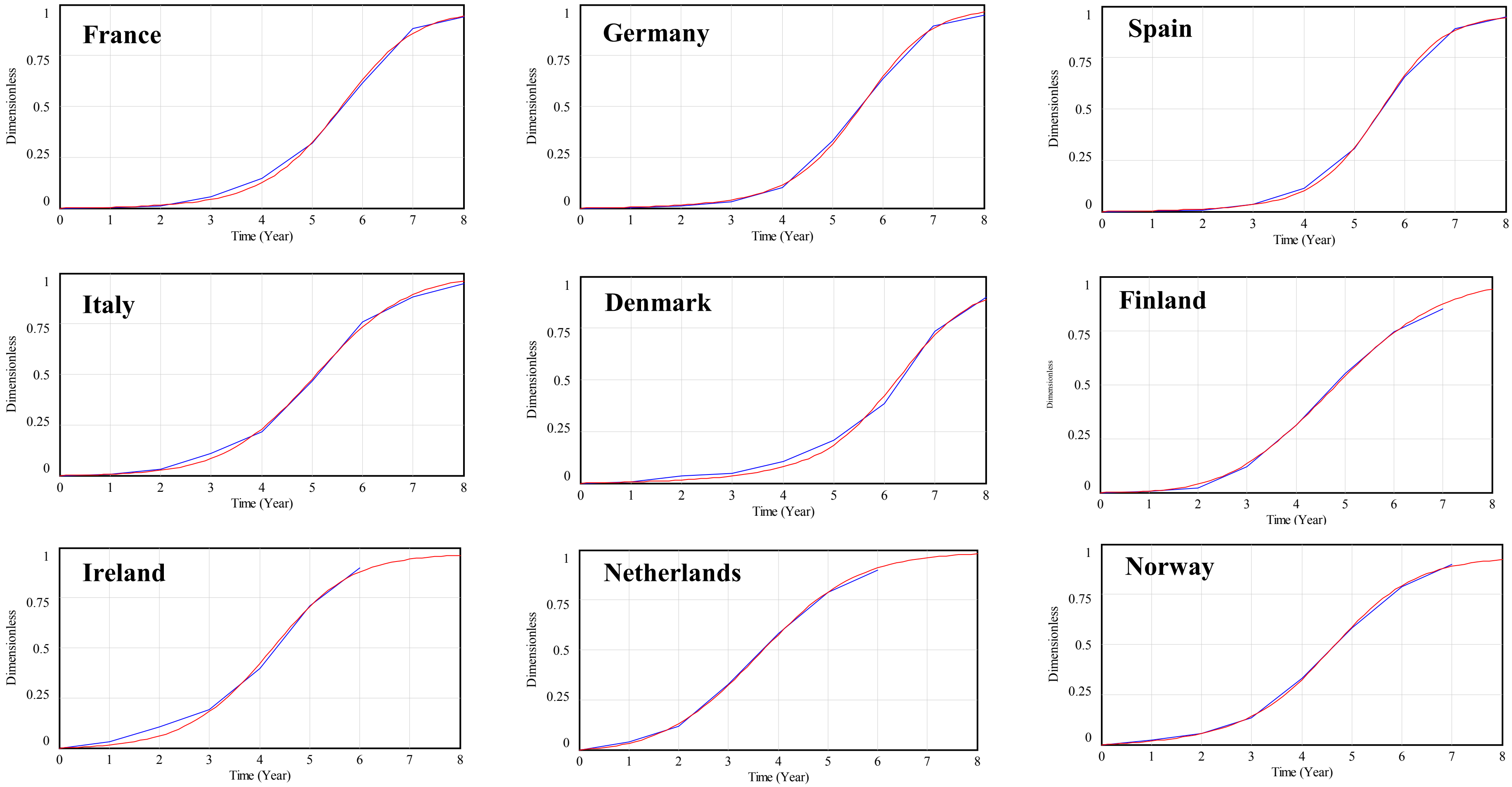
Figure 54: Calibrated values for the Effectiveness of Advertising and Contact rate variables



Additional analyses have been carried in order to increase the explanatory power of the model, by relating these calibration values to known variables (such as contact rate to population density, effect of advertising to other cultural variables, etc.). No such correlation could be identified.

Figure 58 presents the output graphs of the main variables for the case of France. All curves are consistent with the proposed reference modes. The two calibrated variables (*Effectiveness of Advertising on Innovative Adoption*, connected to the innovative adoption loop and *Contact Rate*, connected to the imitative adoption loop) have been set-up to the pairs of values illustrated on the figure below.

Figure 55: 3G mobiles penetration rate across consumers bases in OECD countries – Simulations and observed



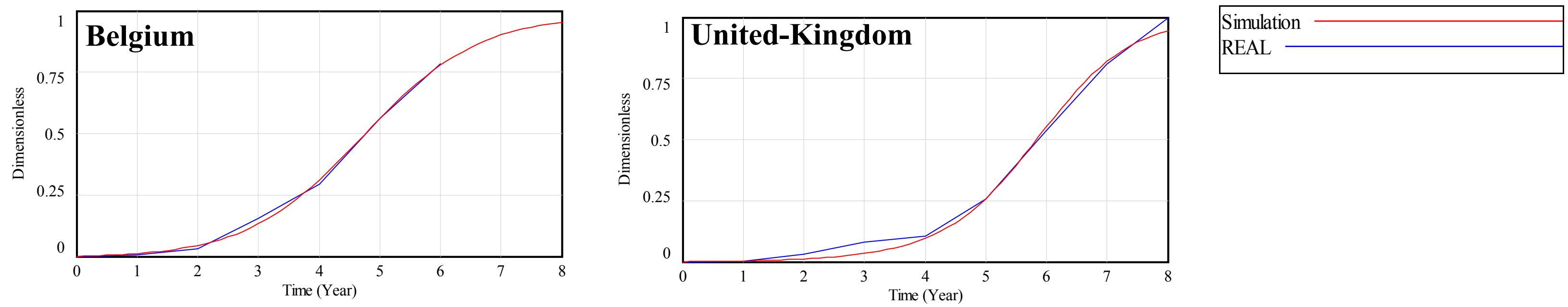


Figure 56: 3G mobiles penetration rate across consumers bases in Eastern and Southeastern Europe countries – Simulations and observed

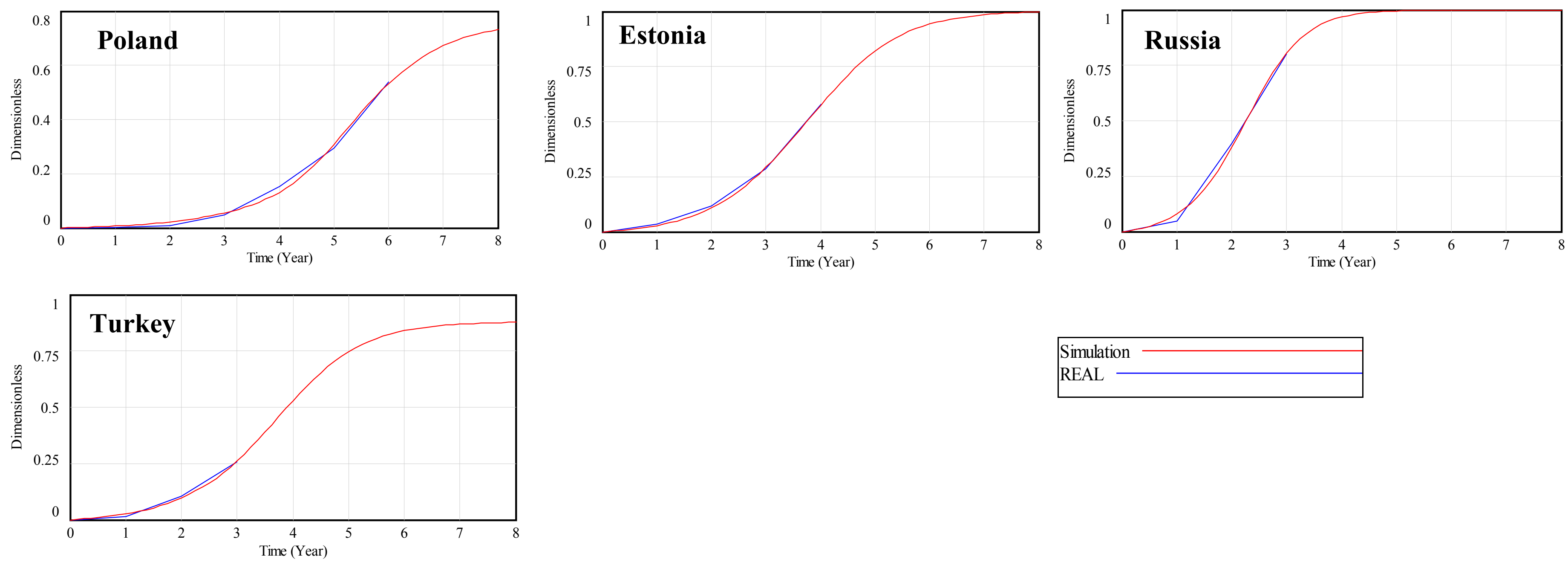
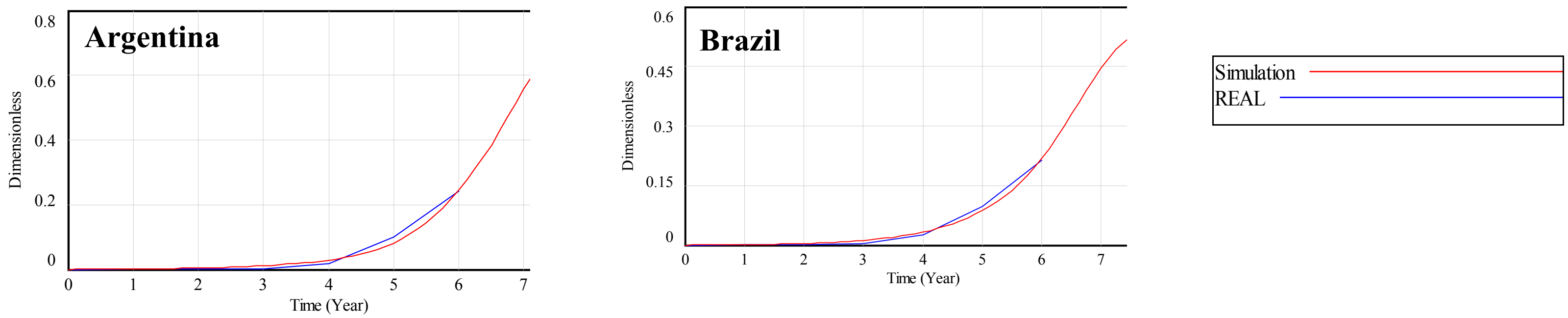


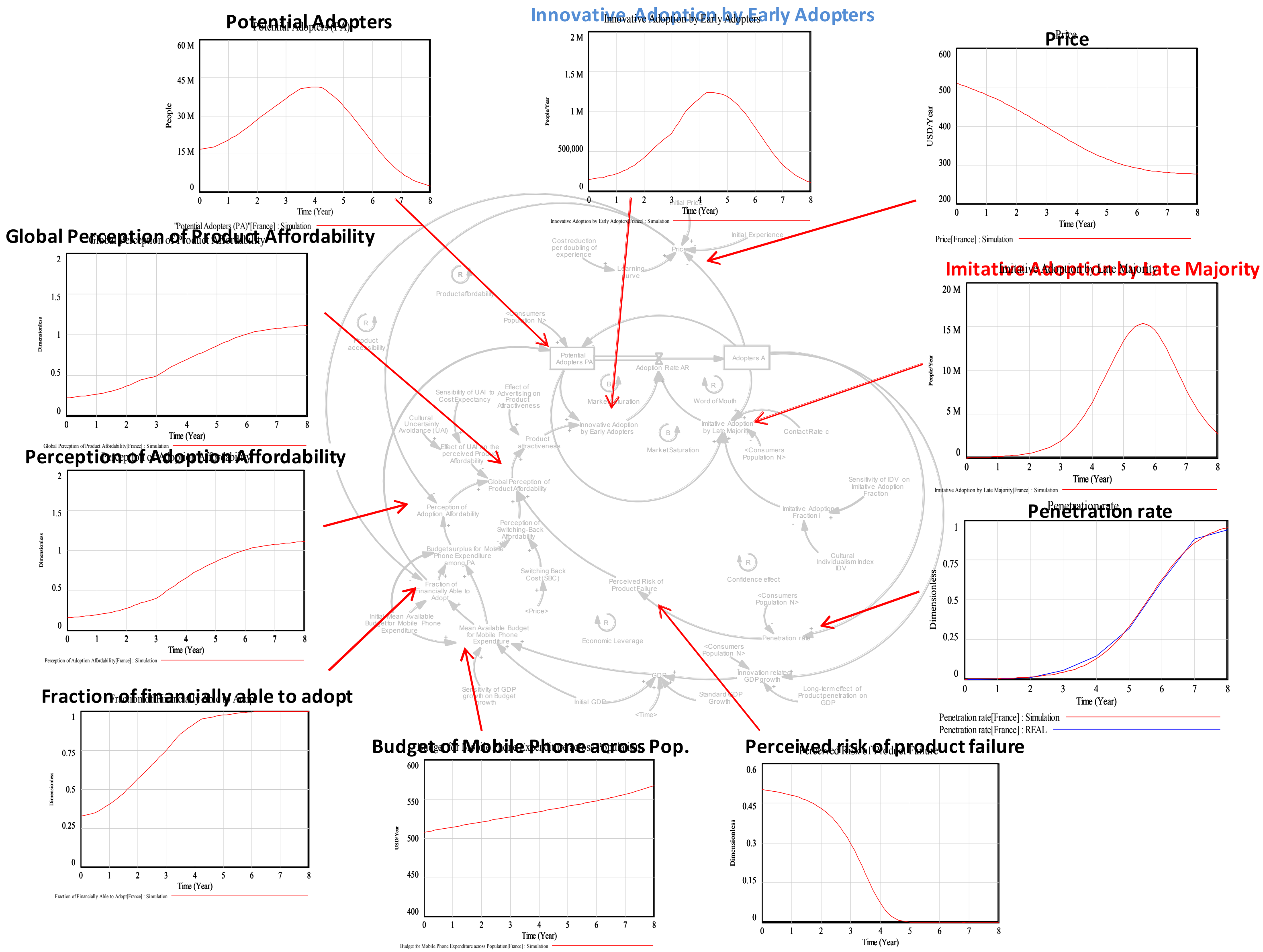
Figure 57: 3G mobiles penetration rate across consumers bases in Latin American countries – Simulations and observed



As can be observed on the 17 set of historic data illustrated above, most historic diffusion patterns follow typical S-shape curve. The most common deviation from this standard S-shape corresponds to more progressive product diffusion up to half market capacity, than with the Bass model (inflection point of the S-curve late in the overall product diffusion history).

Seven countries show, to a certain extent, such this type of diffusion pattern deviation from S-shape: France, Spain, Italy, Denmark, Ireland, Norway and the United-Kingdom. No direct information is available on a case by case on the reasons for such diffusion pattern. It could be assumed that market heterogeneity (in terms of population willingness of capacity to pay) may have been a factor in delaying the trigger of mass diffusion. Furthermore, one can observe that this pattern is characteristic of the penguin effect (called as well herd behavior), in which risk perception plays a significant role in product adoption, and decreases significantly as the adopters' base broadens. Component 4 (Confidence effect and network externalities) integrates these specific mechanisms. The contribution of this component to the goodness-of-fit is further discussed in 28.

Figure 58: Outputs from the calibrated model – 3G in France



The goodness-of-fit has been assessed using various metrics, which all confirm that excellent fits were reached through the calibration. The Theil's inequality statistics show that most of the error relates to covariance, which is logical since the model is not oscillatory. As discussed in section 28, this very strong goodness-of-fit is observed as well with the Bass reference model. The main value-added of the proposed model extension lies first and foremost in the models' capacity to adequately represent the impact of policy actions or business strategies.

It has to be noted that the choice to focus the study on such innovative product in a large number of countries did limit significantly the amount of historical data available for a statistical analysis. In any case, in 11 of the 17 countries, penetration had reached over 75% of potential market, and even though the number of observations was limited, it gave a clear understanding of the main diffusion history.

Table 16: Goodness-of-fit indicators – Extended model calibration

					Theil's inequality statistics		
	Number of observations	R2	MAE / Mean	RMSE	Bias Fraction	Unequal Variance Fraction	Unequal Covariance Fraction
France	8	0.9986	3.3%	1.39%	0.01	0.00	0.99
Germany	8	0.9992	2.9%	1.15%	0.09	0.02	0.89
Spain	8	0.9998	1.4%	0.60%	0.04	0.18	0.78
Italy	8	0.9983	3.2%	1.57%	0.00	0.07	0.93
Denmark	8	0.9961	6.3%	2.20%	0.16	0.00	0.84
Finland	7	0.9985	2.9%	1.34%	0.13	0.01	0.86
Ireland	6	0.9961	5.0%	2.36%	0.23	0.05	0.72
Netherlands	6	0.9994	1.5%	0.84%	0.02	0.03	0.95
Norway	7	0.9996	1.4%	0.64%	0.03	0.03	0.94
UK	8	0.9955	5.5%	2.74%	0.23	0.01	0.76
Belgium	6	0.9978	3.4%	1.33%	0.00	0.03	0.97
Poland	6	0.9958	6.7%	1.31%	0.03	0.09	0.88
Estonia	4	0.9992	2.5%	0.69%	0.16	0.15	0.69
Russia	3	0.9969	4.4%	2.06%	0.17	0.23	0.61
Turkey	3	0.9958	4.9%	0.75%	0.09	0.25	0.66
Argentina	6	0.9886	12.5%	0.96%	0.02	0.03	0.95
Brazil	6	0.9939	9.8%	0.66%	0.08	0.08	0.84

Discussions and Findings

The objective of the modeling exercise was to develop a diffusion model integrating several economical, socio-economical and cultural concepts suggested by literature review and Experts interviews.

Before presenting simulation findings, section 27 discusses the specific application of System Dynamics developed in this research to fit the research objectives and constraints. Assessing the value-added and limits of such extension of the Bass reference model can then be undertaken by comparing the goodness-of-fit of the simulations under both models (section 28), and identifying the potential modeling improvements or limitations unveiled by the extended model. However, such analysis would not be sufficient since the ability to fit the historical data does not provide a sufficient basis for concluding on the relevance and strength of different feedback mechanisms that might be responsible for the dynamics at play. Since the main purpose is to design and test policies for system improvement, the key achievement discussed below is the model's ability to integrate policies and to respond correctly to them (section 4).

27. Comparing Modelling Techniques for Diffusion of Innovations

System dynamics approach, based on differential equation modeling, has been extensively used in the analysis of product diffusion for two reasons. As suggested in the comparison of different modeling approaches – in particular agent-based (AB) modeling vs. system dynamics or differential equation modeling (DE) – performed by Rahmandad and Sterman (2008), the modeling approach seems best appropriate to:

a. include highly aggregated variables (market penetration, product cost, etc.) relevant to the analysis of product diffusion;
b. extend model boundaries, integrating important factors from distant fields (marketing, economy, sociology, policy, etc.) into a unique, holistic representation.

On the other hand, the main advantages of using agent-based approaches lie in the convenient modeling of population complex topology (Axtell, Axelrod, Epstein and Cohen, 1996; Rahmandad and Sterman, 2008). Such approach is therefore better adapted to the exploration of population heterogeneity and social interaction dynamics.

Our research approach combined both types of requirements:

- **best adapted to DE:** including highly aggregated variables (price, average budget, GDP, sales…) and extending the Bass reference model to price, economic, cultural, psychological considerations
- **best adapted to AB:** integrating heterogeneity to the consumers base through income profiles. Intrinsically, the use of cultural indexes can in addition be considered as a simplified parameterization of complex social of interactions.

In the case of this research, the DE approach was more relevant to keep focus at a higher aggregated level in the product diffusion ecosystem. Besides, the only data available to calibrate the model was penetration rate historical data. However, throughout the modeling exercise, our attempt to develop econometric considerations and to recognize the markets heterogeneity have driven the application of an intermediary modeling approached, based on the hyper-segmentation by income level of the main stock variable, potential adopters, (e.g. considering them according to their respective income levels). Such type of disaggregation enables to introduce a certain level of granularity in DE models, by reflecting the diversity of individuals. However, its main limitation is that under a DE approach, interactions between them still cannot be described or parameterized.

To the extent that such interactive process becomes determinant only in a later phase of market diffusion (when imitative adoption takes over innovative adoption as main driver of diffusion), such DE modeling approach including market segmentation appears particularly well adapted to analyze the take-off of innovative products. Similar model developments could enable, for example, to consider entry adoption *price* as heterogeneous, since people's minimal expectations vary according to their means and standards. It would enable to explore the nuances of the uncertainty aversion index, reflecting specific psychological patterns (opinion leadership, willingness to take risks…) of the various adopters' categories: "innovators", "early adopters", "laggards", etc. described by Rogers (1962).

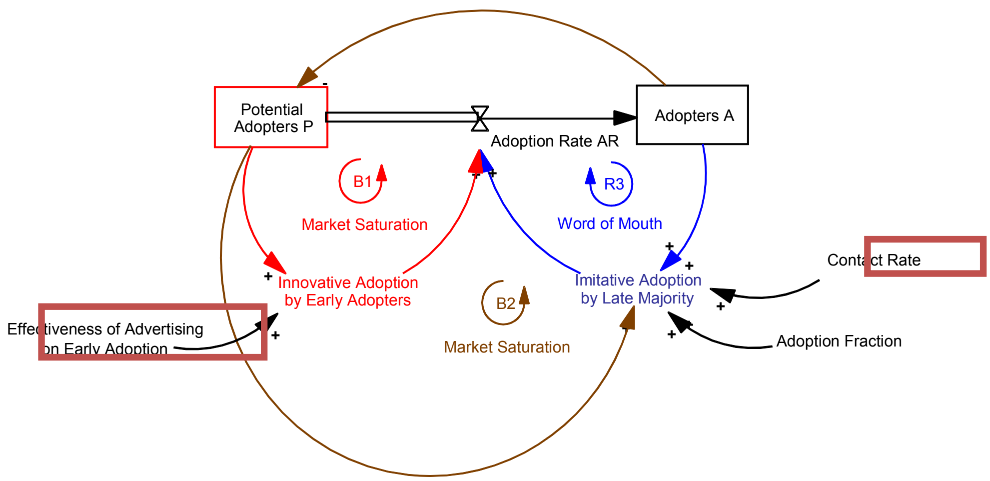
For future development of the model, agent-based analysis would in any case remain relevant to improve the parameterization of the *affordability*, *uncertainty aversion* and *risk perception* concepts when applied to aggregated consumers populations. The DE model shall then be upgraded using this improved parameterization.

28. COMPARING GOODNESS-OF-FIT OF DIFFUSION MODELS

As described in paragraph 26.2, adjustment of the two calibration variables has been performed with each of the 17 countries datasets. Such exercise was carried out in a similar way with the Bass reference model, driven as well by two calibration variables[13], each one attached to a core diffusion loop.

[13] Both the Contact rate and the Adoption fraction can be considered as calibration variables, but since they appear only as their product in the model set of equations, they together represent a single degree of freedom to the model.

Figure 59: Degrees of freedom in the Bass reference model



As with the developed model, the goodness-of-fit of the calibrated Bass model is excellent in all cases. Since both models calibrations have been run using two degrees of freedom, a direct comparison of fit to data statistical indicators can be made. Table 8 presents these results.

Table 17: Goodness-of-fit indicators – Bass model calibration and comparison of fit between models

		R2		MAE / Mean		RMSE		Fit[14]:
	Number of observations	Ref. model	Ext. model	Ref. model	Ext. model	Ref. model	Ext. model	Ext. vs. Ref. model
France	8	0.9985	0.9986	3.7%	3.3%	1.73%	1.39%	+
Germany	8	0.9985	0.9992	3.4%	2.9%	1.71%	1.15%	+
Spain	8	0.9997	0.9998	1.6%	1.4%	0.92%	0.60%	+
Italy	8	0.9981	0.9983	3.1%	3.2%	1.63%	1.57%	0
Denmark	8	0.9953	0.9961	7.4%	6.3%	2.57%	2.20%	+
Finland	7	0.9950	0.9985	5.7%	2.9%	2.44%	1.34%	++
Ireland	6	0.9965	0.9961	4.7%	5.0%	2.16%	2.36%	-
Netherlands	6	0.9987	0.9994	2.2%	1.5%	1.23%	0.84%	+
Norway	7	0.9993	0.9996	2.1%	1.4%	0.97%	0.64%	++
UK	8	0.9911	0.9955	8.7%	5.5%	3.90%	2.74%	++
Belgium	6	0.9982	0.9978	3.9%	3.4%	1.36%	1.33%	0
Poland	6	0.9975	0.9958	13.2%	6.7%	3.05%	1.31%	++

[14] General qualifications used for goodness-of-fit comparison: "++": significant improvement; "+": some improvement; "0": no clear improvement; "-": some deterioration.

	Number of observations	R2 Ref. model	R2 Ext. model	MAE / Mean Ref. model	MAE / Mean Ext. model	RMSE Ref. model	RMSE Ext. model	Fit[14]: Ext. vs. Ref. model
Estonia	4	0.9994	0.9992	2.1%	2.5%	0.61%	0.69%	-
Russia	3	0.9957	0.9969	5.1%	4.4%	2.26%	2.06%	+
Turkey	3	0.9853	0.9958	8.4%	4.9%	1.34%	0.75%	++
Argentina	6	0.9938	0.9852	9.3%	8.6%	0.71%	0.76%	0
Brazil	6	0.9936	0.9939	9.2%	9.8%	0.64%	0.66%	0

It shows that over the 17 countries, the extended model seems to offer better fitted calibration to the 3G mobile sales datasets that the reference model. Goodness-of-fit could be qualified as significantly better in 5 cases, somewhat better in 6 cases, no significantly changed in 4 cases, and somewhat deteriorated in 2 cases.

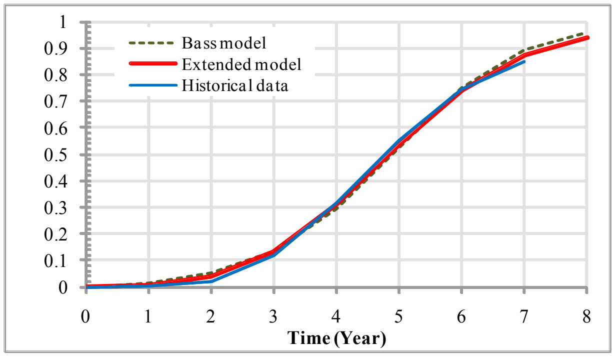
Although in the framework of this research, no sufficient information would have been available at country level to investigate historical factors determining the relevance of the proposed model, we have tried to conduct such analysis at graphical and conceptual levels:

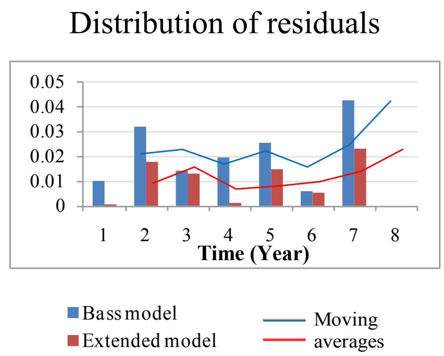
The following graphs on the left represent the fitted penetration curves for the Bass and the extended model, as well as the historical curve. The figures on the right enable to better visualize the magnitude of residuals for each curve, along the diffusion period.

The first four sets of graphs focus on the countries where significant fitting improvement has been observed based on the RMSE and MAE/MEAN indicators (the case of Turkey is not illustrated as the calibration was based on only 3 historical data points):

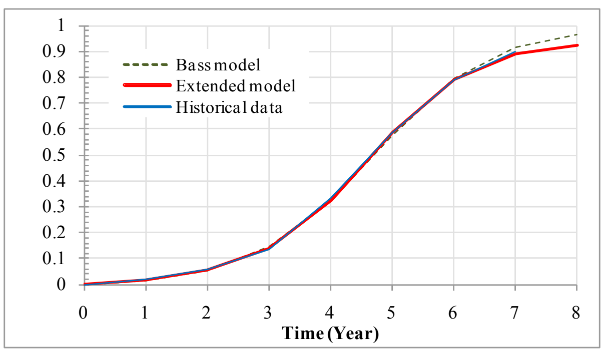
Figure 60: Calibrated vs. Historical curves and Residuals: Bass and the Extended models.

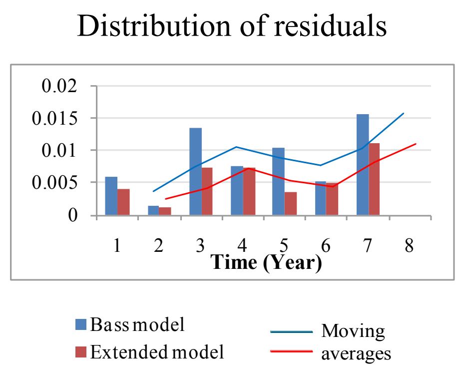
Finland



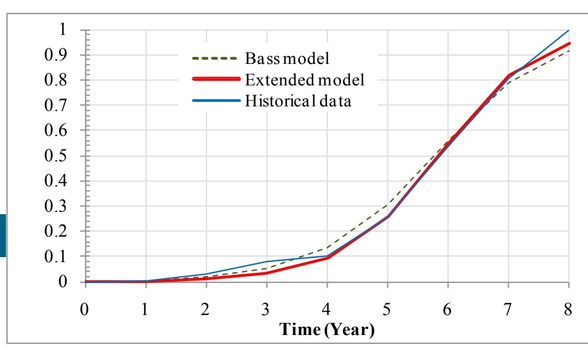


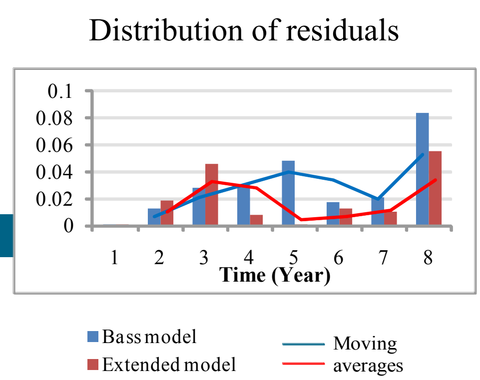
Norway



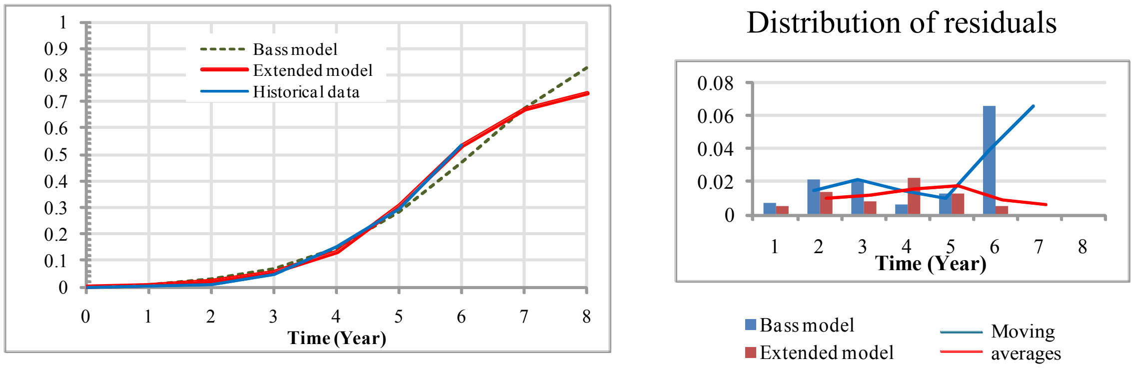


United-Kingdom





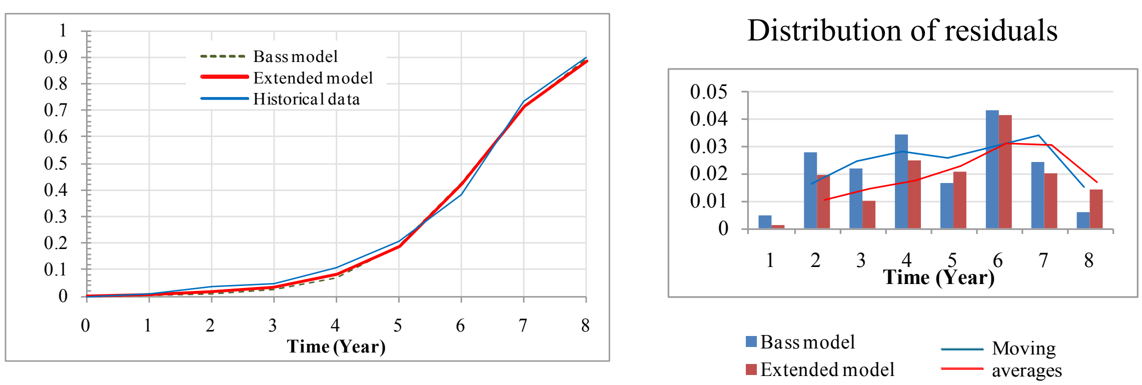
Poland



Two main observations can be drawn from this set of figures:

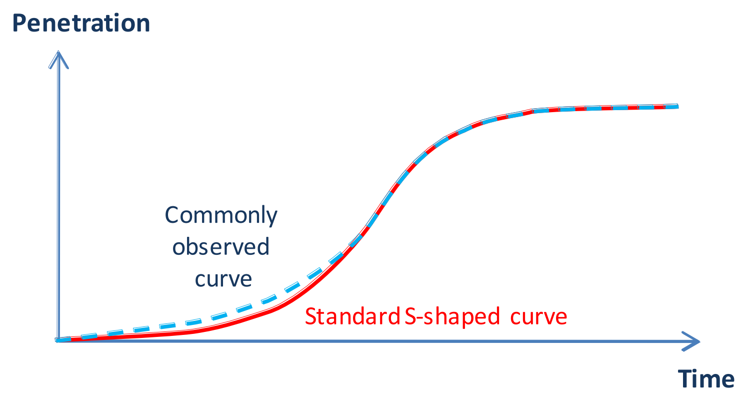
- Improved goodness-of-fit is visible with countries where product diffusion has most departed from a standard S-shaped curve, which is particularly clear in the cases of the UK, Poland or Norway illustrated above or Denmark shown below.

Denmark



In these cases, curve inflection points are reached above 50% of market capacity suggesting that mass diffusion mechanisms have not been triggered as early as a reference Bass-diffusion models would suggest:

Figure 61: Common diffusion pattern deviating from standard S-shaped curve



As commented in section 26.2, no direct information is available on the causes of this deviation from the S-shaped curve in these specific countries. However, two phenomena could seem particularly relevant to explain these specific diffusion patterns:

- market heterogeneity (from the perspective of population capacity to pay) curbs the trigger of mass diffusion until large middle class groups are able to afford the product, as described in the presentation of model *Component 2*. Once large homogeneous groups of potential adopters enter the market, diffusion dynamics start showing standard S-shape curve patterns. Because this phenomenon is observed in Western countries were product was already affordable to a large segment of population at the time of its commercialization, another factors should be considered:
- penguin effect induces a significant market resistance in the earlier diffusion stages, which is releases once a critical mass of adoptions have occurred. Such phenomenon is captured in the extended model through *Component 4* (confidence effects): it integrates into the global product attractiveness the perceived risk of product failure as a dynamically influenced by the history of peers' adoption.
-

The improved calibration would therefore reflect the added-value of the extended model socio-economic components 2 and 4, by incorporating two major dimensions of telecom product diffusion: market socio-economic heterogeneity and confidence effects

- In the case of Norway, we see that two models offering a very strong fit on the 6 to 7 years when historical data is available can significantly differ in their "projections" on the 8th year. This underlines the importance of using additional, qualitative criteria to assess the relevance of a model. It confirms as well that such modeling approach, in particular when applied to diffusion of innovation where historical information is limited, should not be considered as a predictive tool. **Its relevance should rather be sought in its capacity to represent and support the analysis of policy actions.**

29. OVERVIEW OF MODEL EXTENSIONS AND BEHAVIOUR

The Core diffusion system dynamics model based on Bass diffusion model has been extended with the addition of four new feedback loops (components) which have been built using insights from both literature review and interviews, as illustrated in Tableau 7:

Table 18: Summary of the feedback loops/new components added to Bass diffusion model

Model Component name	Captured concept / dynamics	Key related variables
Product accessibility	- Marketing mix	- Price
	- Market heterogeneity	- Fraction of financially able to adopt
Product	- Market	- Available telecom budget after

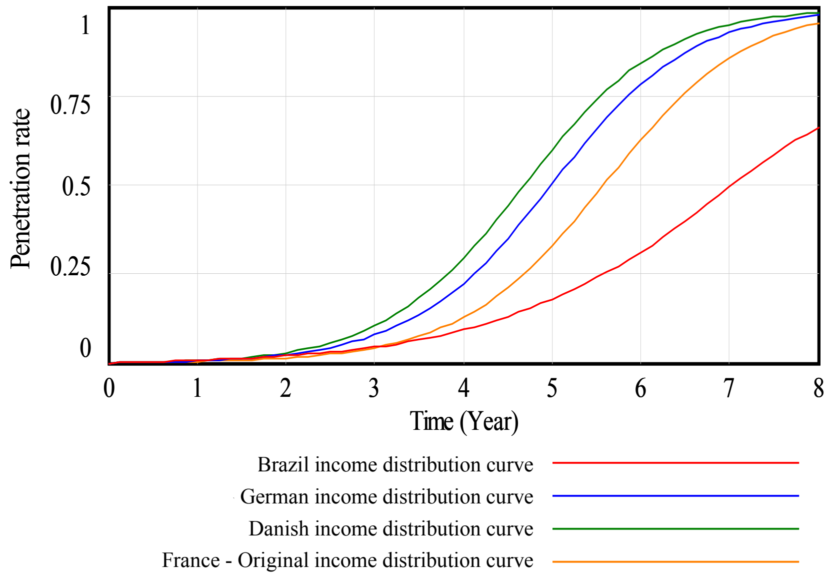
affordability	heterogeneity	product adoption
	- Total cost of adoption	- Uncertainty Avoidance Index - Switching back cost - Global perception of product affordability
Confidence effect	- Penguin effect	- Perceived risk of product failure
Economic leverage	- Effect of mobile technology on GDP	- Long-term effect of product penetration on GDP growth

The model sensitivity to these key variables is of particular interest for practitioners, who may want in particular to appreciate the relative importance of aspects such as *income inequality* and *uncertainty avoidance* in the expected diffusion of products across new markets. To illustrate such sensitivity, we have considered France as the reference diffusion context, and analyzed the sensitivity of two factors on diffusion dynamics:

- **Income inequality**

All other context parameters being kept equal (mean income level, cultural aspects, etc.), we introduced ***variations into the income distribution curve*** in France: we ran two simulations, distorting its budget for telecommunication curve to reflect more income-equal societies (Germany and Denmark) and one curve from a more income-unequal society (Brazil). The following graph shows the variations in penetration rate outputs:

Figure 62: Penetration rate for 3G mobile phone in France + 3 variations in the income distribution curve

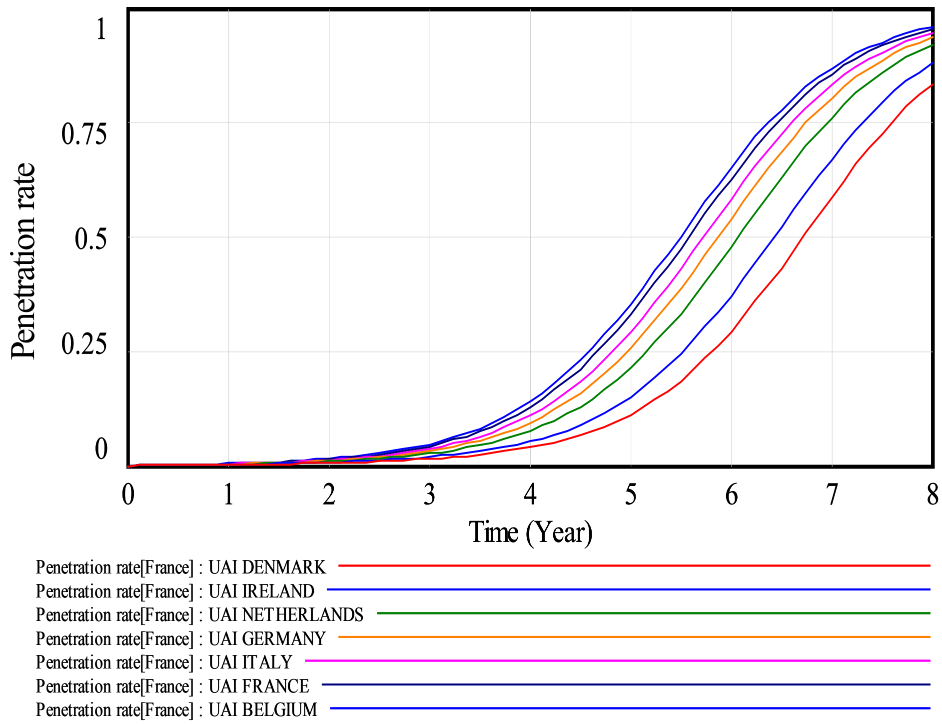


Therefore, income homogeneity is conducive to accelerated diffusion dynamics: all other aspects being kept equivalent, <u>including the global economic level</u>, the income distribution pattern observed among OECD countries induces almost a 1-year difference in the diffusion dynamics. Extended to middle-income countries with higher income inequalities, the difference in the timing of market saturation reaches 4 years.

- **Uncertainty avoidance index**

Similarly: ***variations in the Uncertainty avoidance index value***, all other aspects being kept to their original conditions of the French context, induce variations of about 0.8 years in the sales diffusion dynamics. The following graph gathers simulations for UAI levels varying between 30 (most uncertainty avoidant countries, such as Ireland or Denmark) and 100 (least uncertainty avoidant countries, such as Belgium):

Figure 63: Penetration rate for 3G mobile phone in France + 6 variations in UAI levels



In conclusion, cultural uncertainty avoidance is a significant factor to be taken into consideration while exploring the diffusion dynamics of innovations: all other parameters being kept equal, the levels of cultural risk aversion can impact diffusion speed by more than 1 year,

30. POLICY ACTIONS AND RESEARCH IMPLICATIONS

Policy makers in the telecommunications sector are confronted with conflicting objectives: to ensure universal access to telecommunication services while fostering growth in the most competitive segments of their economy. Telecommunication companies are expected to design ever more innovative business models to fit their marketing objectives with complex institutional and market constraints.

Affordability is the key condition to reach the first goal, while the second one motivates operators to offer and develop services to commercially attractive – higher income – customers. The definition of price structures that adequately support and balance these priorities is therefore a major challenge, which has led to the design and application of a variety of strategies by regulators and operators.

As identified in the literature review and experts' interviews, cross-subsidization is one of the main policy options to increase access to mobile communication services. It is particularly common in developing countries were the promotion of universal service can be a very serious challenge among low-income groups. In this research we use our system dynamics model to assess dynamically the impact of cross-subsidies on mobile telephony diffusion.

Aside of the core role such financing mechanism can play in expanding the coverage to marginalized groups of consumer, our model allows exploring the potential role of cross-subsidization to foster diffusion in its earlier stages.

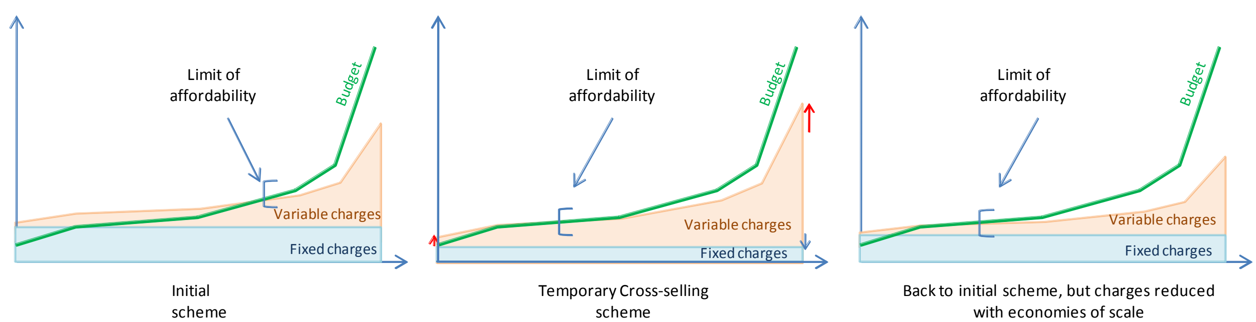
The rationale of this strategy would be to speed-up the launching of self-sustained diffusion mechanisms fueled by imitation and network effects, by reaching out to a larger segment of potential consumers.

Again, such approach is particularly suitable to telecommunication services, for which costs are to significant economies of scale and density and are relatively insensitive to traffic volumes. Economies of scale would then enable to progressively extend unsubsidized products affordability to a critical mass of population, and to progressively reduce and cancel the cross-subsidies.

Finally, since supporting an accelerated penetration of the market would leverage the powerful network effects prevailing in the diffusion of telecommunication products and services, and accelerate market lock-in with the promoted technology.

The applicability of such strategy could, for example, rely on an adjustment of the tariff structure, reducing momentarily connection costs and subsidizing them with higher variable charges. The positive correlation between household revenues and telecom services consumption would mechanically ensure a cross-subsidization across income groups, as illustrated in Figure 11.

Figure 64: Illustration of the impact of cross-selling strategies on project affordability (on budget profile graph, X-axis = population ranked by budget)



Competitive market conditions usually push tariff levels towards real costs, and therefore limit the extent to which such cross-subsidy by tariff adjustment can be used to foster the achievement of universal service. In the case of telecommunication services, appropriate regulation and licensing policies can be tailored to support such approach, at least temporarily.

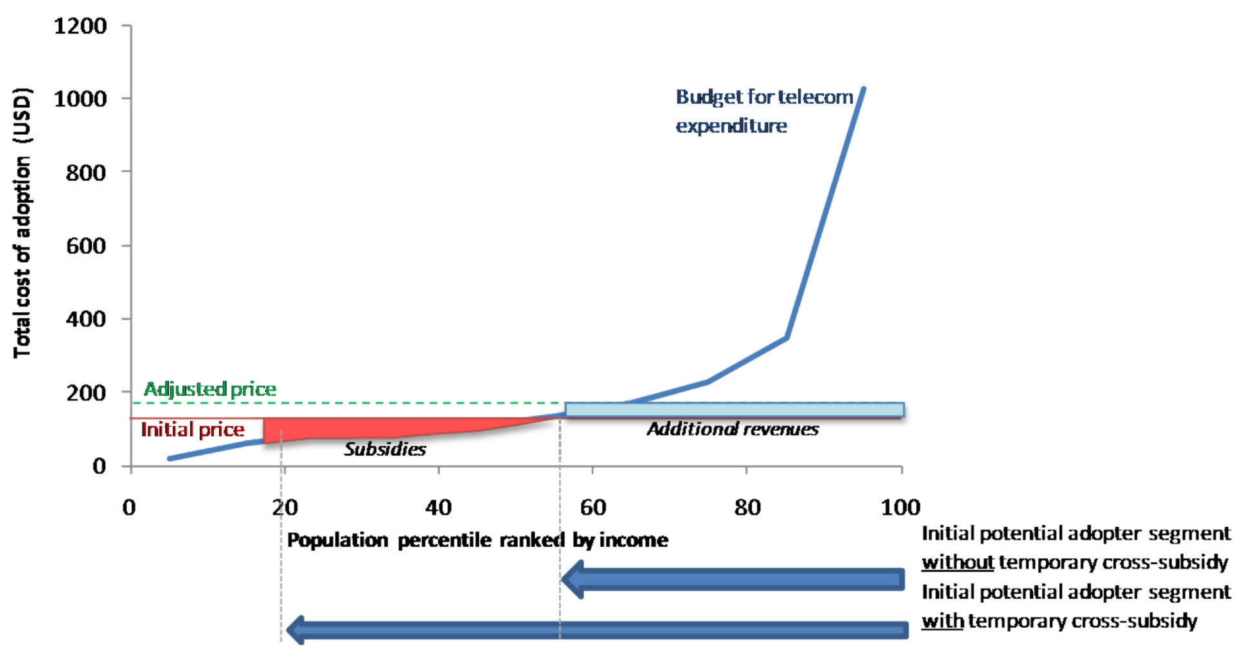
We use our System Dynamics model to test different cross-subsidizing scenarios. These have been tested by adjusting the **Fraction Able to Adopt** and the **Budget Surplus** variables.

For all simulations, we have considered a standard increase of 10% of the product cost, and assessed the extent to which this would leverage sufficient additional revenues among higher-income customers to broaden the potential adopters' base to include lower income groups.

The approach taken is schematically illustrated on Figure 12: the green and red horizontal lines represent respectively the initial price, economically optimal for the company, and the adjusted price, corresponding to a 10% increase. The population ranking 70th to 100th percentile in budget capacity is still able to afford the product, and any adoption at the adjusted price will yield additional revenue to the company. The total additional revenue across that segment is represented in blue. Below the 70th percentile, this revenue can be transferred to support adoption by a segment of population with a smaller purchase power. The total amount of net subsidy provided by the company to this segment is represented in red. The maximum breadth of this segment is limited by the constraint:

Subsidies (red area) ○ Additional revenues (blue area)

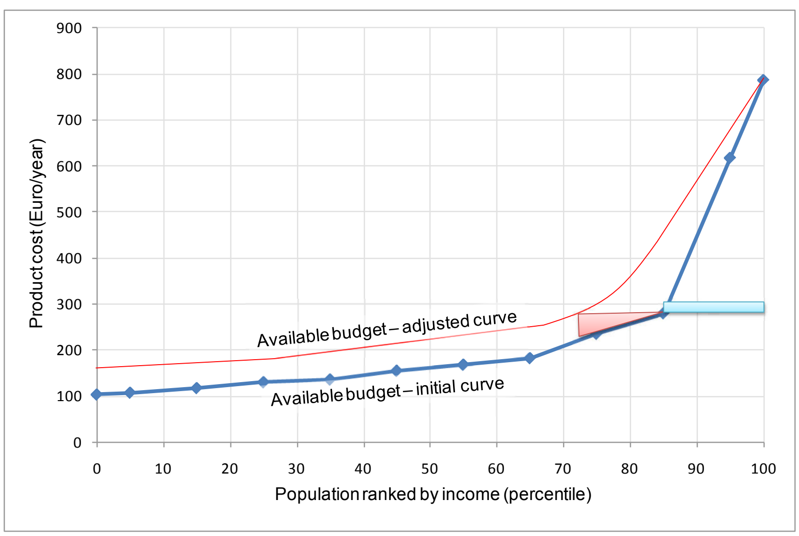
Figure 65: Early cross-subsidization mechanism principle (with a Brazil-type expenditure profile)



Such a representation is of course theoretical: no cross-subsidization mechanism could guarantee that additional revenues could be generated across the whole upper-income segment, and fully transferred through subsidies to a continuous segment of lower-income customers. This assumption can be considered as optimistic, and might be adjusted in future researches that would analyze product diffusion dynamics across socio-economic groups.

As long as this 10% cost adjustment is maintained for higher income groups, the base of potential adopters is broadened as shown Figure 13 below. We have focused the case study on Brazil, the most income-unequal developing of the pool of studies countries. The blue curves indicate, for each population percentile, the limit of affordability without cross-subsidization, and the red line the limit of affordability with a cross-subsidization based on a 10% price increase. Such analysis has enabled to artificially adjust, the *Fraction Financially Able to Adopt* variable, to assess dynamically the impact of such temporary financing mechanisms on early diffusion.

Figure 66: Available budget curves across the population, considering cross-subsidy mechanisms with 10% price increase

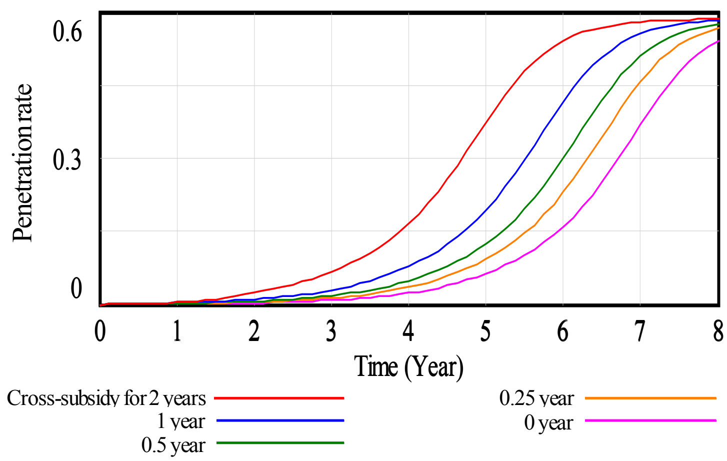


Note: the meaning of the blue and pink objects is the same as on Figure 12.

Similarly, in these scenarios, the 10% price increase was reflected on the *Budget Surplus after Telecommunication Expenditure* functions: the budget surplus curves presented on Figure 34 were adjusted by subtracting 10% of product price to them.

As illustrated below, cross-subsidization in the early stage of diffusion can significantly accelerate product takeoff. Such a mechanism, implemented for one year, just after product commercialization, would allow reducing the time to takeoff from 3.9 years to 2.6 years. This is illustrated in Figure 14 below, showing simulations for Brazil.

Figure 67: Diffusion speed for cross-subsidy programs of various durations (Brazil)



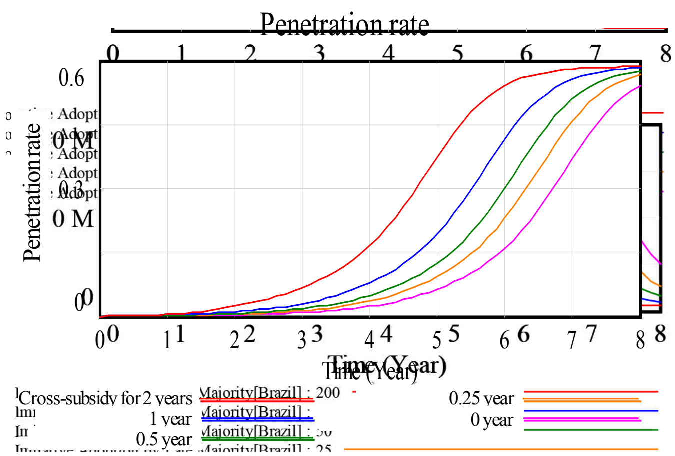
More importantly, applying such strategy early after product commercialization will later impact diffusion on a massive scale, while the number of customers actually benefiting from the cross-subsidy scheme during the first months remains very limited.

As shown below, in the case of Brazil, stimulating innovative adoption in a limited range triggers powerful diffusion mechanisms that will significantly accelerate network effects and imitative adoption: in the 1-year cross-subsidy scenario, stimulating 121,000 innovative adoptions during the first year after commercialization boosts the adopters' base by more than 30 millions additional (imitative) adopters 5 years after commercialization.

Figure 68: Innovative and imitative adoption rates for cross-subsidy programs of various durations (Brazil)

Innovative adopters

Imitative adopters



While the duration of cross-subsidization mechanisms plays a key role in their overall impact, it is preferable to limit in time such types of policy as much as possible: creating artificial market distortions can jeopardize private telecom operators' survival and therefore requires specific regulatory arrangements.

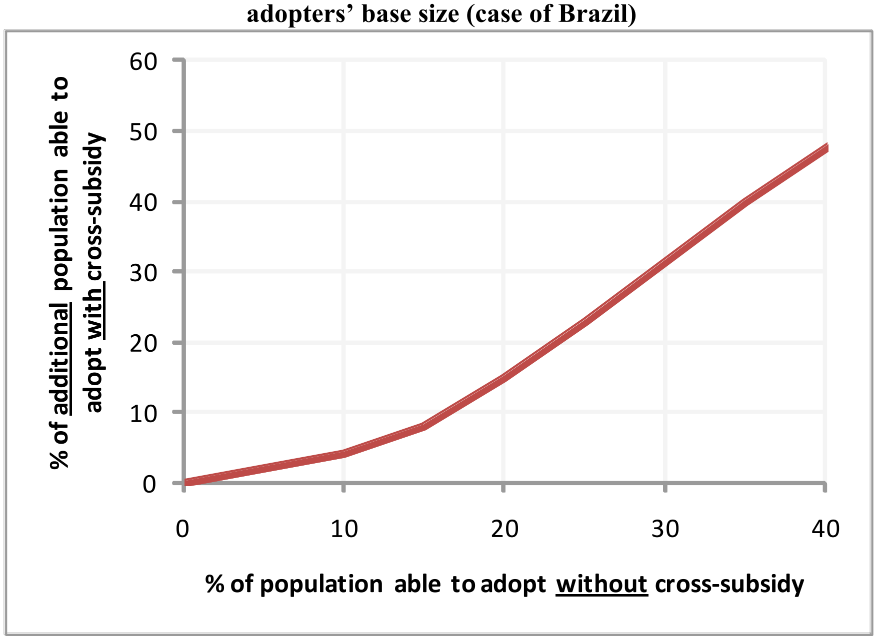
The other dimension to be assessed is the optimal timing of such intervention. In this respect, two aspects are to be considered:

- During early product diffusion phases, positive feedback mechanisms drive the diffusion dynamics, which are a path-dependent process. Therefore, stimulus commercial programs clearly yield stronger long-term impacts on diffusion when launched the earliest possible.

- The extent to which the potential adopters' base can be artificially broadened through cross-subsidization mechanism depends on the product initial affordability. As long as only the narrow upper income consumers' base (beyond 80th budget percentile in the case of Brazil, where the budget curve is steep) can afford the product, cross-subsidy will broaden only marginally the size of potential adopters' base. Once end-user subsidies reach more homogeneous segments of population (before 80th percentile in the case of Brazil, where the budget curve is flat), the level of subsidy required to reach each additional end-user is much smaller, and additional revenues can be transferred to cover a much wider segment of population.

To illustrate that in the case of Brazil, the figure below shows the impact of a cross-subsidy financed by a 10% price increase on the potential adopters' base size, depending on the initial potential adopters' base size.

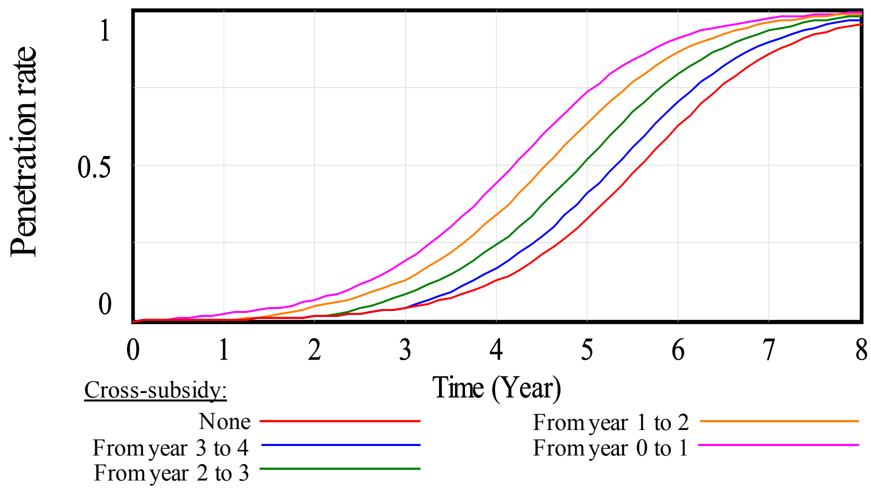
Figure 69: Impact of a cross-subsidy policy on the potential adopters' base size (case of Brazil)



To assess the importance of these dimensions in the optimal timing of the policy, simulations with 1-year subsidy programs have been run:

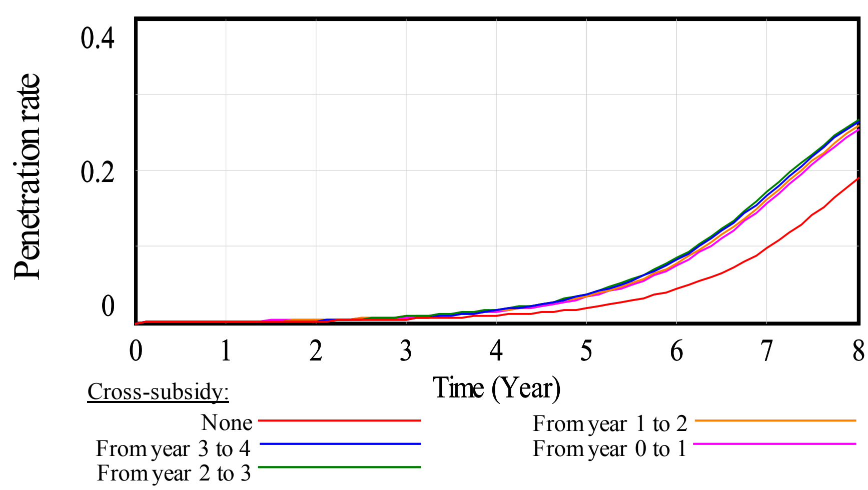
- in the case of France, where product is already affordable to middle-classes at commercialization (flat segment of the budget curve);

Figure 70: Penetration rate with 1-year cross-subsidy policies, depending on their timing – France



- in the case of Brazil, where product is only accessible to upper class consumers at commercialization (steep segment of the budget curve).

Figure 71: Penetration rate with 1-year cross-subsidy policies, depending on their timing – Brazil



The long-term impact of the business model is very sensitive to its timing in France, but almost not at all in Brazil. There, the expected advantage of launching the cross-subsidy earlier is almost completely offset by the fact that the policy remains of limited efficiency as long as cross-subsidies are insufficient to outreach large consumers' bases.

From a financial perspective, **it would therefore be more rational in such heterogeneous countries to wait for economies of scale to draw adoption costs down, and postpone cross-subsidy programs until the product starts to become affordable to the upper segment of mass-markets (defined as the flat portion of the curve)**. In the case of Brazil, this would mean 4 years after commercialization.

Main conclusions of the research

In conclusion, this research allowed exploring the complex process of diffusion of innovations and helped gain better understanding and insights that are useful to support policy-makers and marketing practitioners in designing more inclusive sector development strategies.

Using a multidisciplinary literature review and conclusive interviews conducted among innovation industry and development experts, this research enabled to design a holistic framework for the analysis of ICT diffusion process, helping to capture both the innovative and the imitative adoption mechanisms.

In this research effort, we first identified the major factors affecting diffusion dynamics, along with the interdependencies among these factors. Findings from the literature review have been confronted with the insights drown from the interviews with industry experts. Overall, the results of the exploratory study were convergent with the findings from literature review, and sometimes even complementary, adding new evidence or dimensions to look at. For example, aspects related to the access to knowledge, such as the self-organization of networks of experts and the emergence of consortia, have been brought up by the experts during the interviews. The market context, such as incumbent monopoly or existing infrastructure legacy, has also been an interesting addition to the list of factors believed to influence the diffusion. We used a system thinking approach to develop a System Dynamics model of diffusion, aiming at both comprehensible and holistic representation of diffusion phenomena in the specific context of this research. Of course, not all the factors cited by the industry experts or identified in the literature could be taken into account and actually embedded into the model. However, we believe that a rather large set of factors cited have been considered and ultimately fed into the building of a highly-integrated, calibrated System Dynamics model. Namely, the quantitative System Dynamics model built includes 36 variables, which are organized in 6 major components of the diffusion model. Compared to the Bass reference model, our extension of the diffusion model develops two major dimensions – the cultural and socio-economic factors – and resulted in four additional model feedback loops - the product affordability, product accessibility, cultural confidence effect and economic leverage. As discussed in greater detail in the respective Chapters of this dissertation, we believe that these new dimensions and feedback loops represent indispensable additions to be brought to the analysis of the diffusion of innovations. This is confirmed by the excellent goodness-of-fit of the extended model with the historical data, yielding interesting results when compared with the Bass reference model.

More importantly, we could explore further how the system in its entirety behaves under the influence of this relevant set of factors. Using historical data on penetration of 3G mobile phones across 17 countries, both developed and developing, we illustrated the significant role played by the socio-economic and cultural factors in the diffusion dynamics.

Based on these findings, we argue that beyond the obvious relationship between price and national economic levels, the income distribution patterns across a country, as well as the cultural uncertainty avoidance of its population should be taken into consideration while considering a new technology/product launching strategy. Furthermore, and in order to help policy-makers and telecom companies designing optimal sector development strategies and fostering the inclusion of a broader category of adopters, we used our non-linear model to test relevant policy principles likely to foster the diffusion of mobile technologies for an extended reach to the benefits of mobile technologies.

The key findings of this analysis were that:

1. Country-wide socio-economic heterogeneity and endogenous cultural drivers, such as uncertainty avoidance, significantly influence the dynamics of innovation diffusion across countries. For instance, emerging economies with strong income inequalities and social

stratification are more prone to face exacerbated challenges in the large-scale adoption of new technologies;

2. Well-targeted subsidies in the early stages of mobile technologies diffusion can play a determinant role in their massive diffusion, helping to overcome initial confidence barriers, leveraging economies of scale, and, in the longer-term, triggering macroeconomic positive feedback mechanisms. Temporary cross-subsidizations at the early stages of product diffusion can, in particular, significantly accelerate market penetration. Defining the optimal timing and duration of such subsidizing approaches requires a detailed analysis of the product affordability across the population, as explained in the modeling approach section. In particular in income unequal countries, it is recommended to wait for economies of scale to draw adoption costs down, and postpone cross-subsidy programs until the product starts to become affordable to the upper segment of mass-markets.

The theoretical and managerial contributions of this work are potentially impactful. Indeed, from a theoretical standpoint, this work addresses a significant research interest prevailing in the academic world and encapsulates a both rigorous and innovative approach to modeling the diffusion of innovations. It designs a holistic framework for the analysis of ICT diffusion process, capturing both the innovative and the imitative adoption mechanisms, and allowing evaluating the impact of several important factors that influence the international diffusion of innovations. This is truly of interest to marketing practitioners and policy-makers, as it should enable them to take better informed, more accurate decisions, and to design more effective policy actions. The managerial contribution of this dissertation work consists of relevant insights and holistic approach to the design of strategies that aim to extend the reach to ICTs and mobile technologies to a broader, otherwise marginalized, category of adopters. We hope that with the results from this research work the marketing practitioners and policy-makers are now given the tools to quench the thirst for innovation of these consumers.

Research Limits and Future Research

Beyond its findings and inputs to this field of research, this study includes of course a number of limitations that are highlighted in the sub-sections below.

31. Limitations of the Current Research

This work has some well-acknowledged limitations. First, related to the exploratory study: few interviews focusing on developing countries have been carried out in the framework of this research. Since the aim of this research is to help developing countries access to ICTs and mobile technologies, it would have been better to include in the list of interviewees people from these countries. Many executives were having global oversight though. Second, not all the factors cited by the industry experts or identified in the literature could be taken into account and actually embedded into the model. More precisely, factors in two categories – the Access to Knowledge and the Existing Legacy and Market conditions – are the ones that have been cited by the industry but could not be parameterized and integrated into the System Dynamics model.

Further, relevant literature findings suggested the development of the *economic leverage* component, described in paragraph 23. The feedback effect of this loop includes a multi-year delay between product penetration and its impact on the country's economy. The set of studied countries did not allow fully analyzing and highlighting this effect, since:

- in most studied countries, belonging to high-income groups, penetration rates were above 80% after 8 years of diffusion. At that last stage in the diffusion process, the incremental effect of GDP increase on penetration rates would be non-significant;
- in the middle income countries, diffusion was too recent (3 to 6 years) to have any visible impact. Furthermore, only few developing countries had available historic data on a sufficiently long time scale test the model calibration and behavior.

In addition to these data availability limitations, which have been a true constraint in the case of this research, longer sets of data from lower-income countries (e.g. 2G diffusion in Africa) could have been relevant.

32. Future research directions

The model used a number of assumptions and simplifications to develop adequate parameterization and representation of a number of qualitative concepts. This section intends to list the key topics that would deserve further analysis in priority, to improve the model's robustness and relevance. These topics have been divided in two categories: those related to demand-based dynamics (customers market) and those related to supply-based dynamics (corporate, business, technology, etc dynamics).

32.1. Further exploring demand-based dynamics

Among all assumptions used in this research, the sociology of products adoption would seem particularly relevant to further investigate:

- How robust is the hypothesis that consumers are willing to spend 5% of their revenues to telecommunication expenditures? Preliminary observations and partial consumers' expenditures data would seem to indicate that this figure is quite reliable among poorer segments of populations, but slightly overestimated among the highest income groups. Such analysis would then have to be extended with cross-country comparisons. Since this assumption rules the calculation of the potential adopters' size, the model output (in terms of penetration rate) is of course very sensitive to its definition. If this limit does not affect the model relevance and the nature of its response to policy actions / business strategies, a more quantitative analysis would require a fine tuning of this assumption. Since it is likely to largely differ between countries (as direct surveys have proved for other types of services, such as water or electricity), this analysis would have to be supported by extensive surveys, and could be realistically undertaken in a study focusing on one country in particular.

- How elastic is this concept of telecommunication product affordability considering the increasing number of functions played by mobile devices: not only for communications, but also for leisure, economic productivity, etc. To which extent should this traditional household budget category encompass other expenditure categories, as telecommunication innovations transform our social habits? In that case as well, direct surveys would be necessary to assess the sensitivity of willingness to pay to the scope of offered services.

- The inclusion of cultural dimensions in the model relies on the indexes developed by Hofstede. Numerous critiques have been addressed to this approach, which is considered out-of-date (Holden, 2002), based on limited surveys and non representative of entire nations' cultures, which are actually impossible to capture through simple questionnaires (McSweeney, 2002), or too static and simplistic (Myers and Tan, 2002). In reaction to Hofstede's model, Holden proposed to describe culture as a form of knowledge management, involving specific knowledge transfer and sharing dynamics. Agent-based modeling would seem the most appropriate tool to identify the emergence of large-scale cultural dynamics and attempt their parameterization for further differential equations modeling.

- Despite unfolding the product attractiveness variable proposed in the Bass model through the integration of several demand-based concepts (product affordability, accessibility, confidence effect), an attractiveness dimension was still left as a "black box" and played the role of calibration variable. A further exploration of this variable could be envisaged on the basis of available corporate data and of market surveys enabling to measure the intensity and efficiency of marketing campaigns.

32.2. Further exploring supply-based dynamics

Our research has focused primarily on the demand-based aspects of product diffusion. At corporate, industry and policy levels, various considerations would require further modeling development, to offer a more complete understanding of diffusion dynamics. The extension of the system dynamics model (DE) would be particularly relevant to address the following questions, whose importance has been as well mentioned during the interviews with the sector specialists:

- What are the dynamics of additional operators involvement on a new market, and how these are related in particular to:
    - economic competitiveness and price reduction dynamics ? Another field of research that would complement and improve the robustness of this model would focus of the dynamics of price reduction through economies of scale. In the case of international diffusion, economies of

scales could be considered not only at each market level, but as well fuelled by efficiency gains and experience accumulated on other markets.

- the development of R&D consortiums or task forces, fostering the emergence of technological standards (increasing product attractiveness and non-adoption costs for reluctant consumers) ?

- What role do governments play in the support of these task forces, in the attraction of new operators onto the market which fuel price reductions?

- How do companies schedule specific timings for their marketing campaigns, and how can media interaction influence their impact on demand dynamics?

Specific events and dynamics at institutional and strategic management levels can significantly alter common S-shaped product diffusion patterns. Their integration into an extended diffusion model would in particular better help understanding and capturing a typical diffusion trajectory, such as the one observed in the United-Kingdom (see section 28). We leave these for future research directions and efforts.

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"Assouvir la Soif pour l'Innovation: Modélisation de la Diffusion des Technologies Mobiles"

Résumé

L'expérience montre que les technologies de l'information et des communications (TIC), et services de télécommunications mobiles en particulier, peuvent stimuler une croissance économique soutenue et contribuer au développement humain. Au coeur du secteur des TIC, les technologies mobiles sont de plus en plus utilisées comme un outil transformationnel pour favoriser la croissance économique, accélérer le transfert des connaissances, développer les capacités locales, améliorer la productivité et réduire la pauvreté dans de nombreux secteurs. À cet égard, au cours de la dernière décennie, le développement des TIC est devenu un domaine stratégique d'engagement politique dans les économies émergentes. Afin d'accompagner les décideurs politiques et les marketeurs dans la conception des stratégies optimales de développement du secteur des télécommunications, les chercheurs s'intéressent de plus en plus aux obstacles entravant le déploiement des solutions TIC dans le monde en voie de développement. En tant que contribution à ce domaine de recherche, cette étude vise à (i) identifier les déterminants économiques et socioculturels affectant la capacité des pays émergents à adopter les nouvelles technologies et innovations, et à (ii) proposer des principes d'actions et de politiques susceptibles de favoriser la diffusion des solutions TIC dans les pays émergents qui sont caractérisés par une forte inégalité des revenus et par l'aversion au risque.

Descripteurs *: innovation; diffusion; TIC; technologies mobiles; systèmes dynamiques; modélisation;*

"Quenching the Thirst for Innovation: Modeling the Diffusion of Mobile Technologies"

Abstract

Evidence shows that information and communications technologies (ICT), especially mobile telecommunications services, can lead to sustained economic growth and human development. Mobile technologies are increasingly used as a transformational tool to foster economic growth, accelerate knowledge transfer, develop local capacities, raise productivity, and alleviate poverty in a variety of sectors. In that respect, in the last decade, ICT development has become a key strategic area for policy engagement in emerging economies. To support policy-makers and marketing practitioners in designing optimal telecommunications sector development strategies, an increasing research focus is now being placed on the impediments to implementing ICT solutions in the developing world. As a contribution to this field of research, this study aims at (i) identifying the economic and socio-cultural determinants affecting the capacity of developing countries to adopt new technologies and innovations, and at (ii) defining relevant policy principles likely to foster the diffusion of ICT solutions in emerging economies that are characterized by strong income inequality and uncertainty avoidance.

Keywords*: innovation; diffusion; ICT; mobile technologies; system dynamics; modeling;*