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# Options d'enchères pour la mise en marché du bois par le Bureau de mise en marché des bois du Québec

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# Options d'enchères pour la mise en marché du bois par le Bureau de mise en marché des bois du Québec

*Maurice Doyon*[1], *Daniel Rondeau*[2]

## Sommaire

*La réforme forestière québécoise en forêt publique (85 % du territoire forestier de la province), vise l'établissement pour la première fois d'un marché concurrentiel pour un pourcentage significatif des bois en forêt publique. Puisque les résultats du marché concurrentiel serviront à l'établissement de prix pour une partie des bois vendus et que dans certaines régions les acheteurs potentiels sont concentrés, d'importants enjeux compétitifs doivent être pris en considération dans le design du marché qui sera mis en place. Cette étude est un prélude à des simulations expérimentales ou terrains qui permettront de tester certains éléments de design de marché qui sont explorés ici à l'aide de la littérature et de la théorie économique.*

*Dans un premier temps, certaines des hypothèses de réforme du régime forestier ontarien sont discutées, puis les cinq questions de design suivantes sont analysées :*

1. *Quel est l'impact potentiel de l'imprécision statistique des données d'inventaire sur le résultat des mises?*
2. *Quel est l'impact d'une tarification sur la base de l'inventaire (prix fixe déterminé a priori) versus une tarification sur la base du mesurage (prix en fonction des volumes réellement récoltés), ainsi que la relation avec une obligation de récolte?*
3. *Quel est l'impact du prix de départ sur les mises et le résultat de la vente, l'impact du prix minimum et du prix de réserve sur le résultat de l'enchère si ces prix sont révélés;*
4. *Quelle information devrait être divulguée (et à quel moment), dans le contexte de la forêt québécoise, si une enchère de premier prix avec enveloppe fermée est utilisée?*
5. *Quelle est la façon la plus appropriée de déterminer le prix du bois dans les sous-régions où les conditions de saine compétition sont peu probables?*

*Une discussion sur d'autres mécanismes d'enchère à considérer pour la vente de bois sur pied ou récolté complète l'étude.*

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## 1. Mise en contexte Québec

Le territoire forestier productif de l'État québécois est public à plus de 85 %. Cette proportion excède celle de plusieurs autres pays, notamment les États-Unis avec 18 %. Notons toutefois qu'une grande partie du territoire forestier québécois s'étend du 47$^{e}$ au 52$^{e}$ parallèle Nord. La forêt publique québécoise est donc souvent difficile d'accès et loin des marchés, ce qui impose de nombreuses contraintes à l'exploitation.

Sur terres publiques, les bois sont présentement attribués aux demandeurs selon les besoins d'approvisionnement des usines de transformation, la disponibilité et la localisation de la matière ligneuse. L'attribution se concrétise par un contrat d'approvisionnement et d'aménagement forestier (CAAF). La valeur marchande des bois sur pied (VMBSP) déterminée sur forêt privée sert de base de référence à la détermination de la redevance s'appliquant aux zones de tarification définies par le CAAF. Cette valeur est ajustée pour tenir compte des conditions de récolte, des coûts de construction de chemins, des distances de transport, etc. permettant d'établir une valeur marchande des bois sur pied (stumpage) sur forêt publique. Le marché des bois sur pied en forêt privée est donc à la base du calcul des redevances et de l'application de la technique de la parité.

Or, depuis plusieurs années maintenant, le régime forestier québécois est la cible de nombreuses critiques. Afin de répondre à ces critiques, le gouvernement du Québec a mis sur pied, en 2004, la Commission Coulombe, laquelle avait pour mission de procéder à l'analyse exhaustive du régime forestier québécois et de formuler des recommandations. Le rapport final émis par cette dernière a fait état de plus de 80 recommandations permettant de bonifier le régime forestier québécois.

À la suite de la parution de ce rapport, le Sommet sur l'avenir du secteur forestier québécois a eu lieu, réunissant tous les principaux acteurs impliqués dans la gestion forestière du Québec. Ce sommet a entraîné une série de constats portant sur les lacunes du présent régime forestier. Le dépôt du Livre vert à l'hiver 2008 se veut une réponse aux lacunes précédemment identifiées. Le livre vert propose des objectifs et des orientations visant une réforme en profondeur du régime forestier québécois, notamment l'orientation 7 qui vise l'établissement d'un marché concurrentiel des bois en forêt publique. Cette orientation a pour objectif de dégager des marges de manœuvre pour répondre aux besoins émergents en matière de bois, tout en assurant une certaine sécurité d'approvisionnement aux présents détenteurs de CAAF. Ce marché concurrentiel permettrait d'établir la valeur des bois et favoriserait, ainsi, les entreprises innovantes et émergentes ainsi que les nouveaux projets de développement. Il s'agit donc de changements majeurs dans les façons de faire propres au milieu forestier. Pour identifier les enjeux et les impacts de tels changements, le Ministère des Ressources Naturelles et de la Faune du Québec (MRNF) a financé en 2008, entre autres, une étude sur les modalités et les impacts du nouveau mode de mise en marché des bois.

L'étude fait les suggestions et constats suivants concernant la mise en place d'un marché concurrentiel :

- Il est recommandé de mettre en place un Bureau de Mise en Marché des Bois (BMMB) et des Sociétés d'aménagement au niveau régional;
- Il est proposé d'opter pour un système mixte (bois sur pied et récolté), qui permet aux sociétés d'aménagement une adaptation aux conditions de la région;
- Il est recommandé de permettre les échanges interentreprises et la revente de bois et de donner un accès le plus large possible aux enchères;
- Viser la mise à l'enchère de 25 % des volumes de bois à l'échelle du Québec;
- Suggère l'utilisation d'enchères avec enveloppe fermée dans un premier temps;
- Il est recommandé d'établir le prix de départ (des enchères) de 70 à 90 % du prix de vente estimé;
- Il est recommandé d'utiliser un prix minimum égal ou supérieur aux coûts variables;
- Le prix de réserve devrait se situer entre le prix minimum et le prix de départ. Il ne devrait pas être divulgué pour des raisons de compétition;
- Différents types d'enchères combinatoires devraient également être explorés.

L'étude fait également ressortir le souci d'obtenir un prix représentatif, c'est-à-dire exempt de collusion et/ou de comportement stratégique, pour le bois issu des forêts publiques québécoises. Notons que les entreprises qui disposent présentement d'un CAAF subiront une baisse de leur approvisionnement garantie et devront s'approvisionner, en partie, sur un marché avec enchères. Or, le résultat de ces enchères servira à déterminer le prix de l'approvisionnement garanti (qui représente environ 75 % des volumes actuels). De plus, dans certaines régions du Québec, le nombre d'acheteurs ou de participants aux enchères est relativement faible. Ces conditions sont susceptibles de créer des comportements stratégiques. Concrètement, pour un acheteur, cela pourrait se traduire par l'achat de moins d'unités que ce qu'il désire, si cette stratégie se reflète par un coût moyen moindre sur l'ensemble de ses volumes et donc plus de profit. Le comportement stratégique pourrait également se traduire par une mise plus faible, afin de ne pas signaler pleinement sa valorisation du bien à la compétition et maximiser ses profits dans les rondes d'achat successives. Bref, en présence de comportement stratégique, les agents économiques ne révèlent pas leur vraie valeur.

Quant à la collusion, elle se définit comme étant une entente implicite ou explicite entre des firmes existantes afin d'éviter ou réduire la compétition entre elles. Tout comme pour le comportement stratégique, la collusion a pour effet de biaiser l'information de marché.

## 2. Objectifs et étapes

L'objectif principal de cette étude est d'approfondir, à l'aide de la littérature et de la théorie économique, les questions susceptibles d'avoir un impact sur la collusion et la manipulation de marché, dans un contexte d'enchères pour la vente de bois sur pied ou non en terre publique.

Dans un souci de comparaison, les réformes proposées au système forestier ontarien sont également discutées.

Plus spécifiquement, cette étude vise à :

- Discuter des options de réforme forestière en Ontario et commenter ces dernières en regard d'objectifs d'efficacité et collusion ou comportement stratégiques;
- Identifier et analyser les points importants (questions à approfondir) d'une réforme forestière ayant pour objectif d'établir la valeur des bois de façon concurrentielle, et ce, afin de favoriser les entreprises innovantes et émergentes ainsi que les nouveaux projets de développement;
- Proposer et discuter quelques mécanismes d'enchères ayant un potentiel d'application au Québec, en vue de les tester expérimentalement en laboratoire et/ou en situation terrain.

Dans un premier temps, les propositions de réforme forestière en Ontario sont présentées et discutées. Suit l'identification des points importants à considérer dans le cadre de la mise en place d'enchères forestières au Québec, et ce, afin de minimiser les possibilités de collusion et les comportements stratégiques. Ces points sont par la suite développés de façon extensive à l'aide de la théorie et de la littérature économiques. Finalement, à la lumière des étapes précédentes, quelques mécanismes d'enchères ayant un potentiel d'application au Québec sont identifiés et brièvement discutés.

## 3. Discussion des options de réforme en Ontario

La forêt publique en Ontario représente environ 90 % des forêts de la province, et est divisée en 46 unités de gestion. Trois types de licence existent, soit les *Sustainable Forest Licence* (SFL), les *Forest Resource Licence* (FRL) et les *Wood Supply Agreement* (WSA).

Les SFL sont des ententes ou licences à long terme (20 ans) qui couvrent un territoire forestier distinct (unité d'aménagement). Les détenteurs de SFL (principalement de grandes entreprises) sont responsables de la planification stratégique et opérationnelle (incluant les activités liées à la régénération) de leurs unités d'aménagement. Les détenteurs de SFL ont donc un grand pouvoir puisqu'ils contrôlent le niveau de récolte sur leur unité d'aménagement. Ils sont une cause d'inflexibilité dans le régime forestier actuel et un obstacle important aux réformes.

Les FRL sont attribuées pour une période de 5 ans et la responsabilité des détenteurs se limite à la coupe et la construction ou l'entretien de routes, s'il y a lieu. Le territoire géographique des FRL recoupe généralement celui des SFL, nécessitant des ententes entre les deux types de détenteurs (SFL et FRL). Cette situation occasionne parfois des conflits étant donné le rapport de force détenu par les détenteurs de SFL.

Les WSA concernent un territoire et une période de temps spécifique, durant lesquels un volume de bois est mis à la disposition d'une entreprise. Ces ententes prennent généralement place dans le cadre général et sur le territoire des SFL.

Dans les trois cas, les détenteurs paient une redevance administrativement déterminée, des frais associés à la régénération et la préservation (feux, pestes, etc.). Le fait que la majorité de la forêt publique ontarienne soit sous l'égide des SFL, les chocs structuraux qui affectent le secteur forestier canadien et ontarien ainsi que les constantes attaques américaines sur le système forestier ontarien motivent une révision du système forestier ontarien.

Les objectives sont une plus grande flexibilité et une meilleure réponse aux marchés, et ce, afin de s'assurer que la forêt ontarienne est utilisée de façon optimale pour le plus grand bénéfice des Ontariens. Nos réflexions quant à la réforme forestière en Ontario vont toutefois se concentrer sur l'établissement de marchés sous forme d'enchères (bien que d'autres modes de détermination des prix puissent coexister) et les conditions sous-jacentes qui permettent la détermination de prix reflétant la valeur marchande des bois sur pied ou de billes.

Dans un premier temps, la réforme forestière discutée en Ontario suggère deux types de gouvernance (institution), soit les *Local Forest Management Corporation (LFMC)*, ainsi que les *Enhanced Sustainable Forestry Licences (ESFL)*. Les LFMC couvriraient éventuellement 25 % de la forêt publique ontarienne et seraient sous la responsabilité des instances gouvernementales. Quant aux ESFL, leur gestion serait assurée par un conseil d'administration composé essentiellement des utilisateurs de la forêt.

La motivation d'un conseil d'administration composé des utilisateurs de la forêt pour les ESFL serait de rendre la gestion de la forêt plus réactive face aux évolutions du marché. Toutefois, dans un contexte de mise aux enchères d'une portion de la forêt couverte par les ESFL, ceci pose de sérieux problèmes au chapitre de la gouvernance. Notre constat est que la délégation des rôles de planification de la gestion et de la mise en marché à l'industrie par l'entremise des ESFL comporte des risques sévères, principalement du côté de l'établissement de prix reflétant la valeur économique de la fibre.

Nul besoin d'élaborer sur le fait que les utilisateurs ont comme objectif de minimiser le prix payé pour la matière ligneuse, alors que celui du gouvernement serait d'optimiser l'utilisation de la forêt et d'obtenir des redevances qui reflètent les conditions de marché. Les membres des C.A. des ESFL auraient donc accès à des informations ayant le potentiel d'affecter leur mise, et du coup la détermination d'un prix de marché compétitif. Notons également que les décisions quant au volume mis en marché peuvent également influencer grandement le niveau de compétition dans une enchère. En effet, une offre trop importante aurait pour effet de réduire les prix offerts.

Le double rôle de vendeur et d'acheteur des membres de l'ESFL pourrait empêcher la mise en place d'enchères compétitives. À titre d'exemple, le prix de réserve, qui ne devrait pas être

révélé aux participants aux enchères seraient, sous le modèle ESFL, fixé par le C.A. de l'organisation. Alors que les membres de ce même C.A. seraient majoritairement des représentants d'entreprises forestières qui feront des mises pour ce même lot. En économique, ce type de conflit d'intérêts se nomme le problème du *principal-agent*. Ce problème survient lorsqu'un acteur économique désigné comme étant le *principal* (le gouvernement ontarien au nom de ses concitoyens), délègue à une autre entité - *l'agent* (ici les membres du C.A. de l'ESFL) - la responsabilité d'atteindre ses objectifs (ceux du principal). La difficulté survient lorsque les objectifs du principal diffèrent des objectifs et incitatifs de l'agent et qu'une asymétrie dans l'information disponible aux deux parties limite la capacité de contrôle du principal sur l'agent.

Tous ces incitatifs de comportements stratégiques et collusifs issus de la gouvernance proposée pour les ESFL sont d'autant plus problématiques que le gouvernement ontarien considère, du moins dans les premières discussions de réforme, utiliser les résultats des enchères dans une formule de transposition des prix pour déterminer les redevances de l'ensemble de la forêt publique. Notre conclusion est que le modèle de gestion ESFL qui est présentement au centre du projet de réforme ontarien souffre de handicaps importants qui limitent ses chances de succès. De plus, nous croyons que cette situation laissera l'Ontario vulnérable à des attaques tarifaires en provenance des États-Unis.

La structure des LFMC n'est pas menacée par le problème du *principal-agent* puisque cette dernière relèverait du Ministère de la forêt ontarien, mais ne couvrirait qu'une faible partie de la forêt ontarienne. Nous notons toutefois que dans les discussions concernant la réforme, les LFMC pourraient à leur convenance s'engager dans des discussions bilatérales avec les opérateurs forestiers quant à l'allocation de droit de coupe et à leur prix, et ce, pour des lots qui ne seraient pas mis aux enchères. Une mise en garde s'impose ici. Cette capacité de négocier de façon bilatérale ajoute une flexibilité intéressante, pourvu que ce pouvoir soit utilisé de façon très limitée. Dans le cas contraire, il est possible d'envisager la possibilité où une proportion importante des lots forestiers serait vendue par entente bilatérale à un prix moindre que les prix d'enchères ou en provenance de l'équation de transposition des prix. Outre l'incohérence de message et de marché que cela représenterait, ceci créerait également auprès des acheteurs un incitatif à augmenter leurs volumes achetés par entente bilatérale au détriment des autres formes de marché. De plus, l'argument pourrait être fait qu'une prolifération des allocations par négociations bilatérales serait un recul par rapport au mode d'attribution actuel qui, malgré le manque de lien avec les prix de marché et sa détermination administrative a l'avantage d'être transparent.

Il est également proposé, dans les discussions liées à la réforme ontarienne, d'avoir trois régions distinctes dans l'application d'une éventuelle équation de transposition des prix reposant sur les données des enchères. En d'autres mots, il y aurait trois équations de transposition des prix, soit une pour la région du Sud-Est, une pour la région Centrale et une autre pour le Nord de l'Ontario. Bien que le besoin de représentativité régionale soit important, il est également important de considérer l'impact négatif associé à la capacité d'influence des acheteurs sur les

prix. Or, cette capacité est augmentée dans un contexte régional versus national. Étant donné les caractéristiques de la forêt ontarienne, il nous semble plus approprié de ne pas régionaliser l'équation de transposition des prix, mais plutôt d'ajouter des variables qui permettront de capturer les différences régionales.

Notons que la Colombie-Britannique utilise deux équations de transposition des prix. Une pour la région côtière et une autre pour l'intérieur. Toutefois, ces deux régions diffèrent grandement de par un mixte d'essences mutuellement exclusif aux deux régions, et par des techniques de récolte également propre à chacune des régions. De telles différences n'existent pas en Ontario ou au Québec.

### 3.1. Une réforme ontarienne qui se précise

À la base de la réforme forestière ontarienne, nous percevons le désir gouvernemental de créer des entités autonomes. Rappelons que le régime forestier actuel repose sur les SFL et que l'ensemble des activités de récolte, de gestion, de prévision et de sylviculture est fait par les détenteurs de SFL. Le rôle du Ministère se limite donc à une révision aux 5 ans des licences SFL et à une certaine supervision. Dans les réformes proposées, le rôle du Ministère doit donc demeurer modeste. Ainsi, les LFMC opèreraient sur le principe d'une entreprise et percevraient elles-mêmes les revenus et devraient viser l'autonomie financière. Seuls les frais associés à la protection de la forêt (feu, insecte) seraient retournés au gouvernement. Toutefois, ce dernier se réserve le droit d'éventuellement percevoir des dividendes à même les profits de l'entité. Quant aux ESFL, ces dernières seraient l'aboutissement d'une (longue) transition des SFL à entité unique (une entreprise) vers des ESFL. Les SFL en gestion partagée (au nombre de 18 présentement) ne semblent pas visées par la réforme dans un premier temps. Dans le cas de transition d'une SFL vers une ESFL, une panoplie de modèles sont considérés. Toutefois, le partage des responsabilités entre le Ministère et les SFL et éventuellement les ESFL demeure inchangé.

Ce principe de délégation des responsabilités et de la gestion de la forêt explique pourquoi l'accent de la réforme semble présentement porter davantage sur la gouvernance ou les institutions que sur la façon d'optimiser l'allocation des ressources et la détermination du prix (redevance).

En effet, plusieurs modèles de gouvernance sont considérés dans la détermination de ce que pourrait être une LFMC, mais plus particulièrement une ESFL. Nous avons identifié quatre variables d'importances parmi les modèles considérées : 1- Une entité à but lucratif versus à but non lucratif (OBNL); 2- La présence ou non d'une séparation légale entre l'entité de gestion forestière et les usines (présentement, pour les SFL uniques cette séparation légale n'existe pas); 3- La présence ou non d'acheteurs potentiels dans l'entité de gestion forestière (présence au C.A.); 4- La présence ou non d'une garantie gouvernementale d'approvisionnement des usines. Les modèles considérés dans la réforme sont différentes combinaisons de ces quatre variables identifiées.

Plusieurs de ces éléments sont problématiques quant à leurs incitatifs versus les objectifs de flexibilité et de meilleure réponse aux marchés, notamment dans un contexte d'enchères. Rapidement, mentionnons qu'il semble souhaitable d'avoir des entités à but lucratif plutôt qu'un OSBL, puisque ce dernier aura moins d'incitatifs à rechercher l'efficacité dans ses opérations et pourrait être plus enclin à viser la facilité dans la mise en marché (contrat à court et moyen terme) que l'efficacité économique (enchères). La séparation légale entre l'entité de gestion et les usines nous semble également primordiale, tout comme l'absence d'acheteurs potentiels sur le C.A de l'entité de gestion forestière. Dans les deux cas, le but étant d'éviter le problème de *principal-agent*, lequel a été discuté précédemment. Afin d'assurer un marché compétitif, les utilisateurs de matières ligneuses doivent être en mesure de miser sur des lots forestiers, peu importe leur localisation géographique. Ceci vient donc à l'encontre d'une garantie d'approvisionnement par usine, ainsi que d'une représentativité des usines au sein d'une unité de gestion forestière. Nous faisons ici la distinction entre garanties d'approvisionnement et accès à un contrat d'approvisionnement pour un pourcentage des besoins d'une entreprise.

Le modèle de gouvernance à privilégier serait donc une entité à but lucratif ayant une séparation légale avec les usines, sans acheteurs potentiels sur le C.A. et n'offrant pas de garantie d'approvisionnement pour un important volume aux entreprises forestières de son territoire. Cette description correspond essentiellement à celle des LFMC.

Dans le cadre des discussions concernant la réforme, seulement 2 LFMC sont prévues au cours des 5 prochaines années, avec comme cible probable un volume de 10 % de vente aux enchères. Puisque les ESFL sont issues des SFL (c'est-à-dire que les ESL ne sont pas éliminées ou révoquées, mais *améliorées*). Le cadre législatif limite dans les faits le type de gouvernance des ESFL, si bien qu'il semble que l'indépendance des ESFL quant aux membres du conseil d'administration et quant à la séparation légale avec les usines serait difficile à atteindre. Ceci crée, *de facto*, un environnement favorisant le comportement stratégique et la collusion. Dans pareil contexte, l'utilisation d'enchères devrait être réévaluée.

Il est donc à retenir que l'Ontario semble présentement se diriger vers une réforme beaucoup moins ambitieuse que celle du Québec. Pour le Québec, ceci signifie que les conditions éventuelles prévalant sur le marché ontarien pourraient continuer à favoriser les firmes jouissant présentement de licences à long terme et que les prix payés par ces firmes pour l'approvisionnement en bois pourraient être plus bas que ceux payés au Québec dans des conditions similaires. Par contre, la réforme ontarienne limite le potentiel de revenus pour le gouvernement, ne résout pas le problème d'accès à la ressource par de nouveaux entrants proposant des modes novateurs de traitement de la fibre ou des nouveaux produits, et semble assujettir l'Ontario à de nouvelles représailles commerciales et règlementaires en provenance des États-Unis.

## 4. Points importants à approfondir concernant les enchères en forêt publique

Suivant le rapport *Étude sur les modalités et les impacts du nouveau mode de mise en marché des bois*, des discussions avec les responsables de la réforme forestière québécoise et la littérature économique, les questions suivantes ont été identifiées *:*

- *Quel est l'impact potentiel de l'imprécision statistique des données d'inventaire sur le résultat des mises?*
- *Quel est l'impact d'une tarification sur la base de l'inventaire (prix fixe déterminé a priori) versus une tarification sur la base du mesurage (prix en fonction des volumes réellement récoltés), ainsi que la relation avec une obligation de récolte?*
- *Quel est l'impact du prix de départ sur les mises et le résultat de la vente, l'impact du prix minimum et du prix de réserve sur le résultat de l'enchère si ces prix sont révélés;*
- *Quelle information devrait être divulguée (et à quel moment), dans le contexte de la forêt québécoise, si une enchère de premier prix avec enveloppe fermée est utilisée?*
- *Quelle est la façon la plus appropriée de déterminer le prix du bois dans les sous-régions où les conditions de saine compétition sont peu probables?*

Chaque question est considérée dans le contexte des enchères jugées les plus aptes à être utilisées au Québec. Chaque question est évaluée en considérant les possibilités de collusion et/ou de manipulation de marché, dans le contexte compétitif de son industrie forestière. La théorie économique, la littérature économique générale, la littérature expérimentale ainsi que les cas d'application réels sont considérés.

## 5. Développement des points importants

Le reste du document a été rédigé en anglais afin de permettre une révision par des experts américains. La version complète et originale en anglais est donc en annexe. Les pages qui suivent sont un résumé en français du développement des points importants. Il est fortement suggéré de consulter l'annexe pour une réflexion détaillée et complète sur les points importants précédemment identifiés.

### 5.1. Mise sur lot entier ou sur bois récolté

Le type d'enchères et la méthode utilisés pour déterminer le prix du bois ont des conséquences directes sur les éléments suivants; i) le revenu potentiel du vendeur ii) les calculs de la tarification du bois hors enchère et iii) les comportements anticoncurrentiels. Dans un premier temps, examinons comment le calcul du prix réel influence le comportement des acheteurs potentiels. Considérons une enchère sous pli cacheté pour le bois sur pied d'un territoire de récolte. Le prix à payer par l'acheteur pour le territoire est la mise la plus élevée. Dans ce premier cas, ni la répartition des essences ni la quantité récoltée ne sont considérées. C'est un prix pour le territoire (lot entier). L'acheteur peut récolter ce qu'il veut, en respectant les

contraintes réglementaires du secteur forestier. Dans ce scénario, celui qui gagne l'enchère risque d'avoir surévalué la valeur du territoire, et ainsi de subir des pertes financières. Ce phénomène est bien connu dans la littérature sous le nom de la *malédiction du gagnant.* Un autre inconvénient de ce prix sur lot entier est qu'il ne permet pas de contribuer au calcul de tarification par essence de bois.

Le deuxième mécanisme est une mise à l'enchère d'un territoire de récolte basée sur une estimation du volume avec une répartition de bois par essence et par classe de qualité. L'enchérisseur avec la meilleure offre devient l'acheteur. Par contre, le montant total des droits à payer sera déterminé sur la base des volumes réellement récoltés. Ce mécanisme réduit la malédiction du gagnant, mais dans certains cas, introduit des comportements stratégiques indésirables.

*5.1.1. Offres stratégiquement biaisées*

Considérons une mise à l'enchère de bois sur pied d'un territoire de récolte basée sur une estimation du volume, et qui inclut la répartition de bois par essence et par classes de qualité. Sans perte de généralité, nous examinons le cas où la répartition est limitée à deux essences. Dans ce cas, le volume en mètres cubes total estimé est donné par :

$$Q_{est} = Q_{1est} + Q_{2est}$$

Chaque enchérisseur offre un prix $p_1$ et $p_2$ pour un mètre cube de chaque essence respectivement. L'enchérisseur qui remporte l'enchère, l'acheteur, est celui avec le plus haut prix selon les répartitions estimées, soit :

$$Revenu_{\,estimé} = p_1 Q_{1est} + p_2 Q_{2est} \qquad [1]$$

Le coût réel payé par l'acheteur sera déterminé sur la base des volumes réellement récoltés

$$Revenu_{réel} = p_1 Q_1 + p_2 Q_2 \qquad [2]$$

Ici, il y a dans l'estimation deux sources d'erreur qui peuvent causer une différence entre le revenu réel et le revenu estimé. La quantité totale estimée peut varier, mais cette imprécision n'a pas d'effet sur le comportement des enchérisseurs puisqu'ils ne paient que pour le volume réel. Ce qui importe avant tout est la seconde source de différence, qui est engendrée par une erreur d'estimation sur la distribution des essences. Dans ce cas, si l'enchérisseur possède des informations qui lui permettent de prévoir ces erreurs, il peut miser avec un biais stratégique. En effet, Athey et Levin (2001) ont démontré que dans cette situation, l'enchérisseur a l'avantage de miser un prix plus élevé sur l'essence qu'il croit être surestimé et de miser moins sur l'essence sous-estimée. De cette manière, il augmente sa mise, et sa chance de gagner l'enchère sachant que le prix réel sera moindre. Le gagnant de l'enchère est celui avec la meilleure offre pour les valeurs estimées, ce qui n'est pas nécessairement la meilleure offre sur la répartition réelle. Cette situation est problématique, car elle implique des pertes pour le

vendeur et un problème d'efficacité allocative, puisque l'acheteur qui valorise le plus la ressource n'est pas nécessairement le gagnant de l'enchère.

Un deuxième comportement stratégique existe, que l'on nomme ici « la récolte sélective ». Dans ce cas, l'enchérisseur augmente sa mise sur une essence qui l'intéresse peu et réduit sa mise sur le bois qu'il valorise. Dans un contexte où il n'y pas de pénalité pour le bois non récolté, ou si cette pénalité est petite, l'acheteur ne récolte que le bois qui l'intéresse au prix sous-évalué.

Ces deux scénarios présentent des comportements stratégiques qui biaisent les prix selon l'essence et qui réduisent l'efficacité des calculs de tarification du bois.

Le premier cas de biais est causé par des erreurs d'estimation dans la répartition des essences. Pour pallier ce problème, nous recommandons que le gouvernement adopte un plan pour réviser le calcul de la répartition des essences et pour assurer la précision de l'inventaire forestier. Dans le deuxième cas, le biais peut être éliminé au moyen de pénalités, lesquelles, dans notre exemple, doivent être supérieures à $p_2 Q_2$.

*5.1.2. Récolte obligatoire et la mise négative*

En général, la réglementation impose l'obligation à l'acheteur de récolter et de payer la totalité des quantités sur le territoire visé. Le but de cette réglementation est de favoriser la régénération de la forêt et d'encourager l'usage de bois de trituration. L'obligation de l'acheteur de récolter une essence qui lui cause parfois une perte économique se répercute par des prix à la baisse pour les essences plus profitables. De plus, l'imposition ou non de ces coûts est sur une base quelque peu arbitraire.

Le Bureau de Mise en Marché du Bois du Québec étudie présentement un mécanisme de mise en marché pour éliminer le biais qui peut résulter des récoltes obligatoires. De manière globale, ce mécanisme accepte des mises négatives sur les essences indésirables, ce qui représente la perte économique de l'acheteur causée par la récolte de cette essence. Dans cette optique, ceux-ci peuvent être perçus comme étant une subvention à l'industrie pour les services sylvicoles et les services d'aménagement rendus. Il est essentiel, pour cette option, que le vendeur établisse la valeur maximale qu'il attribue à ce service. Il est important de noter que la mise négative contribue à créer un marché économique efficace et crée un incitatif à valoriser le bois de trituration. Une mise négative ne pourrait, bien entendu, résulter en un paiement si le bois en question n'est pas coupé ou récolté.

### 5.2. Comment le prix minimum, le prix de réserve et le prix de départ influencent-ils le résultat de l'enchère?

Le **prix minimum** représente le plus bas prix auquel le vendeur **peut** vendre le bien sans perte économique, tandis que le p**rix de réserve** est le prix le plus bas auquel le vendeur est **prêt à vendre** un bien lors de sa mise à l'enchère. Si ce dernier prix n'est pas atteint, l'enchère est généralement annulée. Le prix de réserve est fixé à un prix plus élevé que le prix plancher, ce qui

assure un profit pour le vendeur. Étant donné que le prix minimum est utilisé pour établir le prix de réserve, celui-ci ne devrait pas être divulgué. Le **Prix de départ** est le prix qui ouvre l'enchère et donne un premier signal pour les enchérisseurs. Ce prix a des effets directs sur le résultat de l'enchère. Plusieurs études ont démontré qu'un prix de départ élevé réduit la participation, mais augmente la valeur du prix final. Dans certains cas, notamment en Colombie-Britannique, le prix de départ est égal au prix de réserve.

La littérature suggère qu'il est préférable de ne pas divulguer le prix de réserve, car cela réduit le prix final et favorise un marché compétitif. En effet, Athey et coll (2003b), Chan et Coll (2003) et Ashenfelter (1989) ont démontré qu'un prix de réserve inconnu limite les comportements anticoncurrentiels. Pour éviter que les enchérisseurs en arrivent à estimer le prix de réserve, il est suggéré d'ajouter au calcul du prix de réserve une composante aléatoire.

En somme, nous recommandons que le prix minimum et le prix de réserve ne soient pas divulgués. Le prix de réserve devrait être situé entre le prix minimum et le prix de départ, et devrait intégrer une variable aléatoire pour limiter la capacité de l'industrie à le prédire. Le prix de départ devrait être entre 75 % et 85 % de la valeur marchande estimée.

### 5.3. Divulgation d'informations

#### *5.3.1. Quand annoncer l'enchère?*

La durée d'une enchère doit être assez courte pour minimiser les comportements de communication et de collusion, mais devrait donner au participant le temps d'analyser l'offre et, s'il le désire, d'effectuer une évaluation de l'inventaire forestier.

#### *5.3.2. Quelle information partager après l'enchère?*

Le prix de vente du gagnant envoie un message clair sur l'état du marché; cette information devrait être rendue publique, tandis que les autres informations, telles que le nombre de participants et la valeur des autres offres, ne devraient pas être divulguées. Dans un contexte de marché avec un nombre restreint de participants, ces informations pourraient être utilisées pour prédire le prix de réserve et encourager des stratégies de collusion.

### 5.4. Comment établir les prix pour les secteurs où la compétition est faible?

Il y a deux scénarios qui expliquent le manque de compétition aux niveaux local et régional. Le premier est caractérisé par la concentration de l'industrie dans un secteur où seulement une ou deux entreprises exploitent historiquement le territoire. Le second, par les régions éloignées et les forêts avec des qualités biophysiques indésirables, lesquelles rendent difficiles l'exploitation forestière, et ainsi limitent le nombre d'entreprises qui peuvent exploiter ces territoires.

Si la concentration existe pour des raisons historiques, mais que d'autres régions plus compétitives sont comparables, alors la tarification calculée sur la base des résultats des

enchères de ces autres régions est possible. La situation est plus difficile à gérer lorsque les conditions dans une région de concentration diffèrent systématiquement des autres régions. L'objectif serait de prédire, par des modèles économétriques, le prix qui résulterait d'une enchère dans cette région. Dans le cas extrême, pour des territoires à caractéristique unique, les modèles économétriques ne peuvent pas s'appliquer. Dans ce cas, nous recommandons une approche qui utilise un ajustement de la valeur prédite. Une étude indépendante serait nécessaire pour déterminer cette valeur.

### 5.5. Communication et collusion

La réglementation de l'enchère sur un marché avec un nombre limité de participants doit être soigneusement choisie pour décourager les comportements anticoncurrentiels. Les mesures légales qui traitent de communication et de collusion sont essentielles au bon fonctionnement du marché.

Le risque de communication et de collusion indésirables peut être atténué par les considérations suivantes :

1. Un mécanisme d'enchères qui réduit les problèmes de substitution et de complémentarité limite les comportements de collusion. Ces éléments seront examinés en détail dans les sections suivantes.

2. La mise en place d'un marché centralisé pour bois récolté (billes), ce qui permet à l'acheteur potentiel une information de prix de qualité et réduit la motivation de créer des ententes bilatérales pour résoudre un problème d'allocation des essences avant les enchères.

3. La réglementation de l'enchère doit spécifier explicitement que toute tentative qui influence la participation des autres ou qui implique de la collusion sera traitée comme un acte criminel selon la Loi sur la concurrence du Canada. Nous recommandons d'imiter une réglementation en vigueur en Colombie-Britannique, laquelle assure l'immunité juridique à toute entreprise ou tout individu qui expose des comportements de collusion.

### 5.6. Droits de récolte transférables

Offrir la possibilité de transférer les territoires de récolte a de nombreux avantages pour l'acheteur et pour le vendeur. Cela permet à l'industrie la flexibilité de s'ajuster face aux imprévus économiques et techniques. Du point de vue de l'acheteur potentiel, un territoire qui est transférable a une plus haute valeur qu'un territoire non transférable. L'existence du marché secondaire peut mitiger des erreurs d'allocation tout en augmentant les recettes.

## 5.7. Les enchères simultanées

*5.7.1. Le problème de la complémentarité et la substitution pour l'enchère simultanée.*

Lorsque chaque enchère est traitée indépendamment, l'enchère simultanée de plusieurs territoires de récolte représente des défis pour l'acheteur potentiel et pour le vendeur. Il y a deux catégories de problèmes qui se présentent :

1. Le problème de la **complémentarité** est présent lorsque le participant désire obtenir une combinaison de territoires, ce regroupement de territoires étant d'une plus grande valeur pour lui que les territoires individuels. Dans ce cas, si l'acheteur ne gagne qu'un sous-ensemble, il risque de perdre les économies d'échelle prévues pour l'ensemble.

2. La **substitution** est présente lorsqu'un acheteur a besoin d'un certain nombre de territoires de récolte, mais que plusieurs combinaisons sont possibles. Par exemple, considérons trois territoires (A,B,C). Un acheteur peut désirer gagner deux territoires, soit (A, B) ou (A, C). Par contre, il ne désire pas, en raison de contraintes économiques ou techniques, gagner (A,B,C); il est donc obligé de limiter sa mise à deux territoires. Ceci peut avoir des effets négatifs pour le vendeur, si tous les acheteurs potentiels misent sur les mêmes lots. De plus, l'allocation des ressources n'est pas optimale.

*5.7.2. La complexité des enchères combinatoires*

Les enchères combinatoires éliminent les problèmes de complémentarité et de substitution en permettant aux participants de faire des offres sur plusieurs regroupements de territoires. Par exemple, ils peuvent offrir un montant X $ pour les territoires A et B ensemble, et le montant Y $ si un seul des territoires est vendu. Ce mécanisme introduit toutefois certaines difficultés :

1. Le problème du seuil se présente lorsqu'une grande firme inclut dans leur ensemble des lots qui sont indésirables pour elle, mais d'intérêt pour les autres participants. Cette stratégie permet d'offrir une mise totale gagnante, avec des prix moins élevés pour les territoires convoités par les petites entreprises.

2. La complexité de considérer plusieurs regroupements de territoires chez les enchérisseurs augmente de manière exponentielle avec le nombre de territoires. Ceci rend difficile et coûteux le processus décisionnel. Mais dans le secteur forestier, nous croyons que la complémentarité entre territoires est facilement identifiable, ce qui limite la complexité.

3. Du point de vue du vendeur, la complexité à déterminer le gagnant peut être un enjeu. En effet, ce problème peut ne pas avoir de solution unique, ni de solution calculable en temps discret. Toutefois, avec les développements informatiques ce type de problème ne devrait plus être un enjeu. Toutefois, le développement d'un logiciel pour déterminer le gagnant est essentiel dans la mise en œuvre de ce système.

4. Il peut y avoir méfiance envers le processus décisionnel lorsque c'est un algorithme computationnel complexe qui détermine le résultat de l'enchère. Ce manque de transparence peut réduire la confiance des participants envers la structure du marché.

*5.7.8. La distribution dans le temps des enchères peut atténuer les problèmes de complémentarité et de substitution*

Il est important de considérer la répartition des enchères dans le temps, car cela peut atténuer les problèmes identifiés ci-haut. Les secteurs qui sont considérés complémentaires (ex. adjacents) devraient être offerts au même moment, tandis que les autres secteurs devraient être choisis de manière plutôt aléatoire. Afin de limiter le problème de substitution, nous recommandons que l'offre soit divisée en 6 à 8 enchères par année. Ceci permet au participant de s'ajuster par rapport aux résultats antécédents et de trouver des territoires de substitution si nécessaire. Sur un marché faible, il est important de garder une imprévisibilité sur le choix de territoires qui sera offert. Le volume offert pendant une période d'enchère ne devrait pas permettre de prédire le volume total prévu pour le marché. La participation aux enchères et les ventes totales devraient être constamment surveillées pour des indications de faible demande afin d'éviter l'excès d'offre.

**5.8. Devons-nous considérer des mécanismes d'enchère par itération dans l'industrie du bois?**

Jusqu'à maintenant, nous avons considéré que des enchères sous pli cacheté, c'est-à-dire des scénarios où le prix qui est soumis par l'enchérisseur est secret et où seul le prix gagnant est rendu public. Il existe des mécanismes d'enchères où l'offre des enchérisseurs est une information connue. C'est entre autres le cas pour l'enchère par itération ascendante où les offres sont connues de tous. Ceci permet aux participants de découvrir la valeur que les autres accordent aux biens. C'est la méthode qui reproduit l'enchère classique à l'anglaise. Dans le contexte où la participation est faible, l'enchère itérative n'est pas souhaitable. En effet, Saphores et Coll (2006) ont démontré que ce type d'enchère, appliqué au secteur du bois, engendre des comportements de collusion et réduit les prix de vente. Étant donné que l'industrie forestière a un nombre de participants somme toute limité, nous recommandons que le prix des participants demeure caché.

**5.9. Trois suggestions d'enchères**

Dans cette dernière sous-section, nous présentons trois alternatives à l'actuel mécanisme d'enchères sous pli cacheté présentement considéré au Québec et en place en Colombie-Britannique. Nous suggérerons qu'une des expériences économiques en laboratoire et terrain soit éventuellement réalisée sur ces enchères dans le but de tester leur comportement dans le contexte de la forêt québécoise.

*5.9.1. Enchère du premier prix avec regroupements déterminés par le vendeur*

Dans cette première variation, les participants misent sur des territoires individuels ou parmi un choix de regroupements de territoires prédéterminés par le vendeur. La version la plus simple consisterait à offrir les lots sur deux niveaux de hiérarchie; i) des territoires individuels et ii) des regroupements de territoires qui sont mutuellement exclusifs. Lors de l'enchère, les prix gagnants sont déterminés pour chaque niveau de hiérarchie et ensuite, ils sont comparés entre eux pour déterminer le gagnant. Ce calcul est très simple et offre une transparence quant à la méthode d'attribution du gagnant. De plus, nous réglons le problème de complémentarité, avec l'hypothèse que le vendeur puisse facilement identifier la complémentarité et former des regroupements désirables. Le problème de la substitution n'est pas réglé ici, mais tel que mentionné précédemment, il peut être grandement atténué en augmentant le nombre d'enchères dans le temps.

*5.9.2. Enchère du premier prix avec lots déterminés par l'enchérisseur*

Lors de cette enchère sous pli cacheté, l'enchérisseur soumet des offres sur des territoires individuels et il peut aussi créer des offres sur des regroupements. Un nombre maximum de regroupements est fixé pour assurer un algorithme capable de déterminer le gagnant. Ces offres sont analysées par un algorithme (langage XOR), soit une approche de « ou exclusif », c'est-à-dire que l'enchérisseur ne peut remporter qu'un seul regroupement.

Les principaux avantages de cette enchère sont qu'elle est relativement simple à comprendre pour les enchérisseurs. En limitant le nombre de regroupements permis, cela encourage l'enchérisseur à se limiter aux combinaisons avec des complémentarités facilement identifiables. Ce mécanisme utilise le « ou exclusif », ce qui élimine les problèmes de substitution.

*5.9.3. The Clock-Proxy Auction (CPA)*

Ausubel et Coll (2006) présentent le « Clock-Proxy Auction » (CPA) qui combine les éléments de l'enchère ascendante (clock auction) avec l'enchère avec intermédiaire (proxy auction). Examinons premièrement le fonctionnement et les caractéristiques de ces enchères séparément, avant de s'aventurer dans les détails du CPA.

**L'enchère ascendante** se caractérise par le fait que l'enchérisseur ne mise que par des *oui* ou des *non*. Le commissaire-priseur commence l'enchère au prix de départ et augmente à chaque ronde d'un incrément prédéterminé. L'enchérisseur identifie s'il accepte le nouveau prix ou non; l'enchère se termine lorsqu'il ne reste qu'un seul enchérisseur. Dans un environnement peu compétitif, ce mécanisme est propice au comportement de collusion.

**L'enchère avec intermédiaire** demande aux enchérisseurs d'exprimer, sous pli cacheté, le maximum qu'ils sont prêts à payer pour un bien. Le commissaire-priseur commence l'enchère au prix de départ et augmente à chaque ronde d'un incrément prédéterminé. L'intermédiaire détermine si l'enchérisseur participe ou non en se basant sur son prix maximum. L'enchère se

termine lorsqu'il ne reste qu'un seul enchérisseur. Ceci est équivalent à l'enchère au deuxième prix et révèle la vraie valeur qu'un acheteur est prêt à payer, car le gagnant ne paye pas sa mise, mais celle qui la précède. Par contre, l'industrie peut hésiter à révéler la valeur maximale qu'elle est prête à payer, de crainte que le vendeur n'en profite pour augmenter son prix de réserve.

Le fonctionnement du CPA se fait en deux étapes. Dans la première étape, une enchère ascendante est réalisée sur les territoires de récolte individuels; les regroupements ne sont pas considérés. Cette enchère se termine lorsque le surplus de la demande est éliminé.

À la deuxième étape, l'enchère avec intermédiaire ascendante permet aux participants de soumettre des offres de regroupements qui sont mutuellement exclusifs. Le processus s'effectue comme suit :

1. L'**enchérisseur** émet, sous pli cacheté, sa meilleure mise pour chaque regroupement. Seulement un regroupement par acheteur peut gagner.

2. Le prix de départ se base sur le résultat de l'enchère ascendante de la première partie.

3. Au début de chaque ronde, l'**intermédiaire** calcule le regroupement qui représente le meilleur gain pour l'enchérisseur, et celui-ci devient sa mise active. Le gain est la différence entre la mise maximale (établie à l'étape 1) et la somme des prix pour les territoires dans son regroupement.

4. Le **commissaire-priseur** détermine l'allocation des mises qui maximise le revenu du vendeur et déclare l'acheteur, s'il est unique.

5. Pour la mise non gagnante, **l'intermédiaire** augmente d'un incrément le prix offert, et recalcule le regroupement avec le meilleur gain (étape 3).

6. Le **commissaire-priseur** détermine à nouveau l'allocation qui maximise les revenus du vendeur.

7. Les étapes 4 à 7 sont répétées jusqu'à ce qu'il n'y ait plus d'offre. Les gagnants paient le dernier prix établi à l'étape 5.

Le CPA profite de **l'enchère ascendante** pour transmettre des informations sur le prix et sur la concurrence du marché. À elle seule, elle n'assure pas un bon rendement et est sensible à la collusion. L'avantage principal d'ajouter **l'enchère avec intermédiaire** est que celle-ci réduit la collusion tout en assurant un meilleur prix pour le vendeur. De plus, elle s'adapte bien pour accommoder les mises par regroupement.

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## Annexe

**This is the original text that was summarized and translated French. Ceci est le texte original qui a été résumé et traduit en français.**

### 5. Développement des points importants

#### 5.1. What is the impact of statistical variance (uncertainty) of inventory data on anticipated bidding behaviour?

In this section we describe the effect of inventory uncertainty using as an example a block that contains two species. Concentrating on a two species situation simplifies the exposition without loss of generality.

Consider a block offered at auction by the Crown, described in terms of total estimated volume for each of the two species it contains ($Q1_{est}$ and $Q2_{est}$), for a total estimated volume $Q_{est} = Q1_{est} + Q2_{est}$. Each bidder submits prices $p_1$ and $p_2$ per scaled $m^3$ of the respective tree species. The winner of the auction is the firm with the highest projected Crown revenue based on the block's estimated volume for each species:

$$R_{est} = p_1 Q_{1est} + p_2 Q_{2est} \qquad [1]$$

Or equivalently,

$$R_{est} = (p_1 e_{1est} + p_2 e_{2est}) Q_{est} \qquad [2]$$

Where $e_1$ and $e_2$ are the estimated proportions of the total estimated volume for each of the two species (e.g. $e_{1est} = \frac{Q1est}{Qest}$ ).

Actual stumpage fees, however, are assessed on true scaled volume of Timber (Q) and the real distribution of timber across the two species with the licensee paying the separate bid prices $p_1$ and $p_2$ contained in the original winning bid.

$$R = (p_1 e_1 + p_2 e_2) Q \qquad [3]$$

The alternative formulations are useful to illustrate that there exists two distinct sources of uncertainty with respect to the Crown's revenue (and the stumpage costs paid by bidders), that are otherwise hidden in the initial formula.

Comparison of equations 2 and 3 reveals two sources of uncertainty between the estimated value of auction bids and the actual stumpage fees to be paid by the winner and collected by the Crown. The first is the uncertainty surrounding the total volume of wood available. That is, the magnitude of the difference between Qest and Q. The second source of variation is the level of inaccuracy in the distribution of species ($e_1$ and $e_2$).

The two sources of uncertainty have radically different implications for bidding behaviour. The uncertainty in the estimate of total volume (Qest) harbours no strategic incentives. While absent or extremely unreliable estimates might discourage auction participation, this is not thought to be an issue since volume estimates resulting from cruising a block are relatively reliable and winners only pay for actual volumes harvested. Firms could also choose to obtain their own inventory assessment prior to bidding.

Uncertainty regarding the distribution of the forest between different species is a far more important issue. This is because bidders can potentially take advantage of errors in the estimated proportions of the different species and bid strategically so as to increase their probability of winning the auction knowing that they would not, in fact, have to pay as much as the Crown estimates at the time of the auction.

While the source of the strategic incentives to skew one's bid is an error in the estimate of $e_1$ and $e_2$, firms really cannot exploit it unless they have a different private estimate of these proportions. Athey and Levin (2001) derive the benchmark model for this situation and present the game-theoretic equilibrium bidding strategy for participants in a first-price sealed bid auction. They show that bidders have an incentive to strategically skew their bid in favor of the species that they believe was overestimated by the Crown's survey (where the relevant variable is the proportion of the total volume for each species). By bidding more on the overestimated species, and less on the underestimated species, they can artificially increase the value of their bid from the Crown's perspective, but with the belief that the total price they will have to pay for a representative cubic meter (i.e. the average price weighted by the true proportions across species) will be less than the Crown estimate at the time of auction.

In general, greater inaccuracy in the Crown's inventory data (i.e. greater variance in the estimates of proportions measured by the Crown and by private cruisers) inevitably lead to a greater likelihood that the private inventory estimates will differ from the Crown's, and therefore that auction bid prices will be strategically skewed. Not only more bids will be skewed as a result of greater variability in estimates, but the average degree by which individual bids are skewed should also be expected to increase with the variance of the estimates of proportion.

Because auctions results will be used to price other non-auctioned timber, greater variance in winning auction prices should be expected to result in weaker statistical properties of the estimators for the price transposition equation. This would confer less precision to the pricing equation and therefore statistically greater standard errors and less accurate price predictions for non-auctioned blocks. This is not desirable of course, but this is very distinct from any notion of bias in the estimators of the price equation.

In fact, it is entirely possible for the price transposition equation to remain unbiased despite the fact that a majority of the individual auction data underlying its estimation might be biased. Athey and Levin (2001) report that in nearly 700 auctions conducted in Washington and Oregon between 1976 and 1990, some 45% of the inventory estimates (in proportion of total volume) for the most abundant species were off by more than 0.05. They also report that, 17% of estimates were off by more than 0.1. Furthermore, the analysis of auction bids demonstrates a clear tendency of bidders to increase their price bid on the overestimated species and to decrease it on the underestimated species, as suggested by theory. Thus, individual auction bids are on average biased. However, Athey and Levin also conclude that there is no compelling evidence that the average winning price is also biased.

Two elements can explain this seemingly counter-intuitive result. First, the Oregon and Washington inventory data on the proportional representation of each species is on average correct in the sense that the proportion of the most abundant population is just as likely to be overestimated as it is to be underestimated, and by roughly the same degree. Over all 697 observations the proportion of the most abundant species is overestimated by less than 0.1. It follows that individual auction bids are just as likely to show a positive bias as they are to show a negative one. These effects tend to cancel each other once all data is taken into consideration.

The second element suggested by Athey and Levin (2001) to explain the lag of strong bias in the average price is that a sufficiently high degree of competition between bidding firms reduced their ability to take advantage of the informational advantage they had over the Crown. Individual bidders alone would skew their bids significantly, but the most competitive of bidders (those who win the auctions) recognize that they must maintain a competitive price to win the auction (especially on the underestimated species). Potential informational rents based on asymmetric information between bidders and the Crown can be dissipated when a sufficient number of other bidders also have similar information (or are presumed to have it). Thus, ensuring a competitive bidding environment might be the best weapon against the effects of survey uncertainty on the price of timber.

Despite the encouraging results presented by Athey and Levin (the only systematic study of variance in inventory estimates we are aware of), it appears prudent that the Crown monitors the performance of its inventory measurements in order to ensure against systematic biases in estimates (towards certain species, for example), as well as to maintain high levels of accuracy.

Inventory measurement errors, even if unbiased, are undesirable since they ultimately reduce the statistical accuracy of the price transposition equation, and therefore of the stumpage fees applied to non-auctioned blocks. This source of uncertainty can be understood and mitigated by improving the accuracy of cruising methods. We therefore recommend that the governments of Ontario and Quebec take steps to review recent accuracy of their inventory estimates against scaling measurements with a view of identifying systematic biases in the proportion of the principal species and improve the overall accuracy of forest inventory data.

## 5.2. What are the impacts of a pricing system based on a lump sum payment for a tract of forest versus a scaled price per cubic meter by timber species; how does this relate to the obligation to harvest?

Bidding on a specific tract of forest in a sealed bid auction amounts, to some extent, to bidding on a common value asset. A common value asset is an asset that all buyers would value equally if they shared the same information. In the absence of such information, potential buyers face an important valuation risk. Uncertainty regarding the value of the asset sold often leads to what is known as the «winner's curse», where the highest bidder is often overly optimistic about the value of the asset, resulting in a net loss to the winner of the auction. The likelihood of such losses increases with the number of bidders since more bidders increases the probability that one of them will overvalue the resource being auctioned.

The risk of overvaluation typically comes from the uncertainty about the price and volume of timber. Given that the information on price for timber by species and usage is available and accessible, the risk from price uncertainty can be considered relatively small. The risks from volume uncertainty, however, are largely defined by the pricing system used to sell the forest tract. We consider a pricing system consisting of a lump sum payment for a tract of forest; and the alternative based on a price per cubic meter of harvested and scaled fibre.

### *5.2.1. Lump sum payment*

In this situation, a forest tract is auctioned for a lump sum payment. The winner is then free to harvest whatever he wants within the constraints and regulations imposed by the code of forestry practices. If bidders underestimate the timber potential, their bid will be too low and they stand to lose the forest tract. On the other hand, if they overestimate its value, the winner will be afflicted by the winners curse and incur financial losses. Note that this can occur independently of an official government inventory, since no adjustment for discrepancies between the inventory and real harvest exists under a lump sum payment mechanism. This is the main drawback of requiring lump sum payments. Since high bidders are winners of the auction, the winner's curse introduces risks of losses without equivalent risks of oversize profits. This can lead to repeated industry losses. Furthermore, the price paid at auctions – although it is competitively determined – is not an efficient price reflecting the true value of the timber. Therefore, unless bidders appropriately lower their bids in order to optimally avoid the winner's curse, lump sum auctions are not desirable.

The one –sided risks faced by bidders in common value auctions can be avoided optimally by lowering one's bid. Unfortunately, computing the appropriate amount of bid shaving requires knowledge of the number of bidders entering the auction, information that is not available without attempts at collusion or information sharing among potential bidders. Furthermore, and contrary to the normal impact of competition, the presence of a greater number of bidders produces incentive to further shade bids, because, as explained above, more bidders increase on average the difference between the true value of the asset and the highest estimate of its value among the bidders. Therefore, if and when bidders appropriately protect themselves against the risks of the winner's curse, the resulting bids decrease (rather than increase) with increasing competition (Bulow, Klemperer 2002).

*5.2.2. Price applied to scaled timber*

The negative consequences of the winner's curse can be greatly reduced by allocating timber rights to the highest price per unit of volume (weighted by the specific species mix), but by computing stumpage fees based on the actual volumes harvested. Payments based on scaled volumes remove the volume as a source of uncertainty faced by potential bidders. However, this type of sales can also generate other types of strategic behaviour.

The first strategy that can be employed is skewed bidding. This occurs when a bidder in a multispecies sale loads exploits perceived differences between the announced species mix and what they believe is the correct proportions. These perceived inaccuracies provide incentives to overbid on species that are thought by the bidder to be less abundant than the official government inventory suggests, and to lower bids on the species thought to be over-estimated by the Crown's survey (GAO, 1983).[3] Since the outcome of the auction is determined by the weighted price based on government inventory but the price paid is on true volume harvested, the skewed bidding strategy artificially inflates the total value of the bid and generates smaller revenue than anticipated by the auction results alone. It may result in the winner of the auction not being the bidder that offered the highest aggregate price, on a real harvest base. Thus, the allocation cannot be guaranteed to be optimal. In general, the problem of skewed bidding is attenuated by competition.

The second strategic behaviour does not require inventory inaccuracy in species proportion and can be called strategic hauling. In this case a buyer can bid a high price on timber species of low interest and a low price for the most valuable species. Absent any penalty for not harvesting timber species (or in the presence of low penalties), buyers have incentives to harvest only the strategically low priced valuable species, leaving the remaining timber in the field. According to the US Forest

[3] As seen in section 4.1, the statistical variance on inventory is not a critical point here, as long as the species proportion is respected.

Service, strategic hauling does take place, especially when a few trees or small grove represent a large proportion of the value of the forest (GAO, 1983).

Both cases result in biased bids and prices by species, which would then be transposed to price a significant portion of public forest. This is therefore a potentially important issue.

Using the equations developed in the previous section (4.1), the problem of skewed bidding can arise under the following conditions:

$$\left(\frac{e_{1est}}{e_{2est}}\right) \neq \left(\frac{e_1}{e_2}\right) \qquad [4]$$

where $e_1$ and $e_2$ are the estimated proportions of the total estimated volume for each of the two species (e.g. $e_{1est} = \frac{Q1est}{Qest}$ ).

One obvious way to reduce skewed bidding is to get better estimates of species proportion in order to avoid the condition represented by equation [4].

For the problem of strategic hauling, the buyer pays $(p_1 e_1 + p_2 e_2)Q$ , as explained previously, if his interest is for $Q_1$ rather than for $Q_2$, he can then bid such that $p_2 > p_1$ and harvest only $Q_1$.

Whereas the problem of skewed bidding can be attenuated by increased competition, strategic hauling is not since it is entirely artificial bidding on fibre the bidder does not intend to harvest. To avoid this strategic behaviour, a penalty for not harvesting timber species with positive bids must exist. In fact, in our example, the penalty (A) should be such that $A \geq p_2 Q_{2est}$ [5]

*5.2.3. Obligation to harvest and Negative Bids*

Current regulations in most jurisdictions impose the obligation to harvest all volumes available regardless of its economic value. The primary reasons for the obligation are to improve forest regeneration and to force the use of certain wood fibre such as pulp wood. It is important to realize that if an uneconomical species must be harvested and removed by the licence holder, the losses associated with this obligation will necessarily be reflected in a lower price offered for the profitable species. This is an undesirable source of bias in the price of those species. Furthermore, it could reasonably be argued 1) forcing the use of uneconomical resources imposes needless costs on the industry and serves no useful economic purposes; or 2) if the main reason for removing uneconomical or nuisance species is to improve regeneration, the costs of the logging and removal should be attributed to land preparation and sylviculture.

When a tract is close to a pulp and paper mill, the obligation is typically not binding since harvesting is profitable. On the other hand, when the distance is significant and harvesting certain species is

clearly not profitable, some jurisdictions (including Quebec) have at times relaxed the obligation to harvest. For vast areas of the province, however, it is difficult to assess and determine tract by tract whether certain species are profitable.

Rather than arbitrarily defining where the harvesting obligation should be in place, the Quebec Bureau de la Mise en Marché des Bois (BMMB) has expressed an interest in using market mechanisms to deal with the obligation to harvest. In fact, the BMMB is currently considering maintaining the obligation to harvest, but to allow negative bids. Conceptually, negative bids would occur when the loggers are forced to harvest some species at a loss. Negative bids would still leave intact the incentives to find markets for the fibre if the harvester paid to remove the wood remains the rightful owner of the logs; but also because the negative bid on some timber species would reduce the competitiveness of the total bid for a cutting block. Securing a market prior to the auction would allow the bidder to submit a higher bid for the non-profitable species (possibly still negative). It is important for the Crown to recognize that negative bids could be construed as a subsidy to the industry. In fact, the Crown is purchasing a service (clearing the land of nuisance species) from the harvester of commercially viable trees. Viewed from this perspective, it is in the interest of the Crown to properly assess the value of such service, and possibly to impose a maximum it is prepared to pay for such services.

It is also worth noting that negative (or zero) bids could also exacerbate problems such as strategic hauling. Currently, in Quebec, the penalty for not harvesting (A in equation [5]) is the entire bid made on those species. A buyer could bid a high price on the species of interest and a negative bid on nuisance species. Applied literally, the incentives under the current rule would then be to harvest the timber of interest and leave the species with negative value standing and receive payment for doing so. This is clearly not the intended objective. Negative bids, of course, should result in no payment when the timber is not cut or removed. The alternative where the obligation to cut remains - subject to penalty – could also simply be maintained as is currently contemplated.

*5.2.4. Recommendations*

On one hand, a lump sum payment exposes buyers to the winner's curse, reduces government revenues and lead to the result that as competition increases, market price decreases. On the other hand, scale sales can induce strategic behaviour such has skewed bidding and strategic hauling, which results in sub-optimal allocation and lower government revenues. The obligation to harvest and how this obligation is enforced is also an issue related to scale sales.

We recommend the use of scale sales given the importance and implications of the winner's curse on revenues and new entrants[4]. Regarding skewed bidding, it might not be a major issue in Quebec

[4] The winner's curse discourages new entrants, since they are more susceptible to it due to their lack of experience.

and Ontario, given the accuracy of the timber volume estimates. The US Forest Service is known for the poor quality of its estimates. A GAO report found overestimation of 50% for minor species volume on 36% of the surveyed tracts ((GAO, 1983).

Nevertheless, based on the GAO report (1983) and some timber auctions observed in British Columbia, skewed bidding could be partially mitigated by having potential buyers bid a premium over the announced upset price. Under this rule, no bid lower than the upset price is accepted. The bid premium is then spread proportionally among the species being sold. This improves the allocation issue raised by skewed biding (when the highest aggregate bid, based on real harvest, is not the one winning the auction) and, by the fact of, raises revenues. It is, however, a loss of information (bid by species) regarding the data needs for price transposition.

The bid premium spread does not resolve the potential for strategic hauling. Little, outside of an obligation to harvest with a penalty independent of one's own bid can effectively curb it. One option would be to entirely remove the obligation to harvest nuisance species. This would ensure that a tract auctioned would generate revenues (through scaling or penalties), would reduce the incentive for strategic hauling, especially when it is not economical to harvest pulp wood, and still create an incentive to find markets for pulp wood since doing so would generate more competitive bids. Negative bids for uneconomical species could then be considered at the discretion of the Crown.

Practically, a negative bid would be considered an offer of service by the bidder to the Crown. Just as the Crown establishes a reserve price below which it is not prepared to sell logging rights, the Crown should establish its own reserve price for removing undesirable species (the maximum it is prepared to pay for removal of those trees if it is desirable for forest regeneration) and only consider such negative prices as part of the bid if the removal to the Crown were less than its willingness to pay. If the negative bid for the undesirable species exceeded the Crown's willingness to pay their removal, the negative price would be excluded from the bid, but the negative price would be replaced (for the purpose of determining the winning bid) by the Crown's estimated cost of removing the species.

**Table 1**

| | **Firm A** | **Firm B** |
|---|---|---|
| **Bid Species 1 (per $m^3$)** | $12 | $10 |
| **Bid Species 2 (per $m^3$)** | - $5 | - $1 |
| **Net revenue (per $m^3$) with obligation to remove species** | $3.5 | $4.5 |
| **Net revenue when the Crown removes Species B when bids for removing Species 2 exceed $2.4 per $m^3$ (Firm A bid only)** | $4.8 | --- |

Consider an example in Table 1. Two firms, A and B are bidding on a lot which has a measure 1 of fibre (e.g. 1,000 $m^3$) divided equally between Species 1 and 2. Firm 1 bids \$12/$m^3$ and -\$5/$m^3$ for species 1 and 2 respectively. Firm B bids \$10/$m^3$ and -\$1/$m^3$. The Crown establishes a maximum price of \$2.4 per cu metre that it is prepared to pay for the removal of Species 2.

Under the standard assessment of the bids with an obligation to cut species 2, Firm B would win the cutting rights with an average price of \$4.5 per $m^3$. However, with the Crown valuing the removal of Species 2 significantly less than the offer of Firm A to remove it, it should consider removing it itself (or leaving those trees standing). This results in a real or imputed cost of \$2.4 per $m^3$, less than the \$5 charged by Firm A. By asking Firm A to leave species 2 on the lot, it would collect \$6 in revenue and have real or imputed costs of \$1.2 for a net average price of \$4.8. This leaves Firm A the winner of the rights to the lot[5].

### 5.3. What is the impact of an auction's starting price on bidding behaviour and auction outcome? What is the impact of a minimum price and of an upset price on the outcome of auctions if these are made public?

Before answering these questions, it is useful to define some of the terms used. The minimum price is the lowest price at which the seller is willing to sell the good. Under no condition is the seller willing to sell at a price below the minimum price. The upset price is the minimum price the auctioneer is willing to accept in an auction. Thus, it is also the price that commits the seller to selling the good when a higher bid exists. The upset price, by definition should be equal to or higher than the minimum price. The difference between the two prices is that a minimum price is a «permanent» floor price, while the upset price reflects a minimum willingness-to-accept from the seller, and can be revised. The starting price is the price at which bids would start in an open ascending price auction. In a sealed bid auction, this starting price acts as a reference point for bidders. The starting price, by definition, need to be divulgated. On the other hand, announcing the minimum and upset prices has theoretical impacts that we discus below.

#### *5.3.1. The minimum price*

Following the approach of Athey et al. (2003) as well as the one suggested in «Étude sur les modalities et les impacts du nouveau mode de mise en marché des bois», we define the minimum price (no-sale price) as the average total cost (or opportunity cost) of the seller. Another consideration would be to use the average minimum cost (shut down point). This definition implies that the upset price needs to be different (higher) than the minimum price. Having an upset price greater than the minimum price allows increasing sellers' revenues and leaves room to reduce the upset price, following changes in the market. Athey et al. (2003) argue that this is especially

[5] Note that the suggested rule might create a strategic behaviour from bidding firms, especially if their bids reflect an average bid rather than bids based on species.

important with a first price sealed bid auction. In such auction, it is expected that buyers will shade their bids (bid lower than their value to reduce the winner's curse). Having an upset price above the minimum price acts, according to the authors, as a counter effect to the shading behaviour.

Thus, the minimum price, as previously defined, should be seen as an internal parameter used to make decision regarding the offering or not of a forest tract (based on cost/opportunity cost recovery). The minimum price also acts as a limit for downward adjustment to the upset price. On this basis, it should not be made public. In fact, a public minimum price might convey information on the upset price which, in the case of timber auctions in Quebec and Ontario, might be detrimental as discussed later.

*5.3.2. The starting price*

Numerous authors have looked at the impact of the starting price on revenues and bidding behaviour using data from eBay (Gilkeson and Reynolds 2003, Kamins et al. 2004, Bajari and Hortacsu 2003, Ku et al. 2006). Ebay is an ascending auction with proxies, in the family of second price auctions. Most studies found that a high starting price reduces participation but increases the final price, this results hold for private and common value goods. These results are also in accordance with theory where the starting price sends an evaluation signal. A high evaluation signal would be negatively correlated with the number of participants.

It is important to note that with eBay, sellers can use a secret upset price (observed for high value items) but the upset price is typically announced or his equal to the starting price. Kamins et al. (2004) looked specifically at this question and found that when both (the upset and starting) prices are divulgated; the upset price drives the final price. In other words, if one is to make both prices (upset and starting) public, one might as well just give the upset price. This is what the State of Victoria in Australia as well as the province of British Columbia have decided to do in their first price sealed bid timber auctions. In both regions, the starting price is the upset price. If no transaction occurs for a specific tract, the price is reduced and the block offered anew at a later auction. In Victoria, it is reduced progressively up to the minimum price (VicForest, 2006).

Based on previous results, in a closed auction such as the first price sealed bid, the impact of a high starting price observed with ascending bids should hold but might be weaker. The signal sent by a high starting price is not affected by the closed auction, but the impact could be weaker since bids lower than the starting price are accepted. On the other hand, the relation between a high starting price and lower participation should not hold if the upset price is not divulgated and his not equal to the starting price. Furthermore, commercial timber auctions are far more specialized and regionally defined than e-bay auctions. Therefore, while one should still expect that very high starting prices relative to anticipated value might still deter entry, significant problems are not expected if the starting price is set at a reasonable ratio of anticipated market value (B.C. sets the starting price at 70% of the price given by its pricing model).

*5.3.3. The upset price*

Athey et al. (2003) argue that the upset price should not be equal to the appraisal value of timber in order to take into account potential appraisal errors. This is, however, when the upset price is the starting price. Quebec currently uses the appraisal value as a starting price, but lower bids have the potential of clearing the market, as long as they are above the hidden upset price.

The literature presents strong evidence in favour of not announcing the upset price. Athey et al. (2003), Chan et al. (2003) and Ashenfelter (1989) conclude that hidden upset prices can lead to a reduction in collusive behaviour by bidders. The reason is that bidding groups need to know the upset price in order to determine their collusive bids. Others have also found that hidden upset prices increase auctions sale prices (Lucking-Reiley et al. 2007, Bajari and Hortacsu 2003, Vincent 1995, Li and Tan 2000).

In Quebec and Ontario, as transaction data accumulate, the predictability by buyers of the upset price can become an issue. One might also wonder how unsold tracts, which by definition had bids lower than the upset price, should re-enter the market. Should the upset price be reduced? Should it be maintained, hoping that after a set of auctions it will attract buyers whose bids on other tracts were not successful?

Before answering these questions, the current or envisioned rules are reviewed for Quebec. Currently, the starting price in Quebec is based on the appraisal of timbers from an econometric transposition. This appraisal is however bounded by administrative rules on maximum increases that are not linked to timber species and market evolution. The upset price is a percentage of the starting price computed with a non linear formula that takes into account various internal adjustments such as distance and timber quality relative to the mean. Two external adjustments are also made: one for market trend (upward or downward) and one from the market feedback of the successful auctions of the round. For instance, if the successful auctions final price was in average 12% lower than the starting price, the upset price of unsuccessful auction would be reduced by the excess of 10%, in this case by 2%. Bids on unsold tracts would then be revaluated in light of the new upset price. The same rule would apply for upward prices. Quebec also considers returning immediately unsold tracts without change to the upset price, especially if the highest bid is within a range of the upset price.

In Quebec, the nonlinear equation (and once more data is available the standard deviation could be used) with internal and external adjustments, are likely to complicate attempts to forecast the upset price. To increase the forecasting difficulty, one possibility would be to add a random component to the feedback adjustment. For instance, the excess threshold could be drawn from some interval (for instance between 0% and 10%) instead of simply applying the 10% currently used. Li and Perrigne (2003) looked at random upset prices and found that using a computed optimal upset price based on risk neutral buyers' value generated better revenues than a random upset price. However, this approach is not practical. Perrigne (2003) looked at a random reserve

price in the more realistic context of risk averse buyers and found that random upset prices increase sellers expected profits.

The disposal of unsold tracts poses a different set of questions. A rule that stipulates, for example, that if the highest bid is within 20% of the upset price, then the tract would immediately be put back on the market, should be avoided. Such rules carry significant information regarding the upset price. An alternative would be to systematically return on the market all wood tracts whose highest bid is lower than the starting price[6]. In such case, initial bidders can improve their bid, or choose to leave it as it was (if they think that they have the highest bid above the reservation price and that no one would bid higher than them). New bidders could choose to bid but initial bidders would not be able to recall their initial bids. Such rule will not reveal information on the upset price, will create an incentive to increase bids in the initial round at or above starting price and will offer unsuccessful bidders in the initial round the opportunity to buy timber without having to wait until the next scheduled round of auctions. [7]

*5.3.4. Recommendations*

It is recommended that the minimum price be unannounced. The upset price should also be unannounced, be greater than the minimum price, be lower than the starting price and should preferably include a random component to avoid the industry from being able to compute it as auction data accumulates. A public starting price should be in the range of 75% to 85% of appraised value.

We also recommend that all tracts with highest bid lower than the starting price be systematically returned to the market for a second round of bidding where initial bids remain active. Original bidders would have the option to increase their bids and new bidders could compete. Lots that fail to elicit a bid above the starting price in a second round would go unsold and could be offered at a future auction, with or without a change to the starting price.

## 5.4. What information should be made public (and at what time) if the chosen market mechanism was a first price sealed bid auction?

[6] In such case the starting price could be, until more auction data are available, the appraisal value plus or minus a percentage.

[7] This suggestion should not create incentive not to participate in the first round of auctions, since the second round with unsold tracts is not certain (risk issue and localisation) and can potentially be more competitive than the first round. To avoid creating an information advantage, no new information, such as the highest bid of the first round, should be divulgated

We answer this question with the possibility that either a sealed bid or live iterative bidding auctions could be conducted, while anticipating that field implementation is likely to remain a sealed bid auction.

We consider two categories of information. First, the biophysical information regarding the cutting blocks for sale; and second, the broadly defined economic information regarding the overall supply and offering of timber, and information directly relevant to the auctions: rules.

Bio-physical information: It is generally in the province's and in the industry's best interest for the Crown to provide full disclosure of its knowledge regarding the location, accessibility, general conditions of the stand, and assessment of the forest inventory prior to an auction.

For the most part, biophysical information does not incite strategic behaviour or bidding at auctions (see caveat below). The release of complete bio-physical information is therefore desirable in order to make the process more transparent, build trust in the marketing system, remove some of the uncertainty surrounding the value of the blocks offered, and generally favour the participation of small operators and those who can least face such uncertainty.

The only possible caveat concerns the release of the Crown's inventory assessment. As previously discussed, inaccurate assessments might lead to skewed bidding when forest operators obtain a different private inventory assessment. Thus, if it was known that the Crown's inventory assessments were very inaccurate, it would be acceptable and probably desirable to proceed without the release of inventory data. In such case, one option would be to ask bidders to submit a single price per cubic meter of scaled wood harvested (regardless of species). This option would reduce the winner's curse, compare to sales with a lump sum payment (in the same conditions). Unfortunately, this would make the estimation of the price transposition equation substantially more difficult and potentially unreliable. It is therefore desirable for the Crown to obtain reliable inventory and to release this information publicly prior to the sale.

Economic Data

1) Minimum (no-sale) Price

As discussed previously, the Crown's minimum price should never be announced because it would undesirably provide bidders with a lower bound for the upset price, potentially enticing bolder strategic bidding attempts.

2) Upset Price

The evidence previously presented on the impact of upset prices in a variety of auctions makes it clear that a hidden upset price is preferable, especially for thin market. The governments of Quebec and Ontario should also be concerned with the revelation of any information that might help

auction participants estimate the upset price. For this reason, we recommend adding some measure of randomness to the deterministic determination of the upset price.

3) Starting Price

The objective of the starting price is to provide a benchmark to bidders, away from the upset price to guide competitive bidding. Thus, the starting price must be revealed.

4) Anticipated and future supply information

In an ideal world where a large number of bidders compete for identical products, full information about the quantities available would help fulfill the requirements for a competitive outcome.

However, in the current context, the Crown must balance the need for generating pseudo-clearing prices for heterogeneous blocks with the goal of capturing resource rents. In thin markets, the pursuit of revenue maximization and the risk of strategic behaviour make it desirable for timber management agencies to maintain some degree of uncertainty about exactly what other blocks will be offered and when. This is especially important when the forest's overall biological yield exceeds the demand for timber products. In these circumstances, offering more than the market can process and making all announcements ahead of any auctions would likely result in some operators not entering the auction (waiting instead for the release of non-auctioned blocks) and lead to non-competitive bidding and diminished Crown revenue.

In Quebec, the problem of selecting the appropriate overall supply is partially alleviated by the desirable continued existence of long term supply licences. Should the Crown offer too little wood, the response to high prices will be for long term tenure holders to increase their harvesting from those licenses. If the offer is over-abundant, long term licence holders will favour acquiring more supply at the auction's anticipated low prices, keeping their long term rights for more profitable years.

One of the disadvantages of multiple and simultaneous sealed bid auctions is that they do not easily allow buyers to construct a mix of bids that accounts for the substitutability of different blocks offered. Thus, if a sealed bid format is retained, we recommend that the annual offering be divided into as many as 6 to 8 different auctions per year. Blocks that are predictably complimentary to one another (e.g. they are adjacent) should always be offered at the same auction, but all other blocks offered at a specific auction should be selected more or less randomly from the master list for the year or planning horizon. This would remove any risk of order effect that could arise if systematic criteria were applied to the choice of block offered and correlated in time with other endogenous factors (such a systematic time component in the purchase of potential substitute licences). The overall volume offered in each auction should also not systematically reflect the overall volume to be offered in the planning horizon. Auction participation and sales (both of auctions and non-

auctioned sales) should be monitored for signs of weak demand, and future supply decisions adjusted to avoid over supply.

5) Timing of information release

The elapsed time between the announcement of the auction (with the information release) and the auction itself is dictated primarily by administrative and practical considerations. The amount of time should be kept to a minimum in order to limit opportunities for widespread communication and collusion attempt among potential bidders. Yet, they must allow a reasonable opportunity for potential buyers to cruise the tracts offered in order to obtain private inventory assessments if they wish to do so.

6) Post market information

Questions also arise regarding the divulgation of information after a round of auctions. Should the number of participants be released, their bids, the market price, etc.

The market price sends a clear market signal and gives unsuccessful bidders significant feedback. This information should therefore be released. However, other information that enables bidders to assess the degree of non-competitiveness in a thin market should not be released. This includes the number of participants and the value of individual non-winning bids While this information is sometime divulgated or implicitly available in more competitive markets, it seems more prudent to hold this information in a thin market susceptible to strategic bidding and collusive behaviour (Arifovic and Ledyard, 2007). Otherwise, this information can help participants make links between the number of participants and winning bids, conditions that would make a timber tract less likely to have numerous bidders, etc.

### 5.5. How should timber prices be determined in small regions where conditions are not conducive to the existence of a vibrant competitive market?

Two principal reasons may explain the lack of competition at the regional or local level. The first is industry concentration, where only one or two major players historically controlled most of the land holding in an otherwise profitable and sustainable forest industry. The second cause of uncompetitive markets is marginal or poor economic conditions, difficult or remote geographic location and unfavourable forest characteristics that individually or combined confer little value to the timber. This makes forestry a difficult economic activity practiced only by a few firms.

While industry concentration is antithetic to competitive markets, this problem can be worked around as long as the sales from other regions provide a fair representation of the forest and underlying economic conditions prevailing in the monopolised region. There is no guarantee that this is the case, of course, and it is unlikely to prevail where forestry markets are thin because of marginal timber values. If concentration exists for historical reasons but other regions provide good

comparators, a price transposition equation estimated from comparable blocks elsewhere should provide valid estimates of timber value in the non-competitive region and can therefore provide a sound basis for assessing timber values where markets do not exist.

Real difficulties arise if there are systematic differences between the conditions prevailing in the monopolized region and elsewhere. In this situation, the price transposition equation would not be based on data that can adequately forecast market value in the monopolized region. Unfortunately, there are really no alternative market designs that can palliate this situation. To the extent that forestry activities are profitable in the region, the best approach remains to cautiously proceed with an application of the price transposition equation or close proxy of the results it generates but being mindful that such transposed prices may still be too high for the industry to bear. Poor conditions not conducive to an active forest industry pose the worst of these challenges. The issue revolves once more around the ability of an econometrically estimated equation to provide a valid forecast of what prices would be if there were auctions in that region. If it was the case that the region's general situation was represented in the sample of auctions, it would be reasonable to apply the transposition equation without much additional analysis. However, in the case of marginal regions or localities, it is not likely that the forest or economic characteristics will be properly represented by auction data.

This presents an out of sample forecast problem. To illustrate the issue, imagine for instance, that the forest industry becomes less profitable as distance from markets increases. Suppose further that this relationship can be properly captured in an equation by the distance between a tract and the U.S. border. If the sampling of auction data is confined to distances between 0 and 300 km from the border, the equation estimation can best represent the effect of distance over this range. For the estimated equation to correctly predict a price in a non-competitive region located 450 km away from the US border, requires making additional assumptions that whatever pattern of change in market value observed within 300 km of the border extends to 450 km. This would be incorrect and produce biased estimates of timber value if, for example, the value of timber appeared to be linearly decreasing with distance within the auction sample, but in reality dropped sharply or at an increasing rate beyond the competitive regions.

The assumptions that relationships defining the value of timber are stable within and outside the auction sample must of course be maintained for all variables used to predict timber value. The further out of sample one tries to forecast, the less likely it is that the necessary assumptions will hold. In extreme cases, it might be impossible to apply the equation if some variables relevant to the non-competitive region are simply not represented in the auction sample. This would occur trivially, for instance, if a tree species was observed in the non-competitive region, but not in the auction data drawn from competitive regions. No equation could then predict the value of this species.

If there are good reasons to believe that the transposition equation provides a biased estimate of timber value in non-competitive regions, there is little choice but to introduce an alternative method of timber pricing. The preferred and recommended approach would be to apply an administratively determined adjustment factor to the equation's forecast. This would have the advantage of generating adjusted prices that remain sensitive to the many variables affecting timber value (albeit in possible statistically questionable ways), yet, would acknowledge the weaknesses of the equation.

An adjusted equation method would also remove any perverse incentives or allegations of price manipulation that could arise from bilateral negotiations or other ad-hoc pricing formula. A separate study would likely be required to assess the magnitude of the adjustment factor required for each affected region. To the extent that the inadequacy of the transposition equation can be demonstrated for out of sample forecasting, and that the adjustment factor is obtained from sound cost-based principles, the method should provide legally and economically defensible proxies for market prices.

Another alternative would be to consider a single offer from a forest operator for a tract of forest. The crown could then consider the offer against its internally determined upset price and respond by a strict and final decision to accept or reject the private firm's proposal. This approach also requires a clearly defined policy for the upset price and the conditions under which offers would be accepted. The credibility, legitimacy and defensibility of such a pricing system require a firm commitment (ideally a formal regulation) on the part of the Crown to apply systematic rules of decisions that negate incentives for firms to present strategically low offers, or attempt to unduly influence the Crown's decisions on a tract by tract basis.

## 6. D'autres mécanismes d'enchère à considérer pour la vente de bois sur pied ou récolté (cette section est en anglais)

What might constitute the optimal design for timber auctions in Quebec and Ontario? The number of possibilities and design choices is vast, to say the least. Nevertheless, we proceed first by characterizing some of the basic economic challenges associated with auction markets as they apply to timber sales before discussing more precisely four alternative market designs that we propose should be tested in comparative controlled experiments where the number of players is small but uncertain.

### 6.1. Complements and substitutes in simultaneous auctions for individual licences

The simultaneous auctioning of a large number of forestry licenses poses a number of challenges, both for the Crown and for bidders. Auctions that restrict participants to bidding separately on individual licences impose risks on bidders that can result in lost revenue and distorted market prices, primarily for two reasons.

1) Complementarity and the "exposure" problem. Bidders may be interested in obtaining various combinations of licenses and the value of obtaining the licenses as a package may be different (higher) than they would be willing to pay for them individually. Such a situation could arise when there is complementarity between forest blocks offered at auction. Complementarity arises where combining (adjacent) blocks would foster economies of scale through reduced cost per unit of output for equipment transportation, road preparation, harvesting and other activities.

   Auction formats that force separate bids on each block expose bidders to potential losses if they only obtain some but not all of the licenses for complementary blocks and find themselves unable to take advantage of the potential economies of scale (Bykowsky et al., 2000). This results in a potentially inefficient allocation of the resource where the costs of production are not minimized. In practice, one might expect that bidders who must bid separately and simultaneously on individual blocks will bid less aggressively in order to limit their exposure. This not only does not correct the potential allocative inefficiencies associated with not awarding those licences as a package, it also results in lower timber prices.

2) Substitutability between blocks also poses challenges and a different risk for bidders. Forest operators have operational needs and constraints that require them to obtain some harvesting rights, but any subset of a larger group of similar blocks offered at auction may satisfy those needs and constraints. Yet, if there is a limit (technological, financially or economic) on the number of blocks they can or wish to obtain, the auction format should ideally allow the firms to modulate their bids.

   A simultaneous sealed bid auction for individual blocks does not provide this flexibility. It forces a firm who wishes to acquire the rights to either one of two blocks to either bid on both and expose itself the possibility of winning both (in violation of its preferences or constraints), or bid on only one, with the increased risk to the firm of not securing any rights at all. This second scenario could also be deleterious to the Crown, if bidders inadvertently all chose to bid on the same block, leaving the other one unsold despite adequate overall demand for the timber. Either approach by firms to limit their exposure leads to potential allocative inefficiencies and lost revenue for the Crown.

Inquiries by potential bidders in Quebec's first trial auctions in May 2011(simultaneous first price sealed bid auctions) clearly indicate the presence of complementarity due to the geographical proximity of some of the licenses offered (Vincent Auclair, pers comm.).

One should also suspect that mills are flexible in term of the source of their fibre but that they (and other forest operators) have operational constraints that make substitutability an important issue.

### 6.2. The threshold problem and complexity in "package" auctions

Combinatorial auctions are aimed specifically at solving the exposure and substitute problems by allowing participants to submit bids not only for single items, but also on bundles or "packages" of items. The format of these bids can therefore, in principle, allow market participants to fully express their preferences and constraints (e.g. I am prepared to pay a maximum of \$4 per $m^3$ for either block A or B if I can only get one; OR I am prepared to pay up to \$5 per $m^3$ if I obtain both blocks). The flexibility to express complete preferences and constraints eliminates the exposure and substitute problems since – in an ideal setting - no restriction is imposed on the length or complexity of the bids submitted. This ideal situation is not normally achievable in practice, however. Combinatorial auctions do come with shortcomings of their own.

1) The threshold problem. When bidding on many items simultaneously and sequentially (numerous stages), some bidders may only wish to obtain a single block, while others wish to buy more than one. In many cases (that are more likely problematic with a small number of bidders), this can lead to perverse incentives towards coordination and to a final assignment of rights that is inefficient.

   Consider a concrete example with three bidders competing for two blocks. Bidder 1 only wants block 1 at a value of 1000 and Bidder 2 only wishes to have block 2, also at a value of 1000. Bidder 3 wishes to obtain the rights to both, and bids for both of them as a package for 1900. In such an auction where participants can bid on bundles, Bidders 1 and 2 face the challenge of determining how much to bid so as to ensure that the sum of the two bids will exceed the package bid of 1900 submitted by Bidder 3. This gives rise to a strategic incentive problem between bidders 1 and 2: each can benefit from an increase in the other participant's bid. As such, each wants to hold back on his bid on the chance that the other bidder will bid a sufficiently high amount to cross the bidder 3 threshold (of 1900 in this example). Whether bids are sealed or live, this is a classic "chicken's game" where each bidder wants the other one to move. This keeps prices artificially low and can often result in an inefficient allocation of items.

   The threshold problem can be especially troublesome when small firms needing small quantities face larger firms who can be tempted to exclude competitors by buying up large bundles of licenses. The ability of such large firms to include in their package bids some blocks that no other firm wishes to purchase has the potential to further exacerbate the problem. The anti-competitive bundling strategy has the large firm package low value timber that no-one else is expected to bid on with block coveted by its smaller competitors. Including the unwanted blocks increases the overall value of the bid and likelihood of success, and simultaneously takes away blocks that are important to a smaller competitor's profitability.

2) Complexity for bidders. The simultaneous sale of multiple objects may pose inherently complex decision problems for bidders. This complexity increases exponentially with the number of items sold, especially when package bids are allowed. This is due to the fact that the number of possible packages grows exponentially as the number of blocks for sale increases. Bid preparation can then become burdensome and costly. Bidders seem to respond to this complexity by focusing on a small subset of packages of primary interest to their operation. This is likely limiting the efficiency gains that can be realized through package bidding but it may not be a large problem in the forest sector.

3) Complexity for the Seller – the Winner Determination Problem (WDP). From the seller's perspective, an auction with simultaneous individual sealed bids for each item is the simplest possible market mechanism. Bids are received and each tract is allocated to the highest bidder. The polar opposite is true of unconstrained combinatorial auctions where determining the optimal allocation of items from the complex collection of bids can actually be a very difficult computational problem, especially if each item sold is susceptible to be included in package bids. This problem is known in the auction literature as the "Winner Determination Problem" (WDP). It is a potentially vexing integer programming problem that, in the most general case, may not produce a unique solution or even any solution at all in finite computing time.

   The WDP becomes increasingly difficult to solve as the number of bidders and items for sale increase. Thus, various strategies that limit the number of packages under consideration (perhaps only in a second or final stage of the auction) can help reduce the inherently difficult WDP. However, such strategies must be assessed against their impact on bidders and the potential for reduced efficiency and revenue.

   The development of an expert computational system to determine the allocation that maximizes revenue is a pre-requisite to the implementation of all except perhaps the simplest package auctions.

4) Impact of Package Bids on the Pricing Transposition Model
   While package bids would encourage allocative efficiency, they have the potential to introduce two forms of distortion in the price transposition equation. First, bidders submitting a price in a package bid may not put great effort in trying to evaluate different prices for the separate blocks since, if the package bid was successful, the blocks would be sold as one. Second, even if they do carefully consider each block, the complementarity between blocks implies that the economies of scale realized by grouping them must be allocated across the constituent blocks. There is no prescribed formula for how this should be done, and one might expect bidders to adopt rules of thumbs that may be administratively sensible, but not necessarily desirable from the perspective of precisely reflecting the value of a given block. While this could add some statistical noise to

estimation of the transposition equation, we do not expect this added variation to be large. Consideration should be given to controlling for winning package bids in the estimation of the transposition equation.

### 6.3. Collusion and Communication

In choosing auction rules for a relatively small market where different operators are likely to be familiar with each other's operations, great care must put into ensuring that no anti-competitive practices are allowed to persist. Legal obligations surrounding communication and collusion are therefore essential to well functioning market.

The complements and substitutes problems arise from the uncertainty in the composition of the final allocation and the inability of bidders to i) fully express their preferences and constraints or ii) modify their bid as best responses to other bids (lack of market coordination).

While coordination is highly desirable to improve the allocative efficiency of the auction, direct communication among bidders is not. In an ideal setting, the auction mechanism and general institutional and economic environment in which sales take place would provide an adequate mechanism to resolve all coordination issues without the need for participants to communicate directly. Strong incentives for communication among participants in a market with few buyers competing for a large number of licences raise the fear of truly anti-competitive agreements between participants. For instance, bidders could agree to divide the blocks among themselves, each only bidding on the blocks they were "assigned" through informal discussions with other potential bidders. While collusion of the sort is possible under any auction mechanism, the risks associated with the exposure problem and substitutability of blocks makes it more likely.

The fact that many forest blocks are composed of a mix of tree species exacerbates the communication and collusion problem. Bidders who only have use for some species in the mix have obvious needs to find a secondary buyer for the species they do not need. For them, it might be preferable to make such arrangements ahead of the auction. This kind of limited communication serves to remove the bidder's uncertainty with respect to the value of the unwanted species, and should generally be viewed positively rather than as anti-competitive behaviour. However, it opens the door to the direct or indirect sharing of at least part of a firms' bidding strategy with others.

The risks of undesirable communication and collusion can be mitigated by ensuring that:

i) the auction mechanism minimizes the exposure, substitutability and threshold problems, thus limiting the incentives for collusion.

ii) there exists a transparent and competitive post-harvest market for logs (perhaps by mandating that all log sales be offered on a centralized platform). An active log market would provide pricing

information that all potential bidders could rely on when preparing their bids, thus avoiding the desire to resolve the post-harvest market allocation through bilateral agreements between forest operators prior to the auction.

iii) The auction rules should specify explicitly that any attempt at influencing participation decisions by others or fixing bidding strategies is a punishable offence under the rules of the auction and under existing anti-competitiveness statutes. Rules that formally prohibit communication among participants should be implemented, along with a regulatory duty for all participants to report collusion attempts made by other participants. The prohibition would ideally include communication on the post-harvesting allocation of logs but this is contingent on the existence of an active after-market for logs that would minimize the need for pre-auction bilateral agreements between firms.

British Columbia's anti-trust laws and regulations provide a good example of how to deter collusion in timber auctions (Athey and Crampon, 2005). BC has strong anti-trust legislations that make attempts at collusion punishable under both civil and criminal laws. It also has whistle-blower protection providing immunity to the first person to report anti-trust activities, either by his own employer or by another forest operator. This makes firms reluctant to contact each other or management to ask employees to act collusively.

Under Canada's Competition Act (C-34, 1985 – concurrence 17 May, 2011), Article 47 specifically prohibits bid-rigging as a criminal act. Bid-rigging is broadly defined as

> "(a) an agreement or arrangement between or among two or more persons whereby one or more of those persons agrees or undertakes not to submit a bid or tender in response to a call or request for bids or tenders, or agrees or undertakes to withdraw a bid or tender submitted in response to such a call or request, or
>
> (b) the submission, in response to a call or request for bids or tenders, of bids or tenders that are arrived at by agreement or arrangement between or among bidders or tenderers." (p. 54)

Such offenses are punishable by fines or imprisonment for up to 14 years when a negative impact on competition can be proven.

The Competition Act provides a strong legal foundation to combat collusion but it is difficult to enforce and upholds a criminal legal standard of proof. As further deterrent to collusion, we recommend that Ontario and Quebec adopt articles of timber auction regulations making collusion *attempts* a civil offense subject to important administrative penalties (e.g. temporary or permanent loss of right to bid at auctions). A rule like BC's where the first person or firm to report collusion attempts is immune from penalties should also be considered.

### 6.4. Alternative bidding rules: Simultaneous Sealed Bids, Simultaneous Ascending Bids, Clock and Proxy Auctions.

The basic rule describing how bids are to be received (independent of whether or not package bids are accepted) is an essential ingredient of any auction mechanism. Breaking down the options under consideration here, we categorize the choices as revolving around two dimensions.

The first dimension is whether the bids are submitted privately so that other bidders cannot observe them (e.g. simultaneous sealed bids and proxy auctions); or in a live and iterative procedure, so that individuals can observe others' strategies and preliminary allocations before being allowed to modify their own bids.

The second dimension is whether bidders submit actual prices (e.g. First Price Sealed Bid, Simultaneous Ascending Bid), or if instead, are asked to submit lists of "yes" and "no" indicating at each of a series of (increasingly high or decreasingly low) prices whether they are interested or not in purchasing in a particular license. Some auctions can be run either way and combinations of these different approaches can sometimes be used effectively.

Sealed Bids vs. Iterative bidding.

In a standard sealed bid auction, bidders submit an offer for each item in the auction or, if allowed, for packages of individual items. Each item is either sold separately if package bids were not allowed, or alternatively, the seller determines the combination of individual licences and packages that maximize revenue (the WDP).

In complex environments with many goods, iterative bidding helps auction participants assess the competition and discover the value that others place on items. In a truly competitive setting, or where the lack of information on the object injects an important common value component into the valuation process, live iterative bidding helps auction participants understand the market in which they operate and how others perceive the value of tracts offered. Both elements can help generate more efficient outcomes.

In an auction populated by few players, however, the sealed bid format is often preferred because the ability to observe thin markets in iterative auctions can more easily lead to tacit collusion and strategic bidding of various kinds. Following are the principal types of strategic bidding in thin markets.

- Timing of bids. Bidders who have the opportunity to revise their bids can delay entering bids to assess the competition, and identify items with no or few other bidders. Widespread behaviour of the sort can undermine the objectives of the seller and must generally be controlled with auction rules that lower or eliminate it.

- Identification of low competition. While information discovery is desirable in a complex competitive environment, it can have highly perverse effects in auctions with a small number of participants. Iterative auctions can allow bidders to identify licenses with no other bidders. Bidders on those licenses can then limit their bid to the seller's reserve price, with the resulting auction price failing to represent a fair market value.
- Signalling. The ability to revise bids in real time affords bidders the ability to signal interests in certain items through their bids. This can be done by bidding very aggressively (i.e. jump bids) on some items early in the auction in order to discourage others from competing. Clever methods - like employing unusual numbers in some bids to signal interest for other items or threaten retaliation have also been employed in spectrum auctions.
- Retaliatory bidding. In conjunction with signalling, iterative bidding potentially allows participants to identify licences of interest to others and bid up those prices as punishment for bids placed elsewhere by their competitors. Because of the risk that the retaliating firm will end up winning the auction on a block it does not really want, larger firms are more likely to engage in this sort of entry deterrence activity. It potentially has long term negative consequences on the competitiveness of the industry.

To some extent, each of these perverse incentives can be mitigated by appropriately designed auction rules. However, it is necessary to bear in mind that the adoption of any form of package bidding has the potential to significantly increase the complexity of the auction and can impose costs on both bidders and the Crown.

Price Bids vs. Clock Auctions

In a standard auction where price is the message of the bids, bidders simply submit a price they are prepared to pay for each item on sale (either as a final bid in sealed auctions, or possibly as temporary strategy when the auction rules allow revisions). By contrast, a clock auction limits the bidder's action to indicating whether or not he is interested in the item at the price currently called by the auctioneer. Thus, in an English (ascending price) clock auction, the auctioneer announces a price and bidders respond with a yes or a no to indicate whether they remain in the running for the item (or package). Once all indications of interest have been received, the auctioneer increases the price of items for which there was more than one interested bidder (other prices remain unchanged) and the process begins again.[8]

[8] The Dutch clock auction used for the wholesale of horticultural products in Holland is the best known implementation of a clock auction (>3.0 billion euros sold annually). Contrary to the English clock auction in which the price increases, the Dutch clock is *descending* where the first bidder to express interest wins the lot and pays the price indicated on the clock.

Porter et al. (2003) demonstrate in laboratory experiments that clock auctions with package bidding can be highly efficient. Ausubel and Cramton (2004) implemented a version of the auction in electricity markets with considerable success. The main advantage of clock auctions over price auctions is that the clock, when accompanied by rules restricting early round strategizing (e.g. bids indicating interest at a certain price when the same bidder had shown no interest at a lower price) effectively limit the ability of bidders to strategically time their bids, use prices as signals, or use aggressive bidding aimed at deterring competition or retaliating against other participants. Limiting the strategic content of bids can in principle, successfully eliminate attempts at tacit collusion that can more easily develop in the process of iterative price bidding.

However, the clock auction with real time updating of bids is an iterative auction and therefore more susceptible to tacit collusion than sealed bid auctions. In experimental tests, Goeree et al (2009) report that a clock auction generated substantially lower revenue that sealed bid auctions in experiments simulating the European greenhouse gas emissions permit market. These results are consistent with those of Alsemgeest et al (1998) and Goeree et al. (2006) where many of the goods for sale were perfect substitutes. Observed differences may be due to the iterative bidding process rather than the clock itself, but neither experimental design makes it possible to discriminate between the two explanations.

*6.4.1. Implicit vs. Explicit Packages*

In some auction formats such as the clock auction, packages are formed implicitly by participants who bid on individual items. In other auctions such as the sealed bid combinatorial auction, packages are explicit bundles submitted by bidders. These two package structures present bidders with different strategic incentives. Of concern with explicit package bids is the incentive for bidders to include in a package one or more blocks that are not truly desired in order to increase the value of the bid, but with the intention of later defaulting on the obligation to harvest from this block.

For instance, a firm could submit normal prices on blocks it truly wishes to obtain, and highly inflated prices on block it intends to default on. This would increase the overall value of the bid and the odds of the package bid being part of the final allocation, but without the intention of actually harvesting from the high price blocks, would distort the allocation and the validity of the prices obtained at auction.

This problem is similar to the strategic hauling previously identified in section 4.2. Thus, solving the issue of strategic packaging when there are explicit bundles may require imposing severe penalties on firms who fail to harvest a block they obtained at auction. This is not without implications either. Firms that obtain the rights to a block with a genuine intention of harvesting it, may later find themselves with no need for the wood or depressed prices that make it unprofitable (and therefore socially undesirable) to proceed with the harvest. In this situation, harvesting may be the best action for the firm if it means avoiding a severe penalty. However, it could be financially damaging to the forest operator do so, and constitutes an inefficient use of forest resources.

A simpler alternative would be for the Crown to identify a fixed list of packages on which bids can be submitted. This avoids strategic packaging, reduced the complexity and transactions costs of bid preparation, and, would greatly simplify the WDP (especially if the blocks in different packages do not overlap). Potential errors in the formation of packages could reduce efficiency, however. Given that the natural determinant of complementary block is their geographic location, the potential for this type of errors might be relatively small.

*6.4.2. Proxy Auctions*

In a proxy auction, firms bid for a timber tract or package of timber tracts in sealed bids, expressing the maximum that they would be willing to pay for it. Determination of the allocation is done by iteratively increasing the price offered by a minimum increment until only one bidder remains. For example, bidder A would indicate that his maximum bid is $10,000. Assume that bidding starts at $8000, then a bid of $8100 would be made for bidder A, each time that bidder A would be overbid, a bid of plus $100 (the increment in this example) would automatically made for him, up to his maximum bid of $10,000. This is equivalent to determining the first and second highest bids for the timber tract, allocating it to the firm with the highest bid at the price offered by the second highest bidder plus a minimum increment (online auctions such as eBay offer a proxy service freeing bidders from constantly monitoring live sale).

Proxy auctions can be extended to multiple simultaneous sales and accommodate package bids as well. Proxy auctions have the advantage of reducing the incentives for inefficient strategic bidding (bid shading) since the price submitted by a bidder is not the price paid. In other words, it provides the correct incentives for participants to bid their true value for the item for sale.

The main disadvantage of using a proxy auction for the sale of timber tracts is that forestry sector firms who will have to repeatedly participate in auctions may be reluctant to truthfully reveal their value, on the fear that the Crown will use this information to its advantage (e.g. to modify the auction's upset and starting prices in an effort to increase revenue). Repeated interaction between a seller and buyers is an element of the situation that is not typically addressed in the theoretical auction literature.

**6.5. Frequency and Number of Blocks offered at Auctions**

In considering different approaches to resolve the complementarity and substitutability issues posed by the simultaneous sale of many licences in non-combinatorial auctions, it is worth paying attention to the impact of the size and frequency at which the Crown offers timber licences at auction. The Quebec government is currently considering offering approximately 200 timber tracts at auctions annually, divided into two auction sessions.

Offering a greater number of licences in a smaller number of sessions per year favours allocative efficiency if this increase in the offering ensures that all complementary blocks are available at

once. However, dividing the offering over a greater number of sessions can favour efficiency and reduce the potential financial exposure of participants through a reduction in the number of substitutes available at once. This allows participants to safely bid on a number of tracts in each auction knowing that in the event that they do not get an adequate supply, they will likely have the option to bid on comparable tracts in the near future. There is still a downside to more frequent auctions in the fact that dividing the tracts into smaller offerings has the risk of leaving firms with tracts that they wish they had not purchased once they become aware of later offerings.

### 6.6. Tradable timber tract rights

Tradable timber tract rights inject further flexibility in the timber industry. Unforeseen events or changes in the demand for timber products can cause a holder of timber tracts to no longer need the rights it previously obtained. Administrative fines for failure to exercise cutting rights are only useful to prevent gaming of the timber allocation mechanism. In legitimate circumstances when economics dictates that the timber should not be harvested, fines are not serving a positive purpose, especially if the right holder has no means of avoiding the fine. Transferability provides some possibility of relieving the tract holder from its obligation through a sale or transfer of the logging rights.

Transferability confers flexibility and gives options to the tract holder. By the same token, it serves the role of partial insurance against unforeseen events. From a firm's perspective, transferable timber tract rights are necessarily more valuable than non-transferable ones. As such, the market value of a transferable tract should always be of equal or greater value than a non-transferable one for the same block.

It is, therefore, recommended that timber tract rights be transferable. The existence of a secondary market would mitigate auction misallocation, raise the price of timber, and increase Crown revenue

### 6.7. Alternative Auction Designs

At this early stage in the development of auction markets for Quebec and Ontario timber, it would be premature to recommend a precise auction design. We reach this conclusion for three reasons:

i) There is little information available to address the degree of substitutability and complementarity between blocks to be offered at auction in Ontario and Quebec;

ii) there is a genuine concern that the costs of implementing combinatorial auctions on bidders and the Crown may deter participation and outweigh the resulting efficiency gains. Bidder trust in the auction is necessary and dependent on the clarity of its rules and transparency of its allocation algorithm. Complexity and mistrust can deter entry by those who consider the system too complex or opaque, or who feel must engage in costly bid assessment and preparation. There is therefore a

trade-off between the potential for increased allocative efficiency and Crown revenue on one hand, and the transactions costs to bidders and the Crown on the other.

iii) for the most part, auction formats under consideration have not been tested in tough environments characterized by measurable uncertainty regarding the exact (but small) number of bidders, who have opportunities to collude.

In our view, bidder uncertainty with respect to the degree of competition they face and thin markets are critical aspect of timber auctions in Ontario and Quebec and success requires overcoming their potential negative impacts on timber prices.

Additional research is also required to ascertain the possible magnitude of efficiency gains associated with package bidding in alternative auction markets.

We do exclude from the proposed list of market mechanisms any auction format requiring live iterative bidding in the price space. While this could serve as a useful basis of comparison in an experimental test, Saphores and others (2006) have shown empirically this auction format is subject to collusion in timber auctions. Potentially thin markets and the possibility of excessively strategic bidding behaviour, iterative price auctions pose elevated risks of lost revenue to the Crown, threaten the integrity of a timber sales system relying on real time iterated auctions, with the potential to negatively impact the reliability of the transposition equation estimated from auction data to price non-auctioned timber blocks.

In the next sub-section, we describe three alternatives to the simultaneous first price sealed bid auction implemented by British Columbia and currently being deployed in Quebec. We proceed from the least to most complex mechanism and identify their stronger and weaker points.

We propose that a series of economics experiments and field auctions be conducted to provide a reliable statistical comparison of the three auctions against one another and against the simultaneous first price sealed bid auction for individual blocks serving as the baseline control.

*6.7.1. Simultaneous first price sealed bid auction with pre-set hierarchical packages*

In this variant of the simultaneous first price sealed bid auctions, participants are invited to submit bids for as many individual licences as they wish. In addition, they can also bid packages for a list of pre-determined packages. In the simplest implementation of this auction, the Crown would define two hierarchical levels (e.g. individual timber tracts; non-overlapping regional package). By avoiding overlaps between packages within a hierarchy, solving the WDP is straightforward. In the first instance, revenue is calculated from the winning bids at the first level. The winning bid for each package at the next level is then compared to the sum of the bids under the first hierarchy in order to determine whether revenue are maximized by selling the timber tracts at the first or second level. These computations can be done rapidly with nothing more than an excel spreadsheet.

Goeree and Holt (2008) experimentally implemented an iterated bidding version of this auction with great success, and it has been adopted by the U.S. Federal Communication Commission for the sale of radio spectrum. For reasons explained earlier, we do not recommend the iterated version of the auction. The efficiency of this auction depends largely on the ability of the Crown to properly identify complementary blocks and offer them as packages.

The single round version of this auction also fails to solve the substitution problem. That is, it does not allow bidders to withdraw bids when they meet their needs through winning other blocks. The substitution problem can largely be offset by conducting regular sales with fewer blocks offered rather than a few large sales per year. If blocks are substitutes for one another and timber sales are smaller and offered at shorter time intervals, firms participating in a given sale could safely bid on several blocks, limiting their risk of winning more blocks than they need, but also have the knowledge or expectation that if they do not obtain sufficient supply, they will have other opportunities to bid on other blocks in upcoming auctions. The likely presence of imperfect substitutes implies that the substitution problem may not be entirely eliminated by conducting a greater number of smaller sales. However, we would expect it to be greatly mitigated.

Regardless of the frequency of sales, blocks that are likely to be complements should always be offered simultaneously in order to afford bidders an opportunity to fully realize the gains from complementarity and minimize the exposure problem.

### 6.7.2. Simultaneous first price sealed bid auction with bidder formed packages

In this variant of the simultaneous first price sealed bid auction, participants would simultaneously submit as many bids for individual tracts as they please, and up to a set maximum number of "package bids". These package bids would combine individual blocks as the auction participant sees fit.

Package bids would be expressed in the mutually exclusive XOR language (Sanholm, 2002) with a bidder winning at most one of the bids submitted. A restriction on the number of package bids is likely necessary to keep the computational requirements of solving the WDP manageable.

The XOR language with mutually exclusive bids should often lead auction participants to submit multiple bids. For example, a participant interested in any combination of two licences from a group of three - A, B or C - could safely submit three separate bids: (A+B), (A+C) and (B+C). If the same bidder was also prepared to purchase only one of the licences he could rationally submit three additional bids, one for each of the individual licences.

While the XOR language forces bidders to contemplate many configurations of bids, it is the only one among many that can completely eliminate the exposure and substitutability problems. Notwithstanding our previous comments on the accuracy of pricing on blocks within a package, bids would ideally specify a price for each block (and each species if collected this way) so as to provide

the best possible representation of the value of each block and facilitates the estimation of the price transposition equation.

Once the bids are received, the final allocation is determined by solving the WDP with the objective of maximizing Crown revenue (or excess above the Crown's minimum price).

The main advantages of this auction format are that i) retaining a sealed bid auction reduces collusive behaviour; and ii) it remains relatively simple for bidders. Limiting the number of possible package bids restricts the number of possible combination that a firm needs to assess, making them more likely to focus on obvious complementarities between blocks. If the number of complementary blocks is relatively small in the first place, and, as we suspect, easily identifiable, allowing a few package bids may be sufficient to completely eliminate the exposure problem.

*6.7.3. The Clock-Proxy Auction (CPA)*

Ausubel et al. (2006) introduced the Clock-Proxy Auction, combining the price discovery qualities of the clock auction with the competitive bidding of the sealed bid proxy auction. The auction is conducted in two stages.

In the first stage, an ascending discrete-round clock auction is conducted on individual tract (no package bids). The clock is stopped when clock prices have eliminated all excess demand.

In the second stage, participants have the opportunity to submit final mutually exclusive package bids for an ascending proxy English auction. Specifically, the CPA is implemented with the following steps (see Hoffman et al. 2006, p.417 ).

1. Each bidder provides a value (maximum bid) at the beginning of the proxy stage for each of the desired packages.
2. All packages of a bidder are considered mutually exclusive; a bidder can win at most one package bid;
3. The starting prices of the proxy stage are the provisionally winning bids of the clock stage.
4. At the beginning of each round, the proxy bidder of each participant calculates for each package bid the most advantageous package (i.e. the package with the greatest gain for the bidder. The gain is the difference between the value (highest bid) submitted by the bidder and the current price of all items included in a package). The proxy bidder then chooses the package which is most profitable to the bidder if it was purchased at the current price plus a minimum increment for each item in the package. This becomes the bidders active bid.
5. The auctioneer determines the provisional revenue maximizing allocation and informs participants of the winning bids.
6. For each non-winning bids, the proxy agent increases the price offered by the minimum increment and selects the new profit maximizing package. This becomes the bidder's new active bid.

7. The auctioneer selects the new provisional revenue maximizing allocation.
8. Steps 4 to 7 are repeated until no new bid is submitted. Winners pay the last prices submitted by the proxy agents on winning bids.

While it is possible and simpler to deploy a clock auction with package bids without a proxy phase (Porter et al, 2003), Ausubel and Milgrom (2002) show that the proxy auction has highly desirable theoretical properties. Furthermore, Ausubel et al. (2006) argues that the Clock auction alone is more susceptible to manipulation and sub-par revenue when markets are thin and goods are complementary.

The clock phase allows for price discovery and reduces the exposure problem. Prices are responsive to excess demand, which can be a shortcoming when it is revealed that some licences gather little interest. Compared to other combinatorial auctions, the clock phase reduces the complexity and number of packages that bidders need to consider. The clock phase effectively narrows down the list of packages that bidders need to consider in the proxy phase.

The main benefit of the proxy phase is movement towards an efficient allocation with competitive payoffs for the bidders and competitive revenues for the seller. The proxy phase also has the advantage of reducing collusion. Tacit division of licences in the clock phase can be broken by the sealed bids for package the proxy phase.

Implementing the CPA in thin markets also requires putting in place a so called “activity rule” to allow participants to withdraw some bids when attractive alternatives arise, but simultaneously limit strategic moves. Ausubel et al. (2006) introduce a revealed preference activity rule suited to the CPA that we can explore.