b) It generally involves a residence where people live, whereas commercial-scale illicit grow-ops involve much larger scale production than can be accommodated in a family residence also used for the benefit of the family.

Scale of Residential Misuse Marihuana Cultivation

This analysis assumed that the scale of marihuana cultivation for residential misuse is less than that for a grow-op.

The mean number of permitted plants under MMAR-PUPL, based on the mean Proposed Daily Amount of 7.6 grams, is 37 marihuana plants. These are expected to yield 30 grams of dried marihuana but also have a wastage factor of 1.2 so that the effective yield is actually 25 grams per plant per harvest. The yield is based on a 120-day harvest cycle and three (3) harvests per year. The mean PUPL producer, keeping to the maximum allowable number of plants and MMAR yield and harvest assumptions, would produce about 2.8KG of dried marihuana.

Yield per Year = Plants * Yield/Plant/Harvest * Harvest/Year

In terms of the expected actual marihuana consumption of such a person, the CBA used an estimate of about 4.2 grams per day, which comes, for 350 days per year of use, to about 1.5KG of consumption. It is possible that actual consumption accounts for the entire production or that production is scaled to meet consumption for own use.

For the 64% of persons who are not involved in any misuse, it was assumed that there is no illicit distribution of any excess production capacity. For the 36% of persons involved in MMAR misuse it was assumed that they are engaged in illicit marihuana distribution.

Minor Misuse (80%)

For 80% of misuse cases, it was assumed that that such misuse is *minor* in scale. As described below, some parameters were then applied to this activity to estimate the likely returns and risk associated with that activity.

Minor Misuse - Rewards

For minor misuse, this study assumed that the maximum number of plants would be kept at the legal limit (37) and that the yield would be higher (60 grams per plant per harvest) with a 90-day cultivation cycle and four (4) harvests per year. These parameters seem reasonable in relation to actual criminal evidence from grow-op activity [RCMP (2010)].

This would allow for the production of 8.9KG of dried marihuana against estimated personal consumption of 1.5KG, leaving 7.4KG of excess production available for illicit distribution. Data suggests that wholesale distribution [RCMP (2010)] by the pound generates about $2,800 (or $6.17/gram), so that the estimated sales value of the excess production is about $45,000.

This sales revenue is comparable to about half the sales revenue for a British Columbia grow operation, [Easton (2004)]. Allowing the same supply cost per gram as for PUPL production generates an estimated gross margin (over costs) of about $40,000. This represents the 'reward' from criminal activity (for *minor* misuse).

The reference case reward for minor misuse (PUPL) is given in the Policy User Transition by:

(63) Reward-Minor = {[(Plants * Yield/Plant * Harvest/Yr) – Use/Yr]

* Wholesale Price/Gram} – Supply Cost/Yr

Minor Misuse - Risks

Probabilities [Dandurand et al (2002)] were available for the risk of detection, seizure, charges laid, conviction and receipt of fine or prison sentence. The analysis assumed various economic losses as a result of uncertain events occurring for the criminal activity. The study assumed the following values of economic loss: seizure ($50,000[23]), facing charges ($5,000[24]), fines ($1,000[25]) and prison ($9,000[26]).

An important parameter in the model is the aforementioned requirement for additional evidence as evidence of the mere presence of a residential grow operation associated with an MMAR production license will generally be insufficient grounds for obtaining a warrant to search the premises. The result has been, according to law enforcement officials, that police resources are not as effective as they might be in terms of resulting law enforcement actions when there is suspected misuse of such MMAR licenses.

In the CBA model, this effect was introduced by assuming that cases of MMAR misuse faced a 2.5% probability of detection by police and that the probability of police action (given police detection) is reduced by a factor of 75% from its base probability value of 80% [Dandurand et al (2002)]. Therefore, the effectiveness of law enforcement to address MMAR misuse impacts on a lower probability of detection and a lower probability of police action, given police detection.

The analysis assumed that minor misuse does not attract home invasion and 'grow-rip' type robbery by other criminal elements as the scale of misuse is relatively minor. This risk was reserved for major MMAR misuse of residential cultivation.

Based on compound probabilities of law enforcement actions and consequences, an expected value of loss for minor misuse (PUPL) in the Policy User Transition was estimated as:

(64) $\text{Risk-Minor} = [\text{Minor-Misuse} * Pr_{detection} * Pr_{action} * (1 - \text{Enforcement Clarity}) * Pr_{found}]$

$* \{[Pr_{seizure} * \text{Loss-Seizure}] + [Pr_{report} * Pr_{charge} * \text{Loss-Charge}] +$

$[Pr_{convict} * \{(Pr_{fine} * \text{Loss-Fine}) + (Pr_{prison} * \text{Loss-Prison})\}]\}$

where

Minor-Misuse = ATP-P(Apr 2012) * 36% * 80%

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[23] Based on the annual revenue * (1+.10) with an adjustment for the value of seized materials and supplies.
[24] Assumed as an inconvenience (value of time) factor with or without legal fees (which may be by a public defender).
[25] From Dandurand et al 2002.
[26] Based on 2.5 months sentence from Dandurand et al 2002 with hourly wage of $25 for 35 hours per week and 4.1 weeks per month.

$Pr_{detection}$ = probability of police detection (given misuse) = 2.5% (under MMAR)

Pr_{action} = probability of police action (given detection) = 80%

Enforcement Clarity = reduction in Pr_{action} as a result of MMAR = 75%

Pr_{found} = probability of case found (given action) = 95%

$Pr_{seizure}$ = probability of police seizure (given case found) = 100%

Loss-Seizure = expected economic loss from police seizure = $50,000

Pr_{report} = probability of report to Crown Prosecutor (given seizure) = 87%

Pr_{charge} = probability of charges laid (given report to Crown) = 98%

Loss-Charge = expected economic loss from facing charges = $5,000

$Pr_{convict}$ = probability of conviction (given charges laid) = 73%

Pr_{fine} = probability of fine imposed (given conviction) = 39%

Loss-Fine = expected economic loss from fine = $1,000

Pr_{prison} = probability of prison sentence (given conviction) = 42%

Loss-Prison = expected economic loss from fine = $9,000

In the Reference case, the expected loss from police action and criminal justice sanctions was about $270 and largely the result of police seizure.

Minor Misuse – Opportunity Cost

In addition to the supply cost of marihuana production, the analysis also accounted for the opportunity cost of time spent on criminal activity (in terms of additional cultivation time, transaction time and overhead for running of the illicit enterprise). A proportional value of this time relative to a target annual income ($60,000) for a work-year of 1,800 hours (i.e., $33.33/hour) was applied. For minor misuse this opportunity cost was roughly $4,700.

Minor Misuse – Net Expected Return

In the Reference case, the net expected return for minor misuse was about $35,800 and represents an expected rate of return of about 370% over the expected costs of activity (excluding loss from risks).

Minor Misuse – Compensation for Risk

The analysis also considered risk sensitivity, as people are generally risk-adverse. The analysis conceptualized risk sensitivity in terms of the ratio of the expected rate of return to some risk threshold rate of return, which reflects the expected value of loss from risks. The rationale is

that most people care about the absolute level of risk they bear and want a very high return to compensate them for such risk. For the purposes of the CBA, it was assumed that persons engaged in illicit activity want a minimum ten (10)-fold return to compensate them for illicit undertakings. In the reference scenario, the minimum expected return for minor misuse was estimated to be 28%.

Minor Misuse – Reward-to-Risk Multiple

In the Reference case, the expected rate of return (370%) was about thirteen (13) times higher than the minimum expected return for misuse (28%). This reward-to-risk multiple suggests that persons engaged in MMAR minor misuse would appear to be very comfortable in terms of the reward-to-risk profile (under the Status Quo scenario parameters).

If, with the Policy scenario, a marked change is seen in the reward-to-risk multiple, it would be reasonable to expect a reduction in illicit activity. This reflects a form of risk elasticity, for which it is possible to infer some value to generate behavioural change that should result from gaining more clarity under the MMAR (in terms of a higher probability of police detection of potential misuse and a higher probability of police action, given police detection).

The same calculations for major misuse, which also invites the risk of home invasion and 'grow-rip' theft by other criminal elements, are described below. The absolute dollar value of illicit reward was much higher for major misuse but the expected rate of return in the Reference case was lower (305%) and the minimum expected return for major misuse (based on the risk profile and losses) was estimated to be 128%. Therefore, the reward-to-risk multiple was much lower (2.4) for major misuse. However, this multiple is still economically attractive.

Deterrence Effect on Residential Misuse

In terms of the economically rational effect of crime prevention and deterrence on illicit activity, the analysis used a result for the US [Chang et al (2008)] which estimated that a 10% increase in the probability of criminal conviction for drug trafficking/production would decrease the number of active dealers by 0.26%. This implies a 'conviction elasticity' ($\varepsilon_{convict}$) of -0.026.

$$\varepsilon_{convict} = \%\Delta\text{persons involved in cultivation} / \%\Delta Pr_{convict}$$

Using Canadian parameters and the CBA effect of addressing the current need for additional evidence through the policy scenario (equation 62), the cumulative $Pr_{convict}$ for the Status Quo reference case is:

$$Pr^{SQ}_{convict} = Pr^{SQ}_{detect} * Pr_{action} * (1 - \text{Enforcement Clarity}) * Pr_{found} * Pr_{report} * Pr_{charge} * Pr_{convict}$$

$$= 0.296\% \text{ (for the Status Quo reference case)}$$

With the clarifying effect (removing the need for additional evidence), the Pr^{POL}_{detect} increases and results ina higher $Pr^{POL}_{convict}$:

$$Pr^{POL}_{convict} = Pr^{POL}_{detect} * Pr_{action} * Pr_{found} * Pr_{report} * Pr_{charge} * Pr_{convict}$$

$$= 2.365\% \text{ (for the Policy reference case)}$$

The impact in terms of the number of persons involved in illicit misuse (residential marihuana cultivation, formerly associated with MMAR production licenses) is given by:

(65) $\%\Delta$persons involved in cultivation = $\varepsilon_{convict} * \%\Delta Pr_{convict}$

where

$\varepsilon_{convict}$ = -0.026 * {[2.365% - 0.296%] / 0.296%}

= -0.026 * 700% = -18%

Therefore, one would expect there to be 18% fewer persons involved in residential marihuana cultivation as a result of the higher probability of detection and greater policy action effectiveness from the removal of valid MMAR residential production licenses (PUPL/DPPL).

The analysis assumed that this effect would be experienced for *major* misuse activity. As it is likely that persons involved in *minor* misuse are more risk adverse than persons involved in *major* misuse, the analysis assumed that the elasticity response for *minor* misuse would be twice (two times) that of *major* misuse.

Equation 62 is therefore estimated using $\varepsilon^{major}_{convict}$ = -0.026 and $\varepsilon^{minor}_{convict}$ = -0.052. These assumptions were tested in terms of the sensitivity of CBA results.

The number of persons who will cease their residential marihuana cultivation in the Policy transition (due to the clarifying effect of removing the need for additional evidence in enforcement) is given by:

(66) Cease = Misuse (major or minor) * $\%\Delta$persons involved (major or minor)

The number of persons who will continue their residential marihuana cultivation in the Policy transition (despite the 'enforcement clarity' effect) is given by:

(67) Continue = Misuse (major or minor) * [1 + $\%\Delta$persons involved (major or minor)]

Opting-Out for Residential Producers with No Misuse

The analysis also contemplated the possibility that persons who produce marihuana in the Status Quo scenario with no misuse (i.e., strictly for their own consumption) might opt out of the Policy scenario regime, and continue their own production illegally. These are people who were law-abiding in the Status Quo scenario (i.e., legal marihuana cultivation) but who might exercise civil disobedience in the Policy scenario through illegal marihuana cultivation at a small scale and without illegal marihuana distribution or sales.

In the Reference case, it was assumed that the Opt-Out Rate for such non-misuse PUPL users would be 0% (i.e. there is no civil disobedience). However, the sensitivity analysis allowed for a rate up to 20% of such persons.

The number of formerly ATP-P persons who are considered in terms of the Price Elasticity effect as still being in the market, ATP-P*, is given by:

(68) ATP-P* = ATP-P(April 2014) – $Cease_{(minor)}$ – $Cease_{(major)}$

- [ATP-P(April 2014) * (1 - .36) * Opt-Out Rate]

Once the persons who, despite the 'enforcement clarity' effect, will continue to engage in residential marihuana cultivation have been removed, the number of persons who are likely to be involved in the Transition to the new Policy regime can be calculated. It is then necessary to take into account the operation of the Price Elasticity of Demand as it affects these people.

The reference Price Elasticity of Demand ε_p = -0.25 and represents the %ΔQuantity in response to a %ΔPrice (*ceteris paribus*[27]). The situation of the regulatory change involves more than just an effective price change, as it represents a policy change and declaration of a formally legal activity as illegal. As discussed above, persons who were formally (and legally) cultivating marihuana for their own use (with no misuse) are expected to cease this activity as it is no longer considered legal. The analysis separately allowed for some Opt-Out Rate.

The %ΔPrice experienced by these users is given by:

(69) %ΔPrice-P = [LP-Price – Own Supply Cost] / Own Supply Cost

which, for an initial LP Price of $7.50 and an Own Supply Cost of $1.80, gives a %ΔPrice-P of 317%.

The operation of the price elasticity is given by:

(70) %ΔQuantity-P = ε_p * %ΔPrice-P

The %ΔQuantity-P in the reference scenario is -79%. As the Status Quo scenario initial quantity demand (Personal Use) was 41,365KG, this means that the Policy Transition Quantity-P (after the price elasticity effect) will be 8,618KG (i.e. 41,365 * (1 + %ΔQuantity-P).

It is then necessary to assign this %ΔQuantity-P to either %ΔUser-P or %ΔQuantity/Day-P, and to again check to see if the Status Quo Quantity/Day is affordable in relation to Mean Annual Income (as in equation 54).

The Quantity per Day in the Policy scenario, for persons who were on Personal-Use Supply (as of April 2014) is calculated as:

(71) Quantity/Day-P = MIN{4.18, [Mean Annual Income * Max % of Income / 350

/ $7.50]}

In the Reference case, the effective minimum for Quantity/Day-P is 1.7 grams per day. This means that, relative to the Status Quo Quantity/Day-P (4.18 grams), the %ΔQuantity/Day-P is -59%.

[27] Ceterus paribus (roughly 'all other things unchanged") is the assumption used in partial equilibrium analysis.

The number of User-P is calculated as:

(72) User-P = MIN{(ATP-P*), [(Quantity-P * 1,000) / (350 * Quantity/Day-P)]

Where

ATP-P* from equation 68

Quantity-P is the resulting quantity demanded after the operation of the Price Elasticity of Demand; and

Quantity/Day-P is the result from equation 71.

It is then possible to calculate the %ΔUser-P as [(User-P – Base User-P) / Base User-P]. In the reference scenario, the %ΔUser-P is -49%.

Therefore, the base annual quantity of marihuana (in KG) that would be consumed in the Policy scenario, for the expected number of persons with ATP-P who will transition to the LP market at the higher LP market price of $7.50 per gram, would be expected to be:

(73) Base KG-P(Market Price) = ATP-P*(April 2014) * (1 + %ΔUser-P) * 350 * Quantity/Day-P

The number of users in the Policy scenario, for persons formerly in Personal-Use Supply (as of April 2014) is calculated as:

(74) Users-P(Market Price) = ATP-P*(April 2014) * (1 + %ΔUsers-P)

Equations 73 and 74, therefore, represent the KG-Demand and number of users in the Policy scenario that result from the transition from the Status Quo for persons formerly on Personal-Use Supply.

4.7.4 Policy Transition – Designated Person

The analysis considered a transition model for Designated-Person use in a similar manner. Here the situation differed slightly, as the persons consuming the marihuana are different from the persons producing the marihuana. The same reasoning (logic and equations) holds for such persons engaged in DPPL production. Here again it was assumed that the mean DPPL producer supplies for two ATP-D persons. The number of allowable marihuana plants is higher (44), as the Proposed Daily Amount mean is higher (9.0 grams).

Equations 63-67 apply for DPPL producers, resulting in an estimate of the number of persons who cease and continue producing marihuana. Although it not possible to know if the locus of production is a residence, for the purposes of the CBA analysis of safety and security benefits this assumption is made for simplicity.

The number of persons who will cease their residential marihuana cultivation in the Policy transition (due to the law enforcement effect) is given by:

(75) Cease = Misuse (major or minor) * %Δpersons involved (major or minor)

The number of persons who will continue their residential marihuana cultivation in the Policy transition (despite the law enforcement effect) is given by:

(76) Continue = Misuse (major or minor) * [1 + %Δpersons involved (major or minor)]

When the shift is made from DPPL producers to ATP-D consumers, it is not possible to assume that the consumers whose producer is prepared to supply them illicitly will continue to source their marihuana requirements from these illicit producers. This is not an automatic result, as producers and consumers in the DPPL/ATP-D relationship may have different preferences, risk tolerances and other characteristics. The analysis assumed that all persons who held ATP-D authorizations would seek legal sources of supply.

The number of ATP-D persons who were considered as potential Policy scenario users (ATP-D*) was calculated as:

(77) ATP-D* = ATP-D(April 2014)

The price elasticity effect was then applied to these persons.

In the reference case, the %ΔPrice-D is 142% (from $3.10 to $7.50 per gram) and the operation of the Price Elasticity of Demand (ε_p = -.25) requires that the %ΔQuantity-D is -35%. This %ΔQuantity-D must then be assigned to either %ΔUser-D or %ΔQuantity/Day-D. Then, a check must be made to see if the Status Quo Quantity/Day is affordable in relation to Mean Annual Income (as in equation 71). Generally, the same result (as for Personal Use) will apply, so the Quantity/Day-D is 1.7 grams per day, which is a -59% change from the Status Quo scenario.

As the percentage change arising from the affordability condition (-59%) exceeds the required Price Elasticity of Demand required change in quantity demanded (-35%), there is no required change in the number of users (i.e. %ΔUsers-D = 0%). The affordability condition demands that the price response actually exceeds the ε_p = -.25 requirement. This is why the price elasticity in the Policy scenario often exceeds that for the Status Quo scenario.

As above (for ATP-P transition), the analysis estimated the base annual quantity of marihuana (in KG) that would be consumed in the Policy scenario, for the expected number of persons with ATP-D who will transition to the LP market at the higher LP market price of $7.50 per gram, to be:

(78) Base KG-D(Market Price) = ATP-D*(April 2014) * (1 + %ΔUser-D) * 350 * Quantity/Day-D

The Number of Users in the Policy scenario, for persons formerly in Designated-Person Supply (as of April 2014) is calculated as:

(79) Users-D(Market Price) = ATP-D*(April 2014) * (1 + %ΔUsers-D)

Equations 78 and 79, therefore, represent the KG-Demand and number of users in the Policy scenario that result from the transition from the Status Quo for persons formerly on Designated-Person Supply.

4.7.5 Policy Transition – All Users

It is possible to compute, based on the behavioural responses of producers and consumers, what the base level of demand (at an expected Market Price of $7.50/gram) would be across all users and taking into account the likely continued misuse/desire to continue illicit marihuana production and the likely operation of a price elasticity of demand. This gives a first look at the scale of the LP market demand (as of April 2014).

The base annual quantity of marihuana (in KG) that would be consumed in the Policy scenario, for all persons expected to transition to the LP market at the expected LP market price of $7.50 per gram is given by:

(90) Base KG(Market Price) = Base KG-GS + Base KG-O + Base KG-P + Base KG-D

The Number of Users in the LP market at the expected LP market price of $7.50 per gram is given by:

(91) Users(Market Price) = Users-GS + Users-O + Users-P + User-D

The scale of the expected LP market (as of April 2014) at an expected LP market price of $7.50 per gram is 19,385KG for 32,623 users, each consuming a mean of 594 grams per year (or 1.70 grams per day for 350 days per year) at an annual user cost of $4,460. This is the Reference case that was used to estimate the evolution of the LP market over time in the Policy scenario.

The analysis calculated an Implied Price Elasticity, based on the transition from the Status Quo to the Policy scenario and taking into account the options to 'opt-out' of the Policy Regime by illicitly cultivating marihuana for own use.

(92) Transition ε^{*}_{p} = {[KG(Market Price) - KG(User Cost)] / KG(User Cost)}

/ {[Market Price - User Cost] / User Cost}

where

KG(Market Price) = Base KG-Demand at LP Market Price (April 2014)

KG(User Cost) = Base KG-Demand at User Cost (as in Status Quo) (April 2014)

Market Price = $7.50/gram * 1,000 (this study's assumed estimated LP Market Price)

User Cost = $2.60/gram * 1,000 (from weighted average in Status Quo)

The last value is a weighted average of User Costs from ATP-GS, ATP-O, ATP-P, and ATP-D who all face different User Costs in the Status Quo scenario.

For the Reference case, the value of the Implied Price Elasticity is -0.36. This is higher than the initial Price Elasticity-Status Quo assumption (-0.25) as it explicitly allows for choosing to 'opt-out' of the Policy Regime. For the purposes of estimating Consumer Surplus in the Policy scenario, the analysis estimated the Intercept-D (Price Intercept of the Demand Curve) using the Price Elasticity of Demand which is computed in the Policy Transition model.

The Implied Grams Per Year-Policy is estimated using the KG (Market Price) and Users (Market Price) as:

(93) Grams/Year-POL = KG(Market Price) * 1,000 / Users(Market Price)

Implied Annual User Cost-POL is estimated as:

(94) Annual Cost-POL = Grams/Year-POL * Market Price

The Implied Grams Per Day-Policy is estimated using the Implied Grams Per Year-Policy as:

(95) Grams/Day-POL = Grams/Year-POL / 350

4.8 Policy – Demand Curve

The analysis again assumed that the Demand Curve is linear in the Policy scenario, the same assumption used in the Status Quo scenario. From the Transition Model (April 2014), an initial point on the Demand Curve-Policy was estimated, based on an expected LP Price of $7.50/gram.

The equilibrium LP Market Price is known when both a Demand and Supply curve estimate for the LP Market (Policy scenario) are obtained.

4.8.1 Demand Curve - Intercept

From equations 90 and 91 there is a point on the Demand curve (in April 2014) of (Market Price, KG(Market Price)) or ($7,500, 19,385) when expressed as a Price/KG and KG-Demand. The calculated Price Elasticity of Demand (Policy) is -0.36. As above (equations 27 and 28), it is therefore possible to estimate, for a linear Demand curve, the Intercept-D and Slope-D.

The Demand curve intercept in the Policy scenario is given by:

(96) Intercept-D = Market Price * [1 – (1.0 / ε^{*}_{p})]

As there are now two points of the Demand curve (the y-axis intercept) and the estimated transaction point (Market Price, Base KG) the Demand curve slope (which is negative as the curve is downward-sloping) can be calculated.

4.8.2 Demand Curve - Slope

The Demand curve slope (for the Policy scenario at April 2014) is given by:

(97) Slope-D(April 2014) = [Market Price – Intercept-D] / KG(Market Price)

For the Reference case, these values are: Intercept-D = $28,335 and Slope-D = -1.07. It is known that, as the market expands in scale over time, the value of the Slope-D will fall (in

absolute terms) in order to be linear with a constant Price Elasticity over time. This was the case for the Status Quo model.

The Demand curve for the LP Market assumed an instantaneous switch from the Status Quo to the Policy scenario as of April 2014. This is unrealistic, as the complexity of Policy Transition would likely occur over a 6- to 18-month period. As the CBA is intended to look at the long-term (10 year) 'steady state' impact of the Policy scenario, the complexity of the actual transition process is ignored for simplicity.

The model logic and results must now be applied from the Policy Transition to forecast the future evolution of Potential Demand Users over time.

From the Policy Transition, it was estimated that 15% of ATP-Persons in April 2014 would 'opt out' of the new Policy regime and access their marihuana from illicit sources, mostly from own-production that is now illegal (i.e., 6,844 Users 'Opt Out' from 47,123 assumed ATP-Persons).

From the Policy Transition, it was estimated that 16% of ATP-Persons in April 2014 would be 'priced-out' of the new Policy regime at the estimated LP Market Price of $7.50/gram (i.e., 7,656 User 'Priced Out' from 47,961 assumed ATP-Persons[28].

These probabilities were used as a constant over time to remove persons from the stream of Potential Policy User*, which is given by:

$$(98)\quad \text{Policy User}^{*}(t) = \text{Policy User}^{*}(t\text{-}1) + \{\text{New Entrants}(t) * [\,1 - Pr_{optout}] * [1 - Pr_{priceout}]\}$$

where

New Entrants(t)	= ATP(April)(t+1) - ATP(April)(t) for April values of ATP numbers in the Status Quo over time between any two Fiscal Years.
Pr_{optout}	= the probability of Potential Policy Users to 'opt-out' of the Policy regime
$Pr_{priceout}$	= the probability of Potential Policy Users to be 'priced-out' of the Policy regime

In order to compute the Demand curve Slope over time, for the Policy scenario, it is necessary to estimate some position on the Demand curve over time. There is the constant Intercept-D which we calculated from the implied (constant) Price Elasticity of Demand. This analysis estimated a point associated with $7.50/gram LP Price, which was the Reference case price used in the Policy Transition Model. This will not necessarily be the Equilibrium Price when the LP Demand and Supply curves are allowed to intersect.

The KG-Demand in the LP Market, over time and at the estimated LP Market Price of $7.50/gram, is given by:

[28] This study applies the 'price-out' effect against an estimated Market Price of $7.50 per gram. Subsequently, in a model of demand/supply equilibrium in the LP market, the study will determine an equilibrium price which may be greater than $7.50 per gram. The analysis does not estimate a further price elasticity effect should the equilibrium price be greater than $7.50 per gram. This was done to segment the analysis and provide simplicity.

(99) KG-Demand*(t) = Policy User-FY*(t) * Grams/Day-POL / 1,000

where

Policy User-FY*(t) = FY average of monthly values determined over time based on April values for successive years.

The Demand curve slope (for the Policy scenario), over time, is given by:

(100) Slope-D(t) = [Market Price – Intercept-D] / KG-Demand*(t)

As for the Status Quo, the Slope-D(t) declines in absolute value over time as the market expands.

The parameters for the Demand curve (LP Market) over time are given in equation 96 (for constant Intercept-D) and in equation 100 (for time variant Slope-D(t)).

This analysis now turns to the LP Supply Model.

4.9 Policy – Supply Curve

A detailed activity-based costing (ABC) model was built for LP Supply production based on various parameters from the literature, and estimates that are comparable to the Government Supply (Status Quo) production, where these are appropriate.

It was assumed, except for the role of the Incumbent Supplier, that an LP entrant would have a beginning scale of operation of 500KG production. This can change in the actual Supply model and is used as a fixed target for the purposes of supply costing.

LP-Scale = 500KG

4.9.1 LP Production – Supply Cost Model

LP-Production Component

It was estimated that the number of production workers per KG produced is 0.072 FTE, based on reported data in the press (2006) about production at the Government Supply. The Scale = 500KG would require about 36 production workers.

LP-PROD = 0.072 FTE Production Workers / KG-Supplied

It was estimated that the production facility could support about 5 plants per m^2 of production space.

LP-PM2 = 5 Plants per m^2 of Production Space

It was estimated that a marihuana plant produces 33.6 grams/plant/harvest for 4 harvests per year, or 134 grams/plant/year.

LP-GPP = 134 grams / Plant / Year

The production space requirement to achieve the LP-Scale output, in terms of m^2 of production space, can be determined by:

(101) Production Space = LP-Scale / [LP-GPP * LP-PM2 / 1,000]

For the parameters assumed, this results in about $745m^2$, or about $8,000ft^2$ of production facility. In order to allow space for: a) storage and drying; b) worker change/toilets/day-use; c) secure delivery/pick-up; d) administration; e) maintenance/cleaning supplies; and f) miscellaneous needs, the production requirement was effectively doubled to get an overall estimate of the required facility size.

(102) Production Facility = Production Space * 2

It was estimated that a suitable production facility could be obtained for about $\$9.00/ft^2$, including Net Lease and TMI (taxes, maintenance and insurance)[29]. Therefore, the annual Production Facility Cost (LP-PFC) is given by:

(103) LP-PFC = Production Facility * $9.00

which is about $144,000 per year for the assumed LP-Scale.

It was estimated that production supplies are about $\$85/m^2$/harvest for growing medium and other sundry supplies (excluding electricity).

LP-SUPP = $\$85/m^2$/harvest

It was estimated that electricity requirements are 40 watts/ft^2, which, converting to metric for 24 hours per day for the LP-Scale, and converting to KWH, with electricity cost of $0.04/KWH, gives:

LP-ELEC = $\$146/m^2$/year

Variable labour cost (production workers) was estimated at about $35,000/year (based on $15/hour for 1875 hours and EBP Cost Factor of 1.25).

LP-LAB = $35,000/year

Production equipment costs are $\$120/m^2$/year in relation to production space, based on amortized cost.

LP-EQUIP = $\$120/m^2$/year

Production security costs are $20,000/year in relation, based on amortized costs for various security requirements and unit costs (e.g., entrance, fence, detection/alarm systems, IT security).

[29] The $\$9.00/ft^2$ estimate was developed for Toronto Industrial locations (Canadian Property Management website). While these costs may be higher or lower by geographic area, this estimate is used for the reference scenario.

LP-SEC = $20,000/year

Total Production Costs, for the LP-Scale facility, is found by sum of various production cost items:

(104) Production Cost = LP-PFC + [LP-SUPP * Prod-Facility * Harvest]
+ [(LP-ELECT + LP-EQUIP) * Prod-Facility]
+ LP-LAB + LP-SEC

Production cost of about $1.9M is estimated for the LP-Scale production.

LP-Order Processing Component

Average shipment size is estimated to be 50 grams.

The number of annual shipments is given by:

(105) LP-SHIP = LP-SCALE * 1,000 / 50

which is 10,000 in the reference case. This would work out to about 40 shipments per working day (for 50 weeks/year and 5 working days per week). Some peak demand is allowed in the analysis so that the workforce is assumed to accommodate up to 1.5 * Average Orders/Day = 60 shipments/day.

It is estimated that an Order Clerk can process 10 Orders per day, so to accommodate the peak order there is a need for 6 FTE Order Clerks.

LP-ORD = [(LP-SHIP / 250) * 1.5] / 10

The same Annual Salary cost is assumed for Order Clerks ($35,000).

The Courier Cost per Shipment is estimated to be $50.

LP-COUR = $50

Order and Shipping Costs are therefore given by:

(106) Order/Ship = [LP-ORD * $35,000] + [LP-COUR * LP-SHIP]

An order/shipping cost of about $0.7M is estimated for the LP-Scale production.

LP – Corporate Component

There are a total of 36 production works and 6 order clerks. It was assumed that there is a Supervisor Span of Control of 12, so that the number of Supervisors is given by:

(107) LP-SUP = (LP-PROD + LP-ORD) / 12 (rounded to nearest integer)

It is assumed that Supervisors are paid 1.65 times the salary of Production/Order workers.

It is assumed that there are 1.35 Corporate Managers/Executives per $1M in sales revenue. For the LP-Scale that implies 5 Corporate Managers. It is assumed that these Managers earn $90,000 annually.

LP-EXEC = $450,000/yr

It was estimated for 12 Corporate Staff the requirement for Corporate Office space for about 4,600ft^2 at a commercial lease cost of $14.00/ft^2/yr.

The Corporate HQ Space Costs were estimated at $65,000/year.

LP-HQ = $65,000/yr

Corporate Security/IT and Equipment Costs were estimated at $30,000/year.

LP-IT&S = $30,000/yr

Corporate Costs are therefore given by:

(108) LP-CORP = [LP-SUP * $35,000 * 1.65] + LP-EXEC + LP-HQ + LP-IT&S

Corporate Costs were estimated at about $0.8M for the LP-Scale production.

LP – Total Operating Cost

LP-Total Operating Costs are the sum of Production, Order/Shipping and Corporate Costs.

(109) LP-OPER = [LP-SUP * $35,000 * 1.65] + LP-EXEC + LP-HQ + LP-IT&S

It was estimated that Total Operating Costs, for the LP-Scale production, would be $3.4M per year.

LP – Net Margin (EBIDT)

LP-Net Margin (Earnings Before Interest, Debt and Taxes) is given by:

(110) LP-NET = [LP-SCALE * $7.50 * 1,000] - LP-OPER

and the % Net Margin is LP-NET / LP-REVENUE (first part of right-hand side of above equation). In the reference scenario, this results in LP-NET = $390,000 and %Net of 10%.

LP – After Tax Profit

It was estimated that LP interest costs and taxes would be about $105,000, so that after-tax profit is about $285,000, or 8% of Revenue.

By definition, as the analysis has fully exhausted the revenue, the total cost (per gram or KG) is the same as the sales revenue (per gram or KG).

Table 4.6 summarizes the LP Supply Cost model. This is not presented as a reliable guide to LP costing, but as an order-of-magnitude cost estimate that corresponds reasonably well to Health Canada expectation that the LP Market Price could be in the vicinity of $7.50/gram.

In Table 4.6, the LP supply cost works out to $6.72/gram, which, in a market after HST is applied (at 13%), would give a user price of roughly $7.60/gram.

Table 4.6 – Policy – LP Supply Cost		
Model 2.20 LP Parameters (Initial Scale for LP)		
LP-Small Scale (KG)	500	
Target Revenue - Small	$3,750,000	
Production Site Workers	36.0	
Production Space Requirements		
Plants / m^2	5	
Yield / Plant / Year (grams)	134	
Yield / m^2 / Year (grams)	672	
Grow Space Requirement m^2	744	
Grow Space ft^2	8,000	
Storage / Drying ft^2	1,600	20%
Worker Facility ft^2	800	10%
Secure Delivery Space ft^2	1,200	15%
Administration ft^2	1,600	20%
Maintenance/Cleaning ft^2	1,200	15%
Other/Misc. ft^2	1,600	20%
Total Production Facility ft^2	16,000	
Ratio of Grow / Total Space	50%	
Production Facility Cost/Year	$144,000	
Cost per m^2 Grow Area	$194	
Production Facility Value	$1,920,000	
Variable Cost Parameters		
Supplies per m^2 / harvest	$85	
Supplies per m^2 / year	$340	
Supplies per / year	$252,976	
Electricity KwH per m^2 / year	3,650	
Electricity KwH / year	2,715,774	
Electricity Cost / year	$108,631	
Electricity Cost per m^2 / year	$146	
Labour Hours per KG	135	
Labour Hours / year	67,500	
Labour Cost / year	$1,260,000	
Labour Cost per m^2 / year	$1,693	
Equipment Cost / year	$89,286	
Equipment Cost per m^2 / year	$120	
Physical Security Requirements		
Security Cost / year	$20,000	
Security Cost per m^2 / year	$27	
Production Cost Sub-Total		
Total Production Costs / year	$1,874,893	
Total Production Costs / m^2 / year	$2,520	
Total Production Costs / KG	$3,750	
Order Processing		
Average Shipment Size (gram)	50	
No. Shipments / Year	10,000	

Table 4.6 – Policy – LP Supply Cost	
No. Shipments / Day	40
Peak Shipments / Day	60
Shipments / FTE / Day	10
Peak FTE Requirement	6
Order Proc Labour Cost / year	$210,000
Labour Cost / Shipment	$21
Courier Cost / Shipment	$50
Courier Cost / year	$500,000
Management & Overhead	
Operational Staff FTE	42
Supervisors FTE	4
Supervisors Cost	$231,000
Corporate FTE	5
Corporate Staff Cost	$450,000
Corporate Space m^2 per FTE	28
Corporate Staff	12
Corporate Overhead Space m^2	93
Corporate Space m^2	429
Corporate Space ft^2	4,618
Corporate Space Cost/Year	$64,648
Corporate Security Cost/Year	$10,000
IT/Equipment Costs	$20,000
Order/HQ Cost Sub-Total	
Total Order/HQ Costs / year	$1,485,648
Total Order/HQ Costs / KG	$2,971
Operating Cost Sub-Total	
Total Costs / year	$3,360,541
Total Costs / KG	$6,721
Operating Margin	$1,644,107
% Operating Margin	44%
EBIDT	$389,459
% Net Margin	10%
Working Capital Requirement	$616,438
Debt Load	$750,000
Interest Cost	$42,329
EBT	$347,130
Taxes	$62,483
Profit After Tax	
Earning After Tax	$284,647
% After-Tax Profit on Revenue	8%
Sources: Delsys Research	

This LP costing model provides some support for believing that an LP Market could be operative in FY2014-15 at around $7.50/gram.

4.9.2 LP – Compliance Cost

The TBS Regulatory Cost Calculator was used with an activity-costing model for specific policy regulatory requirements to derive an estimated Business Compliance Cost of $20M on an annualized basis for the LP market entrants. This was estimated to involve Fixed Compliance Costs (per year) of $322,160 per LP and Variable Compliance Costs of $62,476 per LP based on the scale of the LP operation.

This study developed a Scale Factor(t) over time based on the KG-Supply in the LP market over time and made adjustments to the Fixed Compliance Cost as additional LPs entered the market.

The LP Compliance Cost was estimated in the Policy scenario to be:

(111) LP-COMP = {Fixed Cost * #LP(t)} + {Variable Cost * Scale Factor(t)}

where

#LP(t) = the number of LP entrants at time t

Fixed Cost = $332,160 per LP

Variable Cost = $62,476 per LP (when Scale Factor = 1.00)

Scale Factor(t) = KG-Supply(t) / KG-Supply(2014-15) which is a value between 1.0 and 6.44 over time

In the reference case, the LP compliance costs represent about 11% of Revenue (FY2014-15) and fall to 3% of revenue (FY2013-14).

4.9.3 LP – Supply Curve

It was not possible to derive the Supply curve Intercept or Slope directly from the LP costing model (above). The Supply curve represents the impact of a (possibly) lower marginal cost Incumbent, and the introduction of LP Entrants with higher marginal costs. It was expected that the Supply curve would have an upward slope, reflecting the fact that market expansion draws in LP entrants, at the margin, who may be less efficient and have higher marginal costs.

The following heuristic rationale was posited for the Supply curve parameters.

It is not anticipated that there would be any LP Market supply at a price (per KG) below $6,000. Effectively, it is believed that the Incumbent's marginal cost is at least $6,000/KG.

It is estimated that the Incumbent could supply, perhaps, 3,500KG, at a marginal cost (Price) of $6,500.

It is estimated that a scaled Incumbent and about 50 LP Entrants (at the LP-Scale used in the Costing Model) could supply 35,500KG at a Market Price of $7,500/KG.

It is estimated that a scaled Incumbent and, perhaps, 400 LP Entrants could supply 200,000KG at a Market Price of $8,000/KG.

Sources: Delsys Research

Initially, in the Reference case, it was anticipated that the LP Market could be supplied by a Scaled Incumbent and 50 New LP Entrants. The analysis allows additional LP Entrants to enter the market in FY2016-17 and in FY2018-19 if the market capacity utilization ratio is sufficiently close to 85% over the average of the next four years. It is assumed that once LP Entrants join the market they scale their production from the Base-Scale of 500KG annually to about 4,000KG annually by 2024-25.

4.11 Policy – User Benefits & Costs

Consumer Surplus – LP Market

Consumer Surplus is estimated in a similar manner to equation 32 (for Government Supply).

The existence of the HST tax wedge means there is a Deadweight Loss associated with the LP market and it is necessary to separately track the Supply Price (P*S-EQ) and Demand Price (P*D-EQ) as well as the Equilibrium Quantity (with Tax) (KG*-EQ) for various calculations. It is also necessary, for the Deadweight Loss calculation, to calculate the Price ($P^{\#}$-EQ) and Equilibrium Quantity (no Tax) ($KG^{\#}$-EQ).

Consumer Surplus (LP Market) over time in the Policy scenario is given by:

(114) CS(LP)(t) = 0.5 * [Intercept-D - Demand Price(t)] * KG*-Demand(t)

Producer Surplus – LP Market

Producer Surplus (LP Market) over time in the Policy scenario is given by:

(115) PS(LP)(t) = 0.5 * [Supply Price(t) - Intercept-S] * KG*-Demand(t)

Deadweight Loss – LP Market

Deadweight Loss is estimated in a similar manner to equation 33 (for Government Supply).

Deadweight Loss (LP Market) over time in the Policy scenario is given by:

(116) $DWL(LP)(t) = \{0.5*[P^{\#}\text{-EQ}(t) - \text{Supply Price}(t)] * [KG^{*}\text{-EQ}(t) - KG^{\#}\text{-EQ}(t)]\}$

$+ \{0.5*[\text{Demand Price}(t) - P^{\#}\text{-EQ}(t)] * [KG^{*}\text{-EQ}(t) - KG^{\#}\text{-EQ}(t)]\}$

The Deadweight Loss calculation requires the area of two triangles to be calculated.

4.12 Policy – Safety Costs

It was estimated in the Reference case of the Policy Transition Model (for April 2014), that 8,000 producers (PUPL/DPPL) might 'opt out' of the Policy regime and continue cultivation, illicitly and principally in their family residence. This was modelled in equation 63-67. This was a reduction of 33% in misuse by persons who held production licenses.

It was also known that about 60% of persons who are interested in accessing marihuana for medical purposes are prepared to undertake own-production. This is a historical fact in the MMAP experience.

It was also estimated, in equation 98, that the number of persons that would enter the new Policy regime, based on the number of persons who would have participated in the MMAP in the Status Quo scenario. The analysis used the number of persons who would have participated in the MMAP as the base against which to estimate the continued stream of persons who will continue to engage in misuse in the Policy scenario.

4.12.1 Policy – Residential Misuse

The number of persons who will continue to grow marihuana in their family residence in the Policy scenario who were, counterfactually, related to MMAP in the Status Quo scenario, is given by:

(117) Misuse(Policy)(t) = 7,605 (for April 2014)

(118) Misuse(Policy)(t) = Misuse(Policy)(t-1) + [MMAP-New Entrant(t) * 0.6 * (1 - .33)]

where

MMAP New Entrant(t)		= the number of persons who would enter MMAP in the Status Quo
Pr(PUPL)	=	0.6
%Misuse Reduction	=	0.33

It is important to highlight that this study does not assume that all residential cannabis/marihuana cultivation would cease as a result of the Policy changes. Effectively, the operation of the crime prevention/deterrent effect of clarification (through the removal of the need for additional evidence) is only assumed to reduce such activity by 33%. It may be that the actual impact will be higher, but this study modelled the response based on evidence in the literature dealing with drug crime prevention.

The analysis assumed, as for the Status Quo scenario, the same parameters for minor and major misuse, fire risk, injury and death rates, economic loss from injury, death and property damage. Therefore, equations 44 to 46 are effectively used to estimate the same losses associated with fire to obtain Fire Costs for the Policy scenario.

4.12.2 Policy – Fire Costs

For each of the fire events associated with misuse, the social costs associated with fires related to marihuana cultivation are given, in the Policy scenario over time, by:

$$(119)\ \text{Fire Costs}(t) = [\text{House Fire}(t) * WTP_{damage}] + [\text{House Fire}(t) * Pr_{injury} * WTP_{injury}] + [\text{House Fire}(t) * Pr_{death} * WTP_{death}]$$

as in equation 46.

4.13 Policy – Security Costs

The misuse stream, over time, in the Policy scenario, as given in equation 118, is also used as the primary input into the Security model which otherwise uses the same parameters and logic as equations 47 to 51 for the Status Quo.

Crime Prevention Benefits & Costs

One intended consequence of the proposed Policy is to improve public security by removing from residential areas the locus of legal marihuana cultivation.

Attribution of crime prevention benefits is made difficult by the presence of the '*displacement effect*'. This is defined as the unintended increase in targeted crimes in other locations following from the introduction of a crime reduction scheme. Five different forms of displacement have been identified [Reppetto (1976)]: a) temporal (change in time), b) tactical (change in method), c) target (change in victim), d) territorial (change in place), and e) functional (change in type of crime).

Effectively, the attribution of benefits to crime reduction must be able to document logically (and with evidence, preferably) that the reduction of crime is not localized in time, space, location or type of crime and merely displaced elsewhere. If such displacement occurs there is no (or less) social welfare gain.

Crime reduction/control benefits arise from:

a) savings of resources for law enforcement activity; and

b) reduced societal harm (i.e. willingness-to-pay (WTP) to avoid harm or willingness-to-accept' (WTA) harm).

The elimination of a legal option to personally produce marihuana for medical purposes under Health Canada regulation is a main feature of the intended improvement in public security outcomes. Such a policy will only have an impact to the extent that the underlying activity is stopped or reduced in level. To the extent that this activity remains (at the same level) and becomes illicit (without cover of the MMAR), there would be no social welfare change. This is an example of what is called the 'displacement effect,' which must be taken into account in CBA related to crime prevention.

There are two main mechanisms by which the proposed Policy could, theoretically, reduce the level of criminal activity related to marihuana cultivation in residences:

a) *Signal effect*: declaration of the activity as illicit may result in some people ceasing their activities; and

b) *Deterrence effect*: increasing the risk of detection, arrest, seizure and punishment without the legal cover of MMAR production licenses may reduce the marginal return of the illicit activity.

The first effect would appear to be naïve. The second effect is based on rational criminal activity and the altering of the risk/reward trade-off. The economic/rational theory of criminal activity [Becker (1968)] treats crime as a rational activity and postulates that crime prevention/control should also be demonstrated to be rational (and effective).

Crime Prevention Impacts of the Proposed Policy

The proposed Policy will no longer allow (following a phasing-out transition period) the legal cultivation of marihuana for medical purposes under what are now MMAR production licenses (that mostly involve family residences). This will eliminate the *legal* ability to cultivate marihuana in a family residence.

As such, it will logically eliminate the threat of violence against families in their residence who legally cultivate marihuana in their residence. This is not to say that some persons may not continue to do so, but this activity will now be illegal. Therefore, the expected magnitude of this impact depends crucially on the degree to which people desist from future illegal marihuana cultivation in their residence.

Crime Prevention Benefits - Policy

By explicitly developing a model (Policy Transition Model) to look at the rewards and risk of marihuana cultivation misuse (under MMAR in the Status Quo) and the economic returns to crime, this study can more accurately estimate, with the assistance of a behavioural parameter found in the 'economics of crime' literature, the possible impact (net of displacement) on the underlying residential marihuana cultivation. As this CBA has explicitly modelled the continuation of some crime (estimated at 67%) in the Policy scenario, the analysis has appropriately ascribed a reasonable estimate for the benefits arising from crime prevention as a result of the intended Policy impact.

4.13.1 Policy – Security Cost

For each of the security events associated with misuse in the Policy scenario, the social costs associated with residential misuse, home invasions and non-fatal/fatal shootings are given in the Policy scenario over time, by:

$$(120)\quad \text{Security Cost}(t) = \text{Social Loss}_{misuse}(t) + \text{Social Loss}_{invasion}(t) + \text{Social Loss}_{non\text{-}fatal}(t) + \text{Social Loss}_{fatal}(t)$$

as in equation 51.

4.14 Policy – Program Administration Costs

As above for the Status Quo scenario, Health Canada Program Administration Costs are comprised of:

- Salary and Human Resources (HR)-related costs such as Employee Benefits Program (EBP) and staff accommodation costs;
- Operations & Maintenance (O&M) costs for travel, training, supplies and professional contracts; and
- Corporate Cost to reflect Departmental shared services and overhead.

4.14.1 Policy – Salary & HR-Related & O&M Costs

Health Canada administrative costs (human resource costs, accommodation, O&M costs) were estimated to be about $1.4 Million in the first year, presumably FY2014-15, for the Policy scenario. These estimates did not include Employee Benefit Program (EBP) costs or HC Corporate functional overhead (which were embedded in the Status Quo MMAP Costs). To ensure consistency between the Status Quo and Policy scenarios, these adjustments were made and the base year costs were associated with activity volumes to allow a basis for forecasting changes in HC Program Administration Cost over time as the volume of activity grows.

The assumptions used by Health Canada to underpin the administration cost estimate was that there would be 60 LPs requiring licensing as producers, and that there was a need for two (2) inspections per license, or 120 field inspections. In addition, there were 100 files to be reviewed, although it was unclear how this related to the licenses issued or inspection volume.

HR salary cost, 'grossed-up' by 41% for EBP costs, results in an estimate of $1.89 Million in the first year. About 79% of this cost is HR-Related and 21% is O&M-Related (travel, training, police accompaniment, office supplies, publishing etc). Certain line item costs appeared to be of a fixed nature, so this study estimated that $132,000 (O&M) and $346,675 (HR) were of a fixed nature and the remainder were variable with the volume of activity which is largely related to the number of LP producers.

Based on the assumed number of 60 LPs, these variable cost elements were $4,258 (O&M) per LP and $19,185 (HR) per LP. There were 13.25 FTEs in this base-year estimate.

In the LP Supply Model, the analysis estimated the number of producers that were expected to be in the LP Market, over time, based on a model of LP New Entrants and a scaling growth path over time as they expand along with the overall market scale. Allowance was also made for a Salary Escalation factor (2%) to increase HR costs over time in real terms.

The Health Canada Administration Cost over time, in the Policy scenario is given by:

$$\text{(121) HC-Admin Cost}(t) = \{\text{Fixed-HR} + [\text{Variable-HR} * \#LP(t) * (1 + \text{Salary Escalation})^t]\} + \{\text{Fixed-O\&M} + [\text{Variable-O\&M} * \#LP(t)]\}$$

This is the counterpart to equation 13 for the Status Quo scenario.

4.14.2 Policy – Corporate Cost

In the Status Quo scenario, there was a fixed component and a variable component of these costs which meant that the Corporate Cost increased at a fixed amount per year.

It was estimated that the HC Corporate Cost represented about 14% of the HC-Administration Cost (FY2013-14), so this ratio was used to benchmark an initial year value of ($1.89 Million * 0.14 = $257,092) for the initial year. Based on the ratio of fixed/total cost in the Status Quo for FY2013-14, it was estimated that about $100,000 is fixed Corporate Cost and about $150,000 is variable Corporate Cost. It was estimated that the step-function increase, per year, would be about $15,000.

The linear equation to predict the future Corporate Cost over time in the Policy scenario is given by:

(122) Corporate Cost(t) = 100,000 + 15,000 * (t)

This is the counterpart to equation 12 for the Status Quo scenario. The value for t (FY2014-15) is 10, which is the continuation of the time trend from the Status Quo.

4.14.3 Policy – Program Administration Costs

The sum of Health Canada administrative cost (equation 121) and corporate cost (equation 122) equal the total Program Administration Costs for the Policy scenario:

(123) Program Administration Cost(t) = HC-Admin Cost(t) + Corporate Cost(t)

This is the counterpart to equation 15 for the Status Quo scenario.

4.15 Policy – Summary of Benefits & Costs

Policy – Program Administration Costs

Total HC Program Administration Costs are from equation 123.

Compliance cost is given from equation 111.

Policy – User Benefits

User benefit is the Consumer Surplus measure from equation 114.

Producer Surplus is from equation 115.

The Deadweight Loss (from the HST tax) is given in equation 116.

Policy – Safety Costs

Safety cost is the sum of the Fire Costs from equation 119.

Policy – Security Costs

Security cost is given from equation 120.

4.16 Net Present Value (Policy vs Status Quo)

The Net Present Value is – with the use of a Social Discount Rate (SDR) – the discounted sum over time of the difference between the streams of benefits and costs in the Policy scenario and benefits and costs in the Status Quo scenario.

The Net Present Value is given by:

(123) $NPV = \sum_t [Policy(t) - Status\ Quo(t)] / [(1+SDR)^t]$

where

Policy(t)	= the sum of the Policy scenario benefit (if positive) or cost (if negative) estimates for each of the components of the CBA;
Status Quo(t)	= the sum of the Status Quo scenario benefit (if positive) or cost (if negative) estimates for each of the components of the CBA;
SDR	= the Social Discount Rate (8%);
t	= time index from 1 (FY2014-15) to 10 (FY2023-24)

This completes the discussion of the CBA methodology. The report now turns to the CBA Model results.

CHAPTER FIVE

5. Cost Benefit Analysis - Results

This section reports the Cost Benefit Analysis results from the model described in the previous section on methodology. It presents the CBA results in four sections and provides detailed tables, including the two Accounting Table summaries required by Treasury Board Secretariat.

The CBA results are presented in terms of:

1. Program Usage & Outcomes: resulting from the proposed regulation changes in terms of legal users and legal consumption, residential producers, marihuana cultivation misuse and resulting safety and security impacts;

2. Monetized Cost and Benefit Measures: related to users, producers, deadweight loss (from taxes and effective subsidies) and safety and security benefits resulting from lower social costs;

3. Net Present Value Measure: the Discounted Net Present Value (NPV) based on the difference between the Policy scenario and Status Quo scenario streams of costs and benefits over time; and

4. Sensitivity Analysis: the sensitivity of the NPV measure to different reasonable parameter values.

In a CBA, the key measure is the NPV measure for the Reference Case, supplemented by Sensitivity Analysis of the CBA results based on Monte Carlo analysis of changes to parameter values that underpin the model dynamics (behavioural responses to changes) and monetization of events (in terms of willingness-to-pay measures).

5.1 Program Usage & Outcomes

Tables 5.1 and 5.2 show the forecast results over the 10 year period (FY2014-15 to FY2023-24) for the Reference case for each of the Status Quo and Policy scenario scenarios. These tables show forecast values for:

Program Usage Indicators:

- Legal marihuana users under the MMAR (Status Quo) and the proposed Policy regime;
- Legal marihuana producers under the MMAR (DPPL/PUPL) and as LPs;
- KG quantity of marihuana consumed from legal sources of supply; and
- Average supply cost (per KG) from legal sources of supply.

Safety Indicators:

- Number of residential misuse cases for marihuana production (i.e., misuse of PUPL/DPPL production licenses under the MMAR; and persons who are forecast to 'opt out' of the Policy regime and continue home cultivation that is expected to involve supply to the illicit market);

- Number of residential fires predicted to occur as a result of residential misuse marihuana cultivation;

- Number of predicted fire injuries resulting from the residential fires resulting from misuse marihuana cultivation; and

- Number of predicted fire deaths resulting from the residential fires resulting from misuse marihuana cultivation.

Security Indicators:

- Number of potentially violent home invasions that are predicted to arise from residential misuse cases for marihuana production;

- Number of non-fatal shootings that are predicted to arise in relation to home invasions and residential misuse cases for marihuana production; and

- Number of fatal shootings that are predicted to arise in relation to home invasions and residential misuse cases for marihuana production.

A discussion follows (below) on the impact of the Policy in terms of changes between the two cases. The change in outcomes is summarized in Table 5.3 as the difference between the Policy and Status Quo scenarios.

TABLE 5.1 - STATUS QUO – PROGRAM OUTCOMES & INDICATORS										
	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Usage Indicators										
Legal Marihuana Users	57,799	93,338	141,461	201,426	267,769	330,345	378,943	409,706	426,025	433,688
Legal Marihuana Producers	38,532	62,226	94,308	134,284	178,512	220,230	252,629	273,138	284,017	289,126
Legal Marihuana KG Consumed	67,573	107,841	163,853	233,748	312,556	388,859	450,964	493,027	517,204	529,672
Value of Legal Consumption ($M)	$156	$248	$373	$526	$702	$869	$1,001	$1,090	$1,143	$1,176
Supply Value Per KG	$2,310	$2,300	$2,277	$2,251	$2,247	$2,235	$2,220	$2,211	$2,211	$2,221
Safety Indicators										
Residential Misuse	15,259	24,641	37,346	53,177	70,691	87,212	100,041	108,163	112,470	114,494
Fires	96	158	237	340	451	557	638	689	718	730
Fire-Injuries	5	7	10	15	20	26	29	31	32	32
Fire-Deaths	0	0	1	1	1	1	1	2	2	2
Security Indicators										
Home Invasions	53	86	130	186	247	305	349	378	393	400
Non-Fatal Shootings	6	9	14	20	26	32	37	40	42	43
Fatal Shootings	1	2	2	3	5	6	7	7	7	8

TABLE 5.2 - POLICY – PROGRAM OUTCOMES & INDICATORS										
	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Usage Indicators										
Legal Marihuana Users	41,384	66,435	100,814	143,138	189,486	233,131	267,559	290,134	302,652	308,755
Legal Marihuana Producers	51	51	51	51	61	61	61	61	61	61
Legal Marihuana KG Consumed	26,734	41,681	61,462	84,809	109,458	132,216	150,204	162,203	168,992	172,450
Value of Legal Consumption ($M)	$179	$284	$427	$604	$800	$989	$1,143	$1,249	$1,310	$1,341
Supply Value Per KG	$6,698	$6,808	$6,955	$7,128	$7,310	$7,478	$7,612	$7,700	$7,751	$7,776
Safety Indicators										
Residential Misuse	11,102	17,276	25,248	34,539	43,957	51,976	57,598	60,873	62,518	63,269
Fires	66	104	152	207	264	312	345	365	375	380
Fire-Injuries	3	5	7	9	12	14	15	16	17	17
Fire-Deaths	0	0	0	1	1	1	1	1	1	1
Security Indicators										
Home Invasions	43	66	97	133	169	200	221	234	240	243
Non-Fatal Shootings	4	7	10	14	18	21	24	25	26	26
Fatal Shootings	1	1	2	3	3	4	4	4	5	5

TABLE 5.3 – CHANGE/POLICY IMPACT – PROGRAM OUTCOMES & INDICATORS										
	2014-15	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**
Usage Indicators										
Legal Marihuana Users	-16,415	-26,903	-40,647	-58,288	-78,283	-97,214	111,384	119,572	123,373	124,933
Legal Marihuana Producers	-38,481	-62,175	-94,257	134,233	178,451	220,169	252,568	273,077	283,956	289,065
Legal Marihuana KG Consumed	-40,838	-66,160	102,392	148,939	203,098	256,643	300,760	330,824	348,212	357,221
Value of Legal Consumption ($M)	$23	$36	$54	$78	$98	$120	$142	$159	$167	$165
Supply Value Per KG	$4,387	$4,509	$4,678	$4,877	$5,063	$5,243	$5,391	$5,490	$5,540	$5,555
Safety Indicators										
Residential Misuse	-4,157	-7,365	-12,098	-18,638	-26,734	-35,236	-42,443	-47,290	-49,952	-51,225
Fires	-30	-54	-85	-133	-187	-245	-293	-324	-343	-350
Fire-Injuries	-2	-2	-3	-6	-8	-12	-14	-15	-15	-15
Fire-Deaths	0	0	-1	0	0	0	0	-1	-1	-1
Security Indicators										
Home Invasions	-10	-20	-33	-53	-78	-105	-128	-144	-153	-157
Non-Fatal Shootings	-2	-2	-4	-6	-8	-11	-13	-15	-16	-17
Fatal Shootings	0	-1	0	0	-2	-2	-3	-3	-2	-3

5.1.1 Legal Marihuana Users

The number of legal users of marihuana for medical purposes decreases by about 30% over the period as a result of potential users: a) 'opting out' to undertake illegal residential marihuana cultivation; and b) being 'priced out' of the market through higher prices and the operation of the price elasticity of demand. This is shown in Figure 5.1.

5.1.2 Legal Marihuana Consumption

The quantity of legal marihuana consumption decreases by over 65% as a result of the reduction in the number of users and the quantity consumed per user. The latter effect results from the higher price, the operation of price elasticity of demand, and an affordability effect that spending on legal marihuana does not exceed more than 15% of the mean annual income of users. This is shown in Figure 5.2.

Figures 5.1 & 5.2 – Program Usage Indicators

Figure 5.1 Legal Users

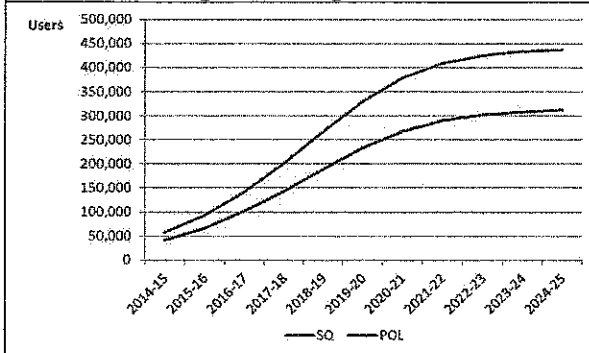
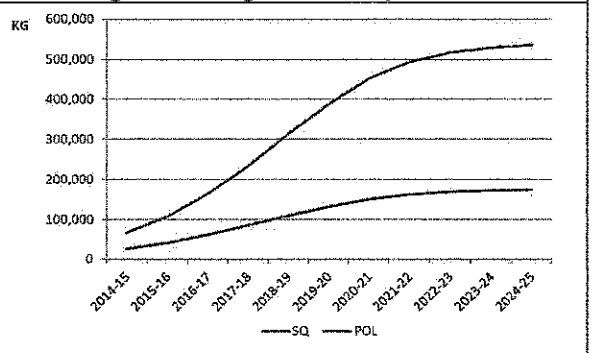


Figure 5.2 Legal Consumption KG



Source: Delsys Research

5.1.3 Legal Marihuana Value

The value of legal marihuana consumption increases by almost 15% as a result of the interplay between lower marihuana consumption and higher marihuana supply price. This value is the product of the quantity of legal marihuana consumption (KG) times the supply price of the legal marihuana consumed. This is shown in Figure 5.3. The Policy change to create a legal marihuana supply market comprised of Licensed Commercial Producers could, over time, grow to be a $1.3 Billion per year industry.

5.1.4 Legal Marihuana Supply Price

The average supply price for legal marihuana increases by about 250% over time as a result of the elimination of low-cost legal own-cultivation (and designated person production) and the transition to LP supply with security, quality control and other regulatory requirements. This is shown in Figure 5.4.

Figures 5.3 & 5.4 – Program Usage Indicators

Figure 5.3 Legal Value $M

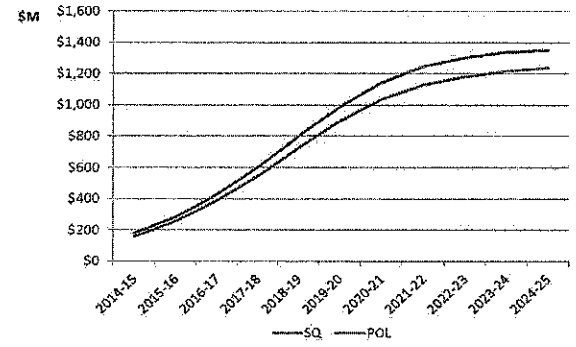
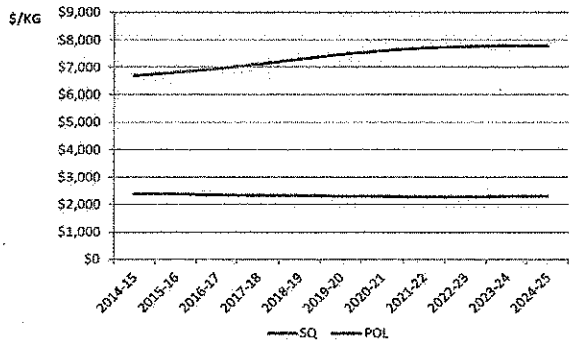


Figure 5.4 Supply Price $/KG



Source: Delsys Research

5.1.5 Safety Indicators

The number of cases of potential misuse in terms of residential marihuana cultivation for the purpose of supplying the illicit market decreases by 45% over the forecast period as a result of: a) more effective law enforcement activity through the elimination of MMAR production licenses by removing the need to obtain additional evidence (above that normally required to obtain reasonable and probable grounds to investigate potential misuse); and b) a deterrent effect as the probability of conviction increases.

The number of residential fires caused by faulty/misused electrical devices and systems that arise from indoor marihuana cultivation decreases by almost 50%. This is shown in Figure 5.5.

The number of fire-related injuries is reduced by a similar percentage – close to 50%. There is a cumulative reduction of 92 injuries over the forecast period. This is shown in Figure 5.6.

There are four (4) fire-related deaths averted over the forecast period as a result of the policy to eliminate legal residential marihuana cultivation.

Figures 5.5 & 5.6 – Safety Indicators

Figure 5.5 Fires Related to Misuse

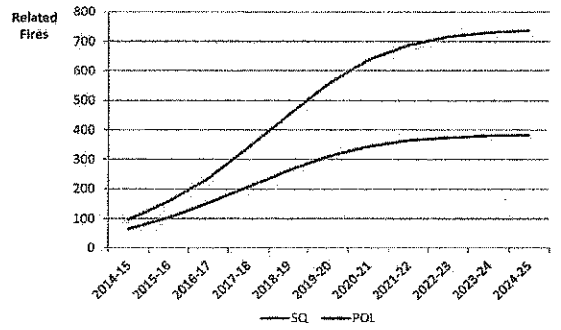
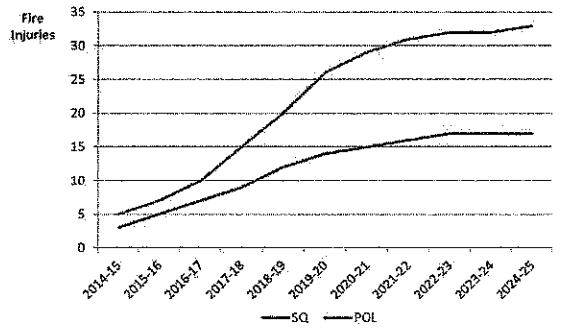


Figure 5.6 Fire-Related Injuries



Source: Delsys Research

5.1.6 Security Indicators

The number of potentially violent home invasions that arise because of misuse in terms of residential marihuana cultivation for the purpose of supplying the illicit market decreases by 40% over the forecast period as a result of: a) more effective law enforcement activity due to the increased clarity as a result of the elimination of MMAR production licenses; and b) a deterrent effect as the probability of conviction increases. This is shown in Figure 5.7.

The number of cases of home invasions with non-fatal shootings decreases by over 40%. There is a cumulative reduction of 94 non-fatal shootings over the forecast period. This is shown in Figure 5.8.

There is a cumulative reduction of 16 fatal shootings over the forecast period.

Figures 5.7 & 5.8 – Security Indicators

Figure 5.7 Home Invasion Related to Misuse

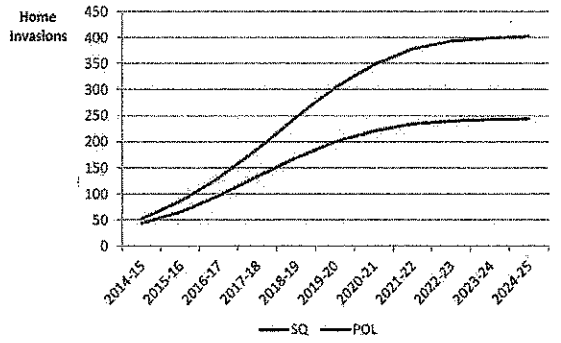
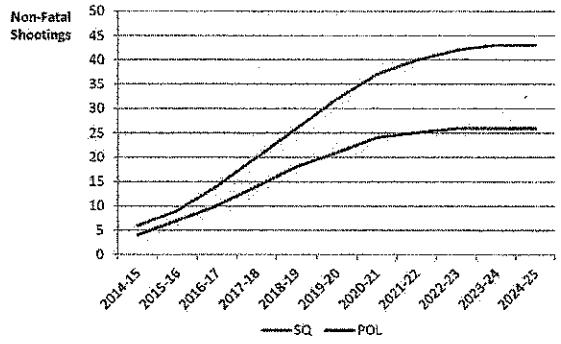


Figure 5.8 Non-Fatal Shootings



Source: Delsys Research

5.2 Monetized Cost & Benefits Measures

Tables 5.4 and 5.5 show the forecast results over the 10-year period (FY2014-15 to FY2023-24) for the Reference case for each of the Status Quo and Policy scenarios. These tables show forecast values for monetized Costs and Benefits including:

1. Consumer Surplus: a measure of user benefit;
2. Producer Surplus: a measure of supplier benefit;
3. Deadweight Loss: a measure of economic loss resulting from tax/subsidy distortions from the market equilibrium most efficient use of resources;
4. Program Administration Costs: Health Canada program administration costs to oversee the Marihuana Medical Access Program;
5. Safety Costs: a measure of the economic loss associated with fires resulting from residential marihuana cultivation;
6. Security Costs: a measure of the economic loss associated with home invasion and shootings resulting from the misuse of residential marihuana cultivation; and
7. Business Compliance Costs: a measure of the incremental costs that business must bear as a result of regulatory requirements that are beyond normal business practice[30].

For the purposes of these Tables, *CBA costs* are those variables with negative values (implying a social cost) and *CBA benefits* are those variables with positive values (implying a social benefit).

A discussion follows of the impact of the proposed Policy in terms of changes between the two cases. The change in outcomes is summarized in Table 5.6 as the difference between the Policy and Status Quo scenarios. These are the values that are discounted, using a Social Discount Rate of 8% in the Reference case, to produce the estimate of the Net Present Value (NPV).

[30] Business Compliance Costs are shown in the CBA as they form a part of the RIAS analysis. As Business Compliance Costs are already included in the cost of supply, these are not additional in terms of the CBA result.

TABLE 5.4 – STATUS QUO – MONETIZED CBA RESULTS

	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	20
CBA - Costs (Negative)										
HC - Program Administration	-20,630,103	-30,008,114	-42,160,070	-56,881,976	-73,004,828	-88,422,448	-101,019,733	-109,963,905	-115,917,275	-120,(
Deadweight Loss	-1,971,263	-3,171,138	-4,526,278	-5,830,658	-7,820,031	-9,236,870	-9,893,372	-10,202,535	-10,731,985	-11,7
Safety - Social Cost	-3,705,188	-6,081,774	-14,916,011	-18,886,520	-23,160,253	-27,257,771	-30,367,814	-38,127,467	-39,239,954	-39,6
Security - Social Cost	-8,864,700	-17,047,400	-18,439,000	-27,375,400	-43,621,300	-52,605,500	-61,187,100	-62,084,200	-62,578,700	-70,0
Sub-Total CBA Costs	*-35,171,254*	*-56,308,426*	*-80,041,359*	*-108,974,554*	*-147,606,412*	*-177,522,589*	*-202,468,019*	*-220,378,107*	*-228,467,913*	*-241,*
CBA - Benefits (Positive)										
User - Consumer Surplus	278,021,823	443,096,890	672,631,011	959,070,572	1,281,745,711	1,594,297,577	1,848,899,513	2,021,398,354	2,120,374,124	2,171,
Producer Surplus	0	0	0	0	0	0	0	0	0	
Sub-Total CBA Benefits	*278,021,823*	*443,096,890*	*672,631,011*	*959,070,572*	*1,281,745,711*	*1,594,297,577*	*1,848,899,513*	*2,021,398,354*	*2,120,374,124*	*2,171,*
Other (Non-CBA) Costs										
Business Compliance	-2,354,664	-3,584,649	-4,927,424	-6,193,331	-8,095,245	-9,437,517	-10,057,428	-10,349,048	-10,848,100	-11,8

TABLE 5.5 – POLICY – MONETIZED CBA RESULTS

	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	20
CBA - Costs (Negative)										
HC - Program Administration	-1,924,268	-1,965,770	-2,007,272	-2,048,775	-2,340,055	-2,385,394	-2,430,733	-2,476,072	-2,521,412	-2,5(
Deadweight Loss	-464,119	-748,188	-1,152,209	-1,671,596	-2,271,736	-2,874,843	-3,385,975	-3,744,253	-3,953,242	-4,0(
Safety - Social Cost	-2,541,498	-4,008,412	-5,854,356	-13,765,621	-15,965,992	-17,811,936	-19,076,035	-19,847,395	-20,239,725	-20,4
Security - Social Cost	-8,489,700	-9,243,400	-17,378,300	-25,700,700	-26,833,100	-34,968,000	-35,673,900	-36,052,600	-43,454,000	-43,5
Sub-Total CBA Costs	*-13,419,585*	*-15,965,771*	*-26,392,137*	*-43,186,691*	*-47,410,883*	*-58,040,173*	*-60,566,643*	*-62,120,320*	*-70,168,379*	*-70,5*
CBA - Benefits (Positive)										
User - Consumer Surplus	289,235,420	448,337,593	656,021,931	896,947,174	1,146,355,466	1,372,117,274	1,547,502,175	1,662,984,297	1,727,796,665	1,760,
Producer Surplus	2,644,475	6,428,038	13,976,839	26,612,531	44,329,865	64,679,652	83,476,731	97,346,190	105,666,227	110,(
Sub-Total CBA Benefits	*291,879,895*	*454,765,631*	*669,998,770*	*923,559,704*	*1,190,685,331*	*1,436,796,926*	*1,630,978,906*	*1,760,330,487*	*1,833,462,891*	*1,870,*
Other (Non-CBA) Costs										
Business Compliance	-20,126,430	-21,907,819	-24,265,316	-27,047,930	-33,307,251	-36,019,576	-38,163,485	-39,593,530	-40,402,723	-40,8

TABLE 5.6 – CHANGE/POLICY IMPACT – MONETIZED CBA RESULTS

	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
CBA - Costs (Negative)										
HC - Program Administration	18,705,835	28,042,344	40,152,798	54,833,201	70,664,773	86,037,054	98,589,000	107,487,832	113,395,863	117,497,64
Deadweight Loss	1,507,145	2,422,949	3,374,069	4,159,063	5,548,296	6,362,027	6,507,397	6,458,282	6,778,743	7,702,681
Safety - Social Cost	1,163,690	2,073,362	9,061,655	5,120,899	7,194,261	9,445,835	11,291,779	18,280,072	19,000,229	19,265,55
Security - Social Cost	375,000	7,804,000	1,060,700	1,674,700	16,788,200	17,637,500	25,513,200	26,031,600	19,124,700	26,478,30
Sub-Total CBA Costs	*21,751,670*	*40,342,656*	*53,649,222*	*65,787,863*	*100,195,529*	*119,482,416*	*141,901,375*	*158,257,786*	*158,299,535*	*170,944,17*
CBA - Benefits (Positive)										
User - Consumer Surplus	11,213,597	5,240,702	16,609,079	-62,123,399	135,390,245	222,180,303	-301,397,337	358,414,057	392,577,459	410,368,95
Producer Surplus	2,644,475	6,428,038	13,976,839	26,612,531	44,329,865	64,679,652	83,476,731	97,346,190	105,666,227	110,034,86
Sub-Total CBA Benefits	*13,858,072*	*11,668,741*	*-2,632,240*	*-35,510,868*	*-91,060,380*	*157,500,652*	*-217,920,606*	*261,067,867*	*286,911,232*	*300,334,09*
Total CBA Net Benefits	***35,609,742***	***52,011,396***	***51,016,982***	***30,276,995***	***9,135,149***	***-38,018,236***	***-76,019,231***	***102,810,081***	***128,611,698***	***129,389,91***
Other (Non-CBA) Costs										
Business Compliance	17,771,766	18,323,170	19,337,892	-20,854,599	-25,212,005	-26,582,059	-28,106,057	-29,244,482	-29,554,624	-28,994,74

5.2.1 Consumer Surplus Measure of User Benefit

Consumer Surplus is a measure of user benefit over and above what is reflected in the user price paid for acquiring the good (i.e., legal marihuana for medical purposes). It reflects the willingness-to-pay by users and is captured as the area under the Demand curve and above the price either paid by consumers or reflecting the supply cost of producing the good.

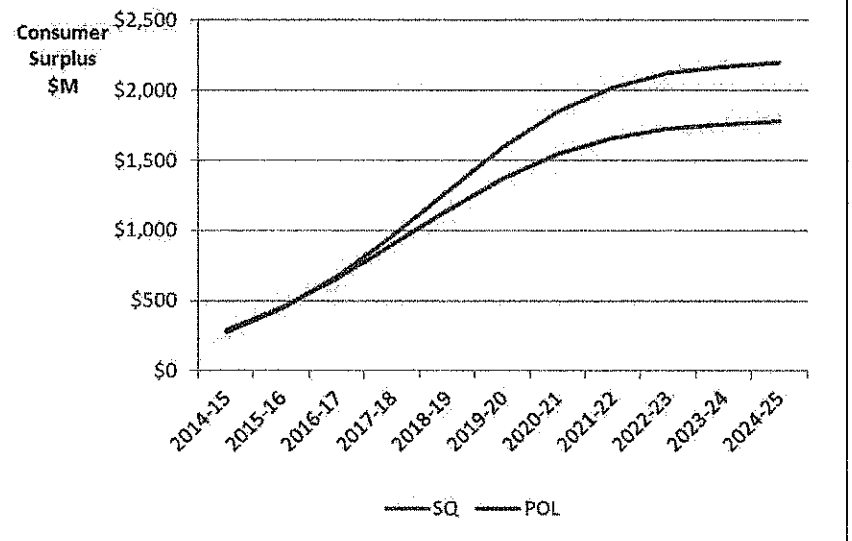
As is shown in Table 5.3 and Figures 5.1, 5.2 and 5.4, the Policy scenario projects a reduction in the number of legal marihuana users and KG consumed, and an increase in the user price of marihuana consumed. These changes indicate that there would be a loss of Consumer Surplus under the Policy scenario.

The valuation of Consumer Surplus depends on the Slope and Intercept of the Demand curve, which was inferred from a single assumption related to the Price Elasticity of Demand for a linear Demand curve. For the Status Quo scenario, separate measures were taken for each of the distinct 'supply markets' pertaining to Government Supply, Personal-Use supply and Designated-Person supply options. These were then summed to give an overall Consumer Surplus.

The Policy scenario has a single legal LP Market for supply and similar reasoning can be applied for the Price Elasticity of Demand and a linear Demand curve to estimate Consumer Surplus.

The Consumer Surplus decreases in the Policy scenario by almost 20% over the forecast period. This is shown in Figure 5.9. That Consumer Surplus decreases by about 20% when the legal marihuana KG consumed decreases by 65% requires some explanation.

Figure 5.9 Consumer Surplus – Measure of User Benefit



Source: Delsys Research

The estimation of Consumer Surplus is influenced by the willingness-to-pay valuation of consumers as reflected in the Demand curve and determined (in part) by the Demand Intercept, which captures the marginal willingness-to-pay for the first user in the market. With linear Demand and this study's estimation of the Demand Intercept based on the Price Elasticity of Demand, the Demand Intercept is much higher when the known (observed) transacted market price is higher.

The Policy scenario involves market transactions in the range of $7.60 to $8.80 per gram over time, reflecting the higher cost of marihuana from the LP market. The higher cost also reflects higher product quality in terms of multiple strains of cannabis and production quality control to limit contaminants and toxic substances and ensure a consistently high quality of product over time. In the Reference case, the Demand Intercept in the LP market is equivalent to $29.20 per gram.

The Status Quo scenario involves three separate supply markets, each with their own supply price. The Demand intercepts for these separate markets are: $25.00 per gram (Government Supply), $14.00 per gram (Designated Person) and $9.00 per gram (Personal Use).

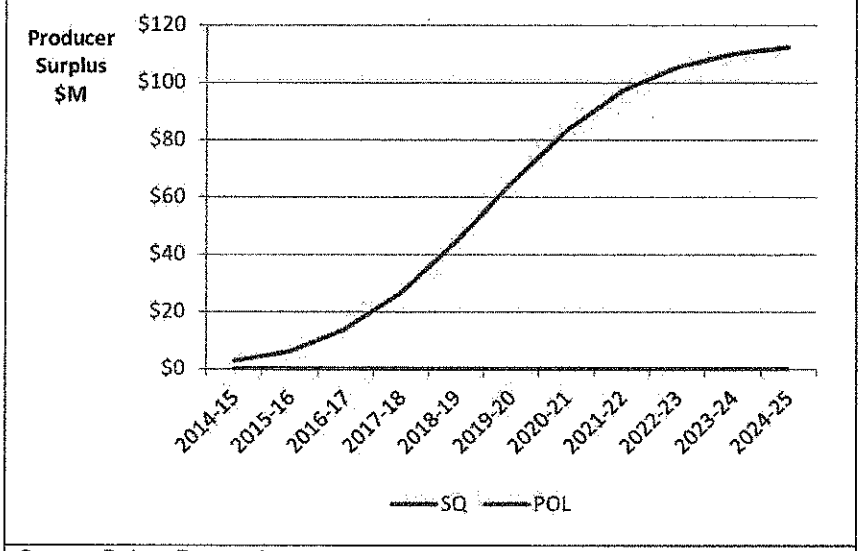
Therefore, the Consumer Surplus measure in the Policy scenario is much higher (for a given level of marihuana consumption) than in the Status Quo scenario. This is a direct result of the mathematical logic of the study's model and is generally reflective of higher product quality and costs associated with marihuana cultivation by LPs operating under rigorous quality control standards.

5.2.2 Producer Surplus Measure of Supplier Benefit

Producer Surplus is a measure of supplier benefit over and above what is reflected in the user price paid for acquiring the good (i.e. legal marihuana for medical purposes). It reflects lower marginal cost for units below the equilibrium quantity. There was no Producer Surplus in the Status Quo scenario as the social valuation of the marihuana produced in the Government Supply was below the supply (and marginal cost) of production as a result of the effective subsidy to production. There also was no Producer Surplus in the Personal-Use or Designated-Person supply markets as these have perfectly elastic (i.e., flat) Supply curves.

There was Producer Surplus in the Policy scenario as the LP Supply curve is upward sloping. The value of Producer Surplus, however, was quite small in comparison with Consumer Surplus, as can be seen in Figure 5.10 (when compared to the scale in Figure 5.9). This result was attributable to the relatively inelastic (i.e., relatively flat) Supply curve in the Policy scenario.

Figure 5.10 Producer Surplus – Measure of Supplier Benefit



Source: Delsys Research

Consumer and Producer Surplus are the two measures of social *benefit* in the CBA. The analysis of the Policy scenario involves a projected reduction in Consumer Surplus and an increase in Producer Surplus. However, because the former overshadows the latter, the overall result is a projected reduction in social benefit, which contributed negatively to the NPV overall result.

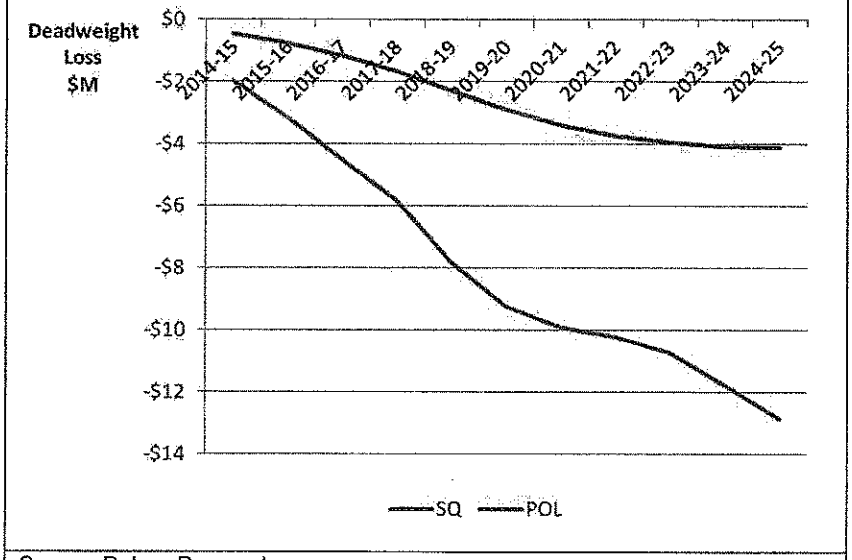
5.2.3 Deadweight Loss from Market Distortion (Tax/Subsidy)

Deadweight Loss arises in the Status Quo scenario from the effective subsidy to production that results in excess demand relative to the market equilibrium without such subsidy. The value of this loss is relatively small as the Government Supply component in the CBA model was comparatively small.

Deadweight Loss arises in the Policy scenario from the application of HST tax on marihuana which creates a 'tax wedge' between the price users would pay and the supply price that would be received by suppliers. The value of this loss is also relatively small.

The estimated Deadweight Loss in both cases, as shown in Figure 5.11, plays no significant role in the overall CBA results and findings. The analysis projects a small Deadweight Loss as a result of the Policy change. The loss is shown as a negative value compared to the benefit measures related to Consumer and Producer Surplus.

Figure 5.11 Deadweight Loss – Economic Cost of Tax/Subsidy



Source: Delsys Research

As the Policy scenario involves a lesser loss (i.e., smaller negative value), this outcome constitutes a reduction in social cost which contributes positively to the NPV overall result.

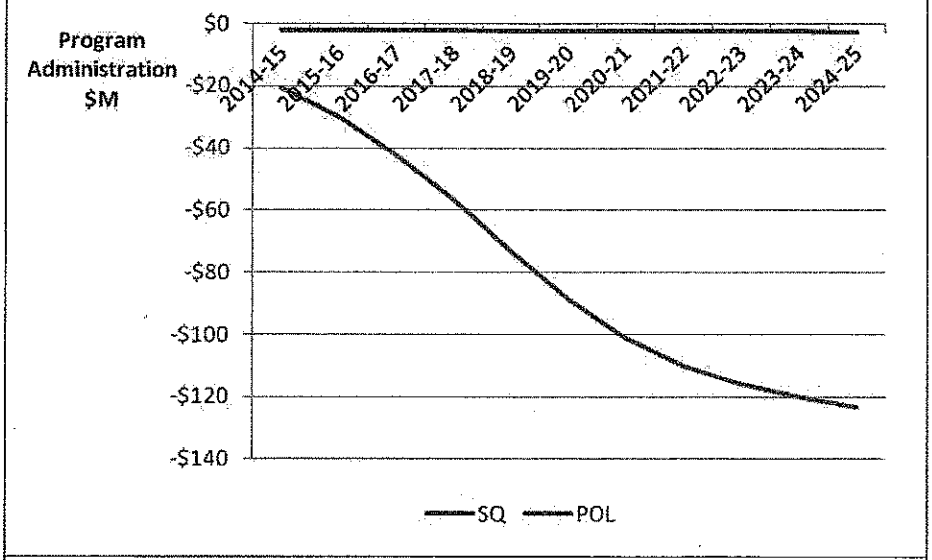
5.2.4 Health Canada - Program Administration Costs

In both the Status Quo and Policy scenarios, Health Canada is responsible for Program Administration in terms of employee salaries, benefits and accommodation as well as travel and supply costs associated with inspections and office work. These are costs and are represented as negative values in the analysis.

The 'contract value' associated with the Government Supply in the Policy scenario is not included in this section, as it forms part of the cost of supply that was taken into account in the estimation of Consumer and Producer Surplus measures.

As Health Canada will eliminate the role it plays in determining eligibility of persons to access the legal supply of marihuana for medical purposes, the Program Administration cost is lower in the Policy scenario than in the Status Quo scenario. This is shown in Figure 5.12.

Figure 5.12 HC Program Administrative Cost



Source: Delsys Research

The Policy scenario reduction of over 95% of Program Administration costs is a relatively modest source of savings (and benefits) in the context of the overall NPV result.

This graphic highlights an important point about the Status Quo scenario. The Status Quo scenario is modeled on the assumption that government resources required to administer the MMAP will continue to grow over time to *fully accommodate* the required program uptake in terms of numbers of persons wanting to access a legal source of marihuana for medical purposes. The Program Administration cost is projected to increase from $13.8M (FY2013-14) to over $120M (FY2023-24). In reality, the Government of Canada is, and will likely continue to be for some time, operating under a fiscal restraint. It is, therefore, highly unlikely that such additional resources would be available (over time) to *fully* accommodate the forecast increase in the MMAP participation in the status quo.

Consequently, achievement of the Status Quo scenario benefits, in terms of increasing Consumer Surplus, is at considerable risk of not being realized. Rather than impose a specific government resource constraint on the Status Quo, the analysis of the Status Quo scenario adopted an assumption of continued ATP growth and growing Health Canada program administration costs (and contract costs) – even though we acknowledge that such growth might well not be realized in reality due to fiscal restraint.

This qualification to the achievement of the Status Quo results is very important when interpreting the overall NPV result. This analysis compares a Policy scenario – whose rationale is partially based on the requirement to reduce administrative costs – to a Status Quo scenario in which it is assumed that sufficient resources would be made available to scale program delivery capacity in response to service demands growing at an exponential rate up to some limit – even though there is substantial risk that this would not be realized in reality.

Figure 5.12 shows the large resource 'gap' (the difference between the Status Quo and Policy scenarios) which represents the Health Canada savings that would be required to respect overall departmental and Government of Canada fiscal restraint objectives.

The impact of a resource constraint was analyzed (Figure 4.5 above) using a System Dynamics simulation model. The simulation results indicated that the number of ATPs in a constrained Status Quo scenario might be only about 1/3rd of the unconstrained case (i.e. perhaps only 150,000 ATPs could be accommodated in the program over the forecast period in the constrained Reference case compared to the ceiling value of 450,000 in the unconstrained Reference case). The practical implication of a resource constraint is that there would be substantial backlogs and lengthy time delays for processing new applications and renewals of ATPs.

5.2.5 Monetized Safety Costs

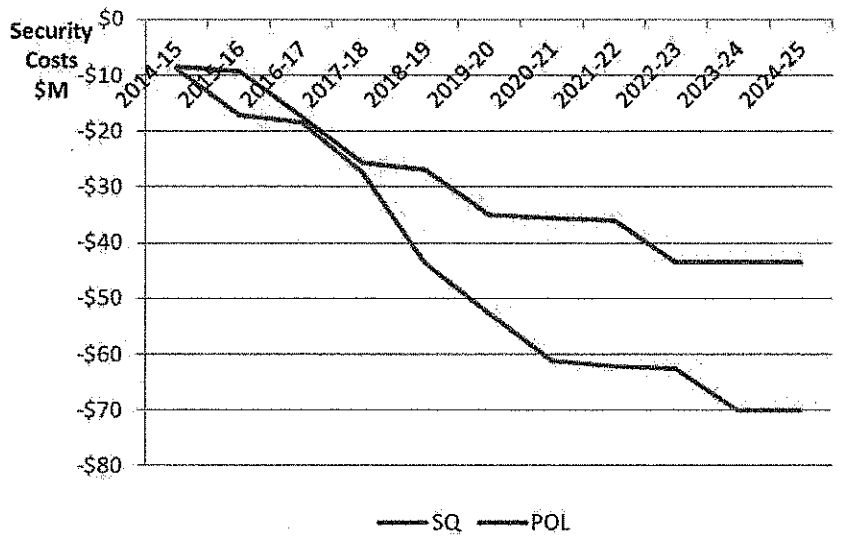
Monetized Safety Costs relate to residential fire events and the estimated property damage and willingness to pay to avoid fire-related injuries and deaths. Canadian data for fires specific to electrical causes have been used to estimate fire risks and outcomes in terms of damage, injury and deaths. The property damage estimate (from insurance claims) provides a direct estimate for that cost. Willingness to pay to avoid injury and death has been borrowed from other Canadian CBA studies.

It is known (Table 5.11 and Figure 5.5) that the Policy scenario involves a reduction in the number of residential cases of misuse and fire events related to marihuana cultivation and residential misuse. It would therefore be expected that the Safety Costs would decrease in the Policy scenario. As costs are treated in the CBA analysis as negative values, the reduction in negative values is a positive benefit.

The Policy scenario involves a decrease in Safety Costs of almost 50% over the forecast period. This is shown in Figure 5.13. The scale of the Safety Costs is small in relation to the Consumer Surplus change so these represent a modest source of savings (and benefits).

The Policy scenario involves a decrease in Security Costs by roughly 40% over the forecast period. This is shown in Figure 5.14. The scale of the Security Costs is small in relation to the Consumer Surplus change, so these represent a modest source of savings (and benefits).

Figure 5.14 Security Costs



Source: Delsys Research

Security Costs are estimated to be about twice the scale of Safety Costs and contribute proportionally the same to the NPV benefit gain of the Policy scenario over time.

The Deadweight Loss, Program Administration Costs, Safety Costs and Security Costs are the four measures of social cost in the CBA. As the Policy scenario involves a reduction in all these costs the overall result is a reduction in social cost, which contributes positively to the NPV overall result.

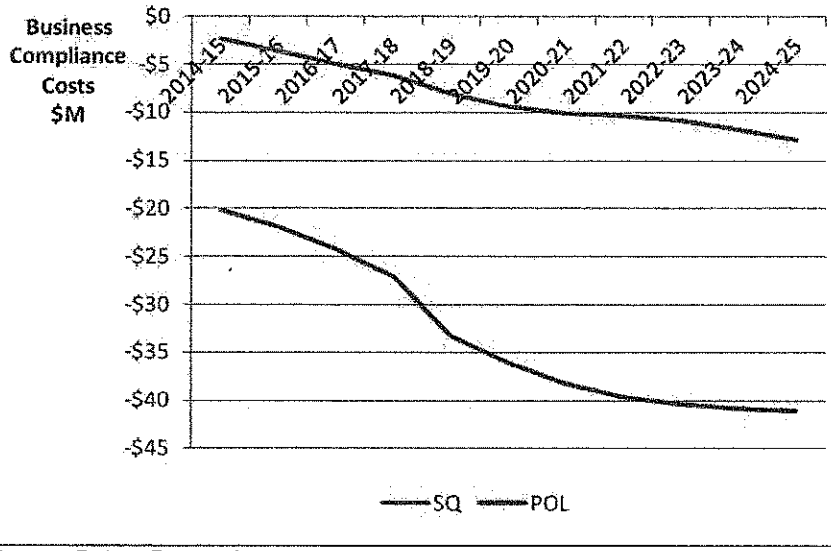
5.2.7 Business Compliance Costs

Business Compliance Costs are estimated in both the Status Quo and Policy scenarios. The assumption used in the Status Quo scenario is that a fixed share of overall Supply Cost (10%) is comprised of Business Compliance Costs. This is a fairly high value as a result of the nature of the contractual relationship between Health Canada and the contracted Government Supplier. It is generally perceived by Health Canada that the regulatory burden faced by LPs in the Policy scenario will be considerably less per unit of production (i.e., reduced red tape per supplier).

However, Government Supply represents a small share (about 10% in terms of people, about 3% in terms of KG consumed) of legal marihuana supply in the Status Quo scenario, whereas the Licensed Producers will account for all (100%) of the legal marihuana supply in the Policy scenario. Therefore, while the regulatory compliance burden per unit of activity will be substantially less, it will apply to a much larger volume of activity. Business Compliance Costs are anticipated to fall from 10% of revenue in the Status Quo scenario to about 3% of revenue in the Policy scenario (by FY2020-21).

The overall result, as shown in Figure 5.15, is that the Business Compliance Costs will be about two to three times greater in the Policy scenario.

Figure 5.15 Business Compliance Costs



Source: Delsys Research

As Business Compliance Costs are incorporated in the Supply Cost for both the Status Quo and Policy scenarios, they do not form part of the CBA result and are used, instead, in the RIAS analysis and other TBS regulatory assessment processes[31].

The Business Compliance Costs mostly fall on Medium and Large Business (as opposed to Small Business) as the scale of LP activity (in terms of employees and sales revenue) is expected to grow beyond that of a Small Business after two years.

[31] TBS 'One for One' and 'Small Business Lens' requirements.

5.3 Net Present Value

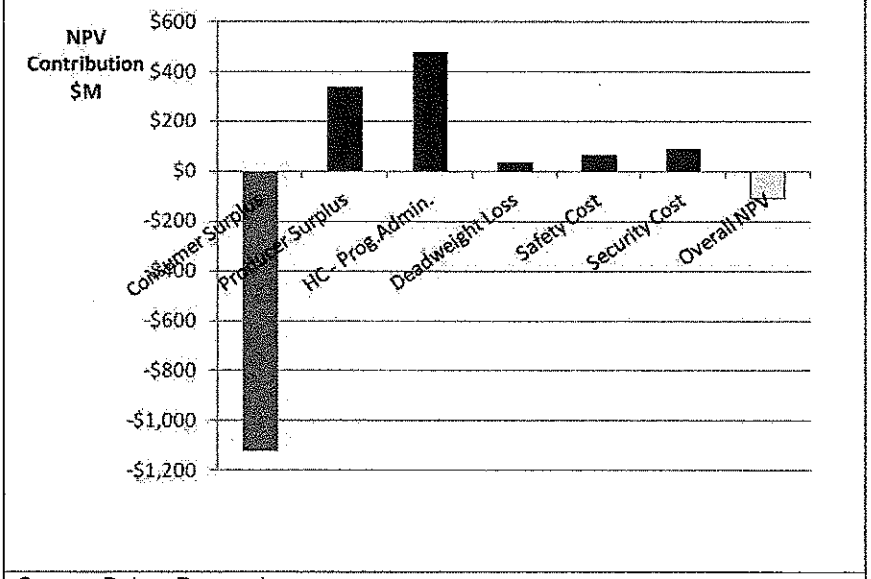
The main focus of the CBA results is on the Reference case (i.e., most likely) estimate of the Net Present Value. This sums the various cost and benefit measure differences between the Policy and Status Quo scenarios, over time, after discounting by a social discount rate that values future year results as less valuable than more current year results. The purpose of social discounting is to reflect the social opportunity cost of resources which are values higher the closer they are in time to the present period.

5.3.1 Reference Case

The Reference case NPV is -$109 Million, with an annualized NPV of -$16 Million. This result is shown in Table 1 of the CBA Accounting Statement (as per TBS guidelines).

As discussed in the previous section, the bulk of the NPV result arises from the loss of Consumer Surplus resulting from reduced consumption and a higher supply price for persons consuming legal marihuana for medical purposes. Figure 5.16 shows the contribution to the overall NPV result from each of the CBA cost and benefit components. In terms of the offsetting positive contributions the largest contributors are the reduction in Health Canada Program Administration costs and the Producer Surplus. While the contribution to the NPV result from reduced safety and security costs is small in comparison to the overall NPV result, these are still large in absolute value.

Figure 5.16 Composition of Reference Scenario NPV By Benefit-Cost Component



Source: Delsys Research

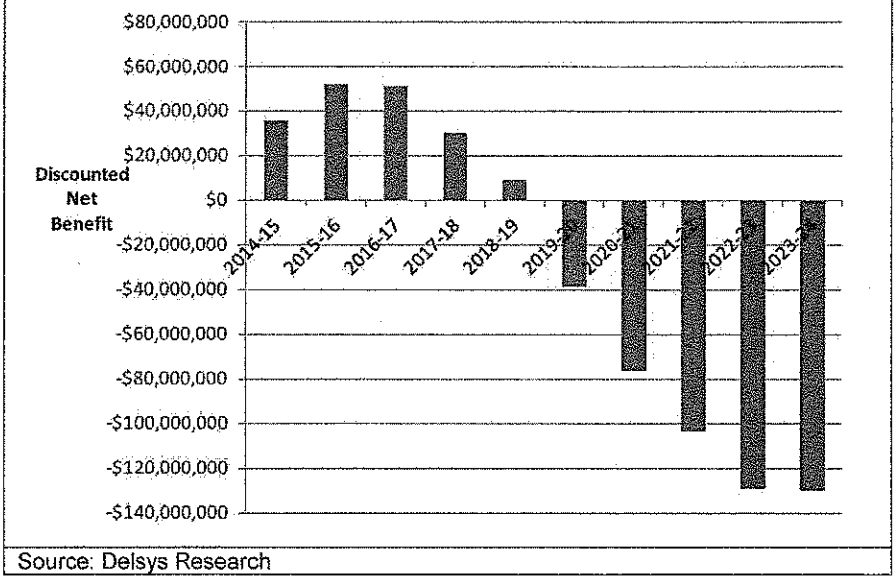
The relative magnitude of the net benefit contributions to the overall NPV result can also be seen, in undiscounted flows by year, in Table 5.6.

5.3.2 Time Profile of Discounted Net Benefits

The Reference case NPV of -$109 Million results from the sum of a discounted stream of net benefits (i.e., benefits less costs) for each year. This is shown in Figure 5.17.

The net benefits start off positive for the first five years (i.e., discounted benefits exceed discounted costs), then turn sharply negative for the remaining five years of the time horizon. The sum of positive discounted net benefits for the first five years (+$158 Million) is more than offset by the sum of negative discounted net benefits for the last five years (-$268 Million), which generates the negative NPV result in the Reference case.

Figure 5.17 Time Profile of Contribution to NPV Result



Source: Delsys Research

In the first five years, with positive discounted net benefits, there are a number of circumstances that produce greater benefits (with positive discounted net benefit) than costs (with negative discounted net benefit):

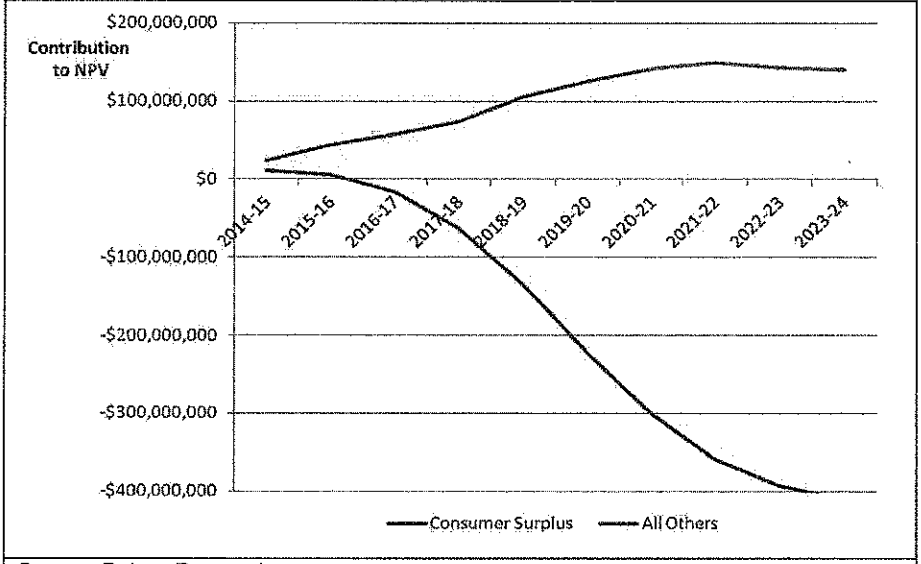
a. The change in Consumer Surplus (Policy scenario minus Status Quo scenario) starts off as positive and becomes negative by year 3 – up until that point, all components of NPV are positive; and

b. With the Consumer Surplus contribution negative in year 3, it is not sufficiently negative for another three years (until year 6), at which time the negative value for the change in Consumer Surplus fully offsets the other positive components of NPV.

This can be seen in Figure 5.18, which shows the time paths for Consumer Surplus (in red) and for the sum of 'Other' components (in blue). Consumer Surplus grows more rapidly (i.e., negatively) than the Other components grow (positively). It is between the fifth and sixth years that the vertical distance between the blue line and the x-axis is the same as the vertical distance between the red line and the x-axis. This is where the contribution to NPV becomes

zero and the negative contribution to NPV from Consumer Surplus is exactly offset by the positive contribution to NPV from Other components.

Figure 5.18 Time Profile of Consumer Surplus and Other Components: Contribution to NPV Result



Source: Delsys Research

Rationale for Positive Initial Consumer Surplus Contribution

This study now turns to the rationale for the change in Consumer Surplus starting off positive for the first two years of the time horizon. The change in Consumer Surplus is broken down as a function of: a) lower KG-Demand moving towards the higher priced Policy scenario; and b) a higher valuation of Consumer Surplus in the higher priced Policy scenario (as seen in Figure 5.19):

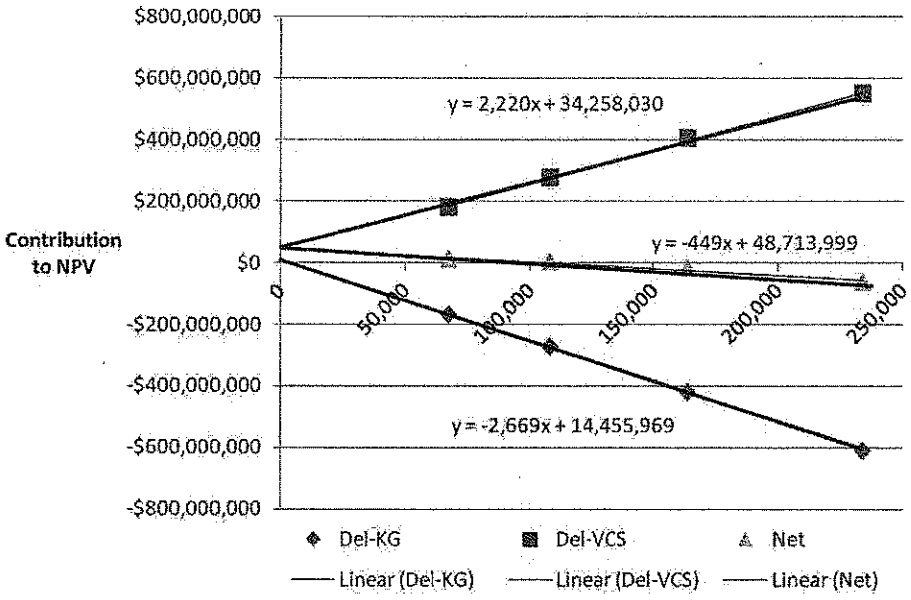
a. *Less KG-Demand*: If this is valued at the Consumer Surplus value (per KG) in the Status Quo scenario, the impact of reducing KG-Demand in the Policy scenario is negative (in terms of contribution to NPV) – as seen in the blue data points – and its slope, in terms of KG-Demand, is -$2,668/KG; and

b. *Greater CS-Value per KG*: In the Policy scenario, each KG-Demand adds to Consumer Surplus at a higher value (per KG) – roughly $10,500/KG – than each KG-Demand in the Status Quo scenario – roughly $4,100/KG. This is a consequence of the higher exchange value (i.e., price) and the higher price intercept for the Demand curve. When this contribution is valued at the KG-Demand in the Policy scenario, its contribution is positive (in terms of NPV) – as seen in the red data points – and its slope, in terms of KG-Demand, is $2,220/KG.

As the combined effect (i.e., slope) is the sum of these separate effects (i.e., slopes), the overall slope of the relationship (i.e., the marginal effect on Consumer Surplus per KG-Demand) is negative ($2,220 + - $2,668 = -$449).

However, the intercept of the net relationship is positive ($34.3 Million + $14.5 Million = $48.7 Million). Therefore, the overall contribution of Consumer Surplus is positive up to the value of KG-Demand = 109,000KG (where this is KG-Demand under the Status Quo scenario) – which is not reached until year 3.

Figure 5.19 Consumer Surplus Contribution to NPV as a Function of KG-Demand (Status Quo) showing a) Impact of Lower KG-Demand; b) Impact of Higher Consumer Surplus Value per KG; and c) Net (combined) Impact



Source: Delsys Research

5.3.3 Discussion of Results

This CBA has undertaken a careful, informed approach to the monetization of some of the major (but by no means exhaustive) anticipated outcomes of the proposed regulatory change for access to marihuana for medical purposes. This has attempted to capture meaningful and realistic behavioural changes to the removal of legal marihuana cultivation by individuals for their personal or designated-person use. This study thus documents a likely reduction in the number of adverse safety (i.e. fires) and security (e.g. misuse and home invasion) incidents that can be monetized in terms of social and security costs to society.

The CBA documents significant reductions in Health Canada Program Administration costs that are likely to arise as Health Canada ceases to be the principal medium of individual access to legal marihuana for medical purposes and focuses its regulatory effort on licensing and inspection of the commercial (legal) producers. These savings are significant, as the scale of the MMAP is expected to expand by over 750% in the ten year forecast period (for ATP persons in the Status Quo).

The impact on legal marihuana users of the elimination of legal personal-production and designated-person production and its replacement by commercial supply will make the legal supply price higher, although this analysis does not presently observe the transacted market price for Designated Person supply and only the supply price for Personal Use supply can be estimated. Also, only the likely LP Market price can be forecast. However, the Reference case, reflecting the best information and data available, indicates a relatively large supply price increase in the Policy scenario.

There is some possibility that the LP Market price could be lower than what is estimated in this analysis. This will only become known once the market is established in FY2014-15. Competitive market pressure between LP suppliers and greater production efficiencies, if supported by the Regulatory regime, may drive the supply price in the Policy scenario lower than this study's Reference case.

The impact of higher LP market price a reduction in the KG consumed in the market. The effect of the elimination of legal own-production is not expected to result in the cessation of that activity but its curtailment, as a result of a higher expected probability of police action, arrest and conviction.

The reduction in the KG consumed in the market is reflected in the reduction in the Consumer Surplus measure that tends to dominate the overall NPV result. While the sensitivity analysis (in the next section of this report) demonstrates that there are realistic parameter estimates that generate a positive NPV result, this analysis suggests that the Reference case result with a negative NPV result is the single most likely CBA result.

The *TBS Guidelines for Cost-Benefit Analysis* direct the results to be summarized (primarily) in terms of the Reference case results. This report presents them as such. These Guidelines also require a sensitivity analysis of the CBA results to investigate the range of NPV results that can arise from alternative, realistic parameter estimates. This is undertaken below. At this stage of the report it is important to highlight that the results show considerable variability and that the Reference case finding of a negative NPV result is not, in fact, statistically significant in light of the standard deviation of the resulting NPV distribution[32].

[32] The mean and standard deviation of the NPV distribution, based on 10,000 Monte Carlo trials, are: μ (mean) = $-1,476M; σ (standard deviation) = $2,799M. As a rule of thumb, there is a 95% probability that this study's estimate of the mean lies within a bound of +/- (2*Std Dev) of the 'true' mean. As that range includes the value zero and this study's Reference case estimate of -$728M this analysis can not say that a Null Hypothesis that this study's estimate is equal to zero can be rejected (at the 95% confidence interval).

CBA Accounting Statement (Table 1)
NPV Results & Sensitivity Analysis

PART 1: Deterministic Case

Category of Impact	*NPV*	*Annualized NPV*	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 1*
1. Monetized							
Benefits			13,858,072	11,668,741	-2,632,240	-35,510,868	-300,334,09
Costs			21,751,670	40,342,656	53,649,222	65,787,863	170,944,17
Net Benefits (All)	-109,723,604	-16,352,053	35,609,742	52,011,396	51,016,982	30,276,995	-129,389,91
Net Benefits (Exc. Users)	1,004,940,153	149,765,717					
2. Quantified / Non-Monetized							
Benefits							
Reduction-Legal Users			-16,415	-26,903	-40,647	-58,288	-124.93
Reduction- Legal KG-Consumed			-40,838	-66,160	-102,392	-148,939	-357.22
Costs							
Reduction-Misuse (Residential)			-4,157	-7,365	-12,098	-18,638	-51,22
Reduction-Residential Fires			-30	-54	-85	-133	-35
Reduction-Fire-Injuries			-2	-2	-3	-6	-1
Reduction-Fire-Deaths			0	0	-1	0	-
Reduction-Home Invasions			-10	-20	-33	-53	-15
Reduction-Non-Fatal Shootings			-2	-2	-4	-6	-1
Reduction-Fatal Shootings			0	-1	0	0	-
3. Unquantified							
Benefits	There are additional benefits in terms of reduced health to family residents as a result of mould/chemical exposure resulting from residential marihuana cultivation in the home. There are also other general security benefits from removing marihuana cultivation from homes.						
B. Cost-Effectiveness Analysis	Not Applicable						

PART 2: Risk/Uncertainty

Category of Impact	*Values of Risk Variables (Low-High Range)*			*Type of Probability Distribution (Distribution Parameters)*	
1. Key Risk Parameters	**Lo**	**Mean**	**Hi**	**Type of Distribution**	**Parameters**
Designated Person - Supply Cost	$1.40	$2.80	$5.00	Uniform	Minimum - Maximum
Max % of Mean Annual Income	10%	15%	20%	Uniform	Minimum - Maximum
Price Elasticity of Demand	-0.50	-0.25	-0.10	Triangular	Minimum - Likeliest - Maximum
Personal Use - Supply Cost	$1.00	$1.80	$2.50	Uniform	Minimum – Maximum
Utilization Rate - Personal Use	40%	55%	65%	Uniform	Minimum - Maximum
Utilization Rate - Designated Person	35%	47%	55%	Uniform	Minimum - Maximum

2. Monte Carlo Simulation	**Project Outcome Values (NPV)**	
	Mean Value	-1,687,872,721
	Median Value	-1,342,604,699
Sensitivity Analysis Results	**Standard Deviation**	2,855,961,358
	Low	-26,289,518,277
	High	10,010,797,264

Source: Delsys Research – as per TBS (2007) p.42

5.3.4 Stakeholder Analysis

The reference scenario NPV of -$109 Million can be broken down by results attributable to different stakeholders. This is summarized in Table 2 of the CBA Accounting Summary (as per TBS guidelines) and shown in Figure 5.20.

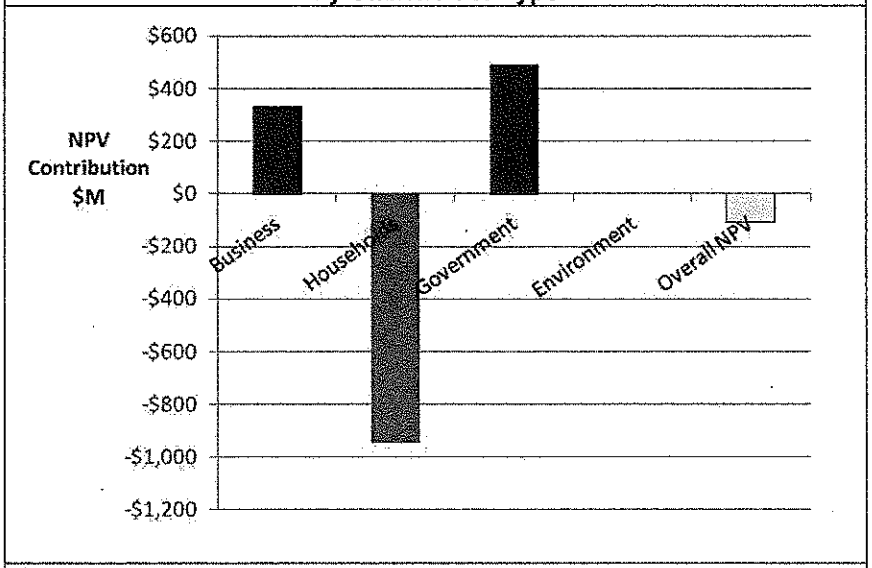
a) By Type of Stakeholder

Government, especially the Federal Government, is the main beneficiary of benefits resulting from the Policy scenario through the reduction in Health Canada – Program Administration Costs.

Households, especially MMAP users, are the main stakeholder group impacted in terms of reduced Consumer Surplus benefits.

Businesses, especially Medium-Sized Businesses, are also a main beneficiary of the Policy scenario in terms of Producer Surplus benefits. It is important to note that Producer Surplus is not related to profitability and should not be taken as an indicator of such.

Figure 5.20 Composition of Reference Scenario NPV By Stakeholder Type



Source: Delsys Research

CBA Accounting Statement (Table 2)
Stakeholder Impacts

Category of Impact	*NPV*	*Annualized NPV*	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 10*
Cumulative Net Impact	-109,723,604	-16,352,053	35,609,742	52,011,396	51,016,982	30,276,995	-129,389,915
1. Impact on Business							
Small Firms	7,622,719	1,136,010	2,368,944	5,674,077	0	0	0
Medium Firms	293,793,341	43,783,871	275,531	753,961	13,976,839	23,491,078	98,517,365
Large Firms	34,377,298	5,123,231	0	0	0	3,121,453	11,517,494
2. Impact on Households							
Participants in MMAP	-1,000,602,469	-149,119,274	12,002,322	13,110,613	-8,565,862	-58,585,004	-375,552,827
Non-Participants in MMAP	58,312,807	8,690,328	2,075,690	3,446,330	4,984,947	6,679,612	14,335,706
3. Impact on Government							
Federal Government	481,637,405	71,778,176	18,749,528	28,286,699	40,267,369	55,012,377	118,558,853
Other Government	11,081,795	1,651,514	137,728	739,715	353,689	557,479	3,233,494
4. Impact on Environment							
Not Relevant in Context	NA	NA	NA	NA	NA	NA	NA
5. Impact by Region							
Atlantic	-93,371,867	-13,915,162	2,222,267	3,051,185	970,316	-4,364,215	-38,001,962
Quebec	11,183,903	1,666,731	1,008,401	1,716,715	1,962,993	1,796,741	1,193,257
Ontario	199,063,164	29,666,281	24,567,758	35,888,291	41,784,033	41,018,600	6,015,633
Prairies / Territories	35,464,319	5,285,229	2,208,915	3,828,505	4,611,755	4,709,199	6,389,183
British Columbia	-260,950,029	-38,889,249	5,585,289	7,505,651	1,691,620	-12,821,928	-104,557,718

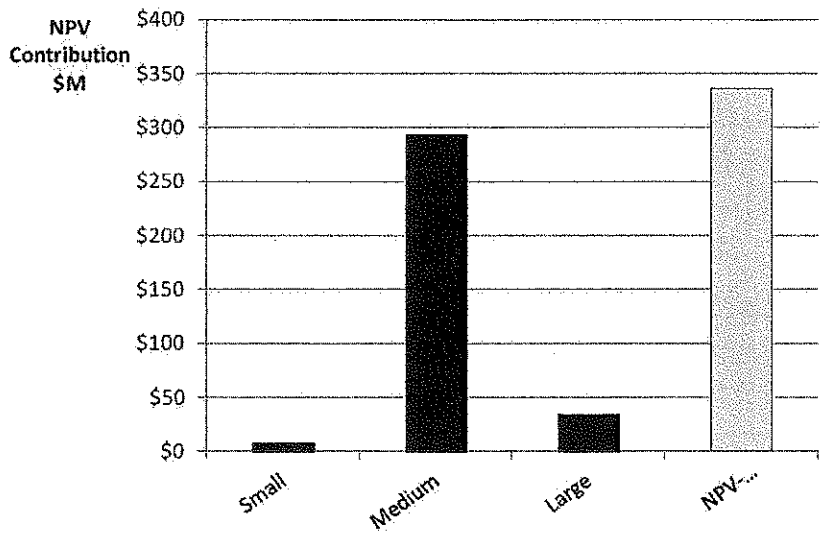
Source: Delsys Research – as per TBS (2007) p.43

b) By Size of Business

The Government's regulatory streamlining initiatives place considerable focus on the elimination of business compliance costs and administrative burden on business, especially on Small Business[33].

The distinction between results in terms of size of business requires careful interpretation. Basically, all new LP entrants start as Small Businesses and grow to become Medium Businesses during the forecast period. Therefore, there is no real result specific to Small Business, as this is a transitory impact in the first two years, which is then overwhelmed by gains achieved – by the same businesses – over the balance of the forecast period as Medium-sized Businesses. This is shown in Figure 5.21.

Figure 5.21 Composition of Reference Scenario NPV By Size of Business



Source: Delsys Research

[33] Small Business is defined as less than 100 employees and/or less than $5M in Sales Revenue. In the CBA model for this regulatory proposal, New Entrant LPs are all Small Businesses during the initial two years of their operation and grow to become Medium businesses after two years.

c) By Household Type

The CBA considered two types of households: a) those associated with a family member who accessed marihuana for medical purposes or with a family member who is a Designated Producer; and b) members of the general public. These are shown in Figure 5.22.

i. Households – Family Member Participating in the MMAP

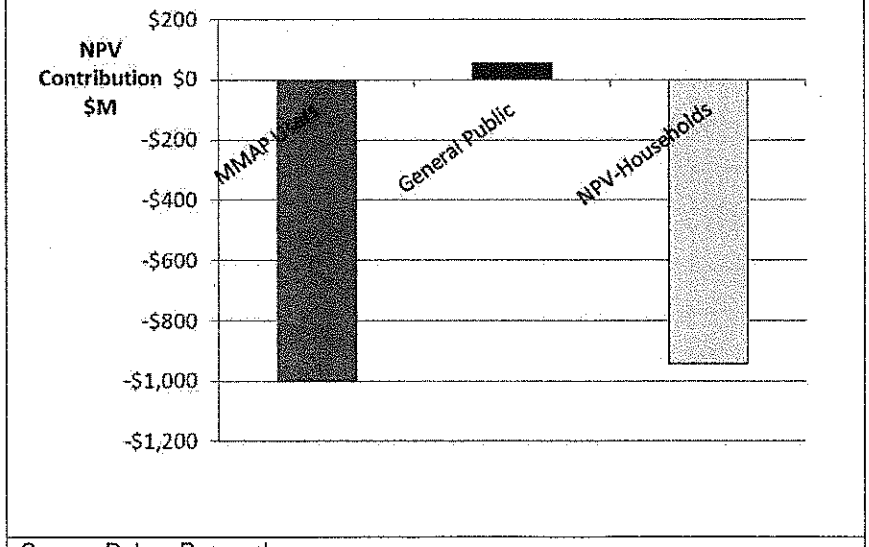
These households experience the loss of Consumer Surplus associated with more expensive marihuana and less quantity of marihuana consumed, the non-insured portion of fire property damage and the consequences of fire death and fire injury not attributed to firefighters, as well as the majority of home invasion consequences that are not attributed to the criminal justice system. Of these impacts, the monetary value associated with Consumer Surplus is the largest.

ii. Households – General Public

The General Public bears the Deadweight Loss associated with the market distortion arising from the effective subsidy or tax impact on legal marihuana supply, as well as the insured component of the property damage associated with fire events attributable to misuse of residential marihuana cultivation related to the MMAP.

It should be noted that, ultimately, the impacts on Governments (Federal and other) are also borne by these households as taxpayers. This value is not included, as Government is a separate Stakeholder in the analysis.

Figure 5.22 Composition of Reference Scenario NPV By Household Type



Source: Delsys Research

If attributed, the Government impact to the General Public would result in an increase to the NPV of almost $500M.

d) By Level of Government

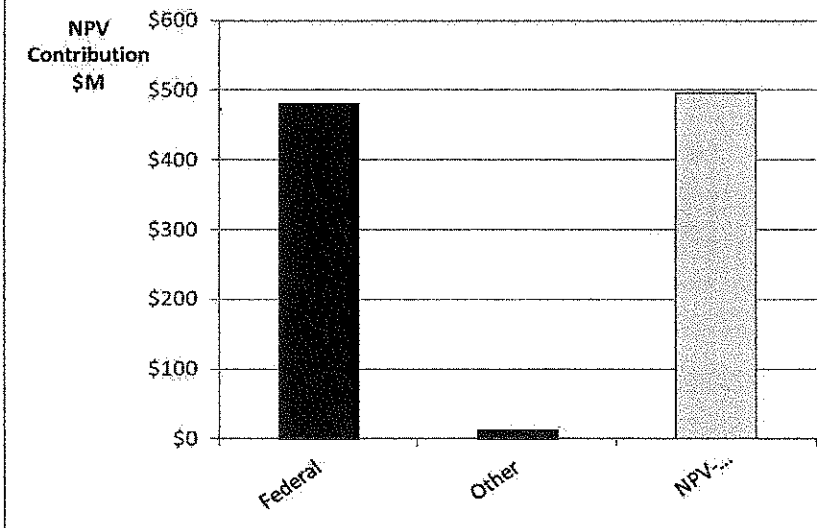
The Federal Government receives benefits from: a) the reduction in Health Canada – Program Administration Costs and b) a share of the costs of the criminal justice system as it pertains to Security social costs that are not borne by victims of Home Invasion crime.

Other Government receives benefits from: a) fire injuries sustained by firefighters associated with misuse of residential marihuana cultivation and b) a share of the costs of the criminal justice system as it pertains to security social costs that are not borne by victims of home invasion crime.

The bulk of Government benefits are related to the reduction in Program Administration cost and accrue to the Federal Government. This is shown in Figure 5.23.

It should be noted that, ultimately, the impacts on Governments (Federal and other) are also borne by the general public as taxpayers.

Figure 5.23 Composition of Reference Scenario NPV By Level of Government



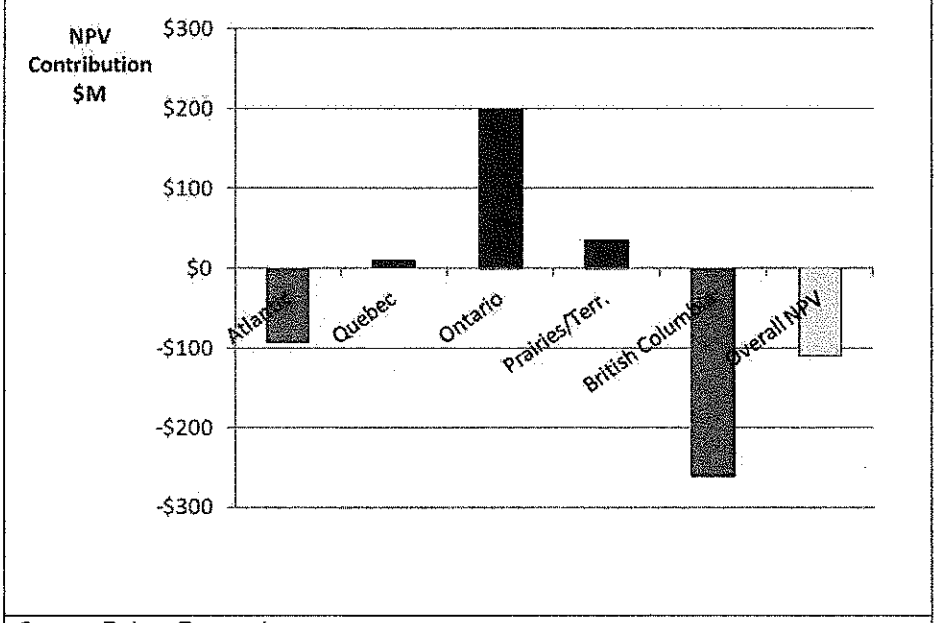
Source: Delsys Research

e) By Geographic Region

The CBA costs and benefits were allocated by geographic region of Canada according to known distributions of MMAP participation (which determines the bulk of the allocation) and an assumption about the expected locus of LP market production.

The large negative NPV attributable to British Columbia and the Atlantic[34] region result from their disproportionate share of MMAP participation in terms of persons authorized to possess marihuana for medical purposes. This is shown in Figure 5.24.

Figure 5.24 Composition of Reference Scenario NPV By Geographic Region



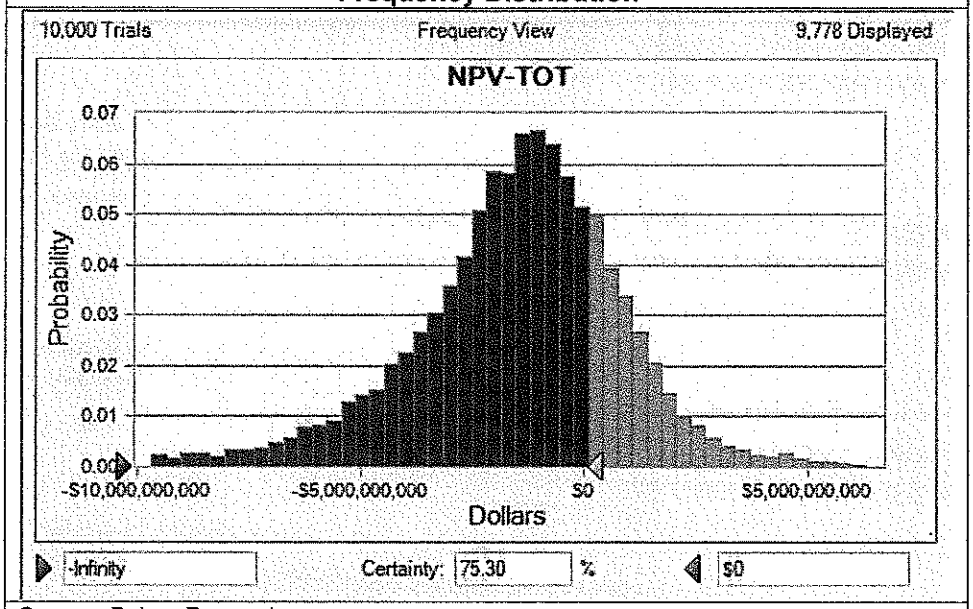
Source: Delsys Research

[34] The Atlantic region concentration of MMAP participation is largely driven by the high MMAP participation rates in Nova Scotia.

5.4 Sensitivity Analysis

The Monte Carlo simulation results, given the various assumptions and parameter distributions assumed in this model, are shown in Figure 5.25 and Table 5.7.

Figure 5.25 – NPV Result Distribution
Frequency Distribution



Source: Delsys Research

When the NPV distribution of results from the 10,000 Monte Carlo trials are examined, it is evident that the NPV central tendency is about -$1,690 Million with a range from -$26 Billion to +11 Billion. About one quarter of all sensitivity trials resulted in a positive NPV.

Table 5.7 – NPV Result Distribution
Summary Statistics

Forecast: NPV-TOT		Forecast: NPV-TOT	
Statistic	Forecast values	Percentile	Forecast values
Trials	10,000	0%	-$26,289,518,277
Mean	-$1,687,872,721	10%	-$4,860,448,101
Median	-$1,342,604,699	20%	-$3,346,114,210
Mode	'---	30%	-$2,481,262,361
Standard Deviation	$2,855,961,358	40%	-$1,880,177,393
Variance	8.157E+18	50%	-$1,342,809,145
Skewness	-1.4200	60%	-$859,519,865
Kurtosis	9.02	70%	-$329,264,841
Coeff. of Variability	-1.69	80%	$310,124,093
Minimum	-$26,289,518,277	90%	$1,160,314,066
Maximum	$10,010,797,264	100%	$10,010,797,264
MSE	$28,559,614		

Source: Delsys Research

Investigation of the trials for which there is a positive NPV showed that such trials were more likely to be associated with:

- lower Status Quo scenario supply prices (combined across the three supply markets), primarily lower Designated-Person supply price and Personal-Use supply price;

- relatively higher consumption in the Policy scenario as a result of more Grams Per Year and a lower proportion of cases (21% of trials with positive NPV) for which the affordability constraint was operative (compared to 61% of trials with negative NPV) and/or higher maximum percentage of mean annual income comprising that affordability constraint; and

- more inelastic demand in the Policy scenario (although more elastic than the Status Quo) which results in a higher Demand intercept and slope[35].

The first of these reduces the Consumer Surplus measure in the Status Quo scenario. The second and third increase the Consumer Surplus measure in the Policy scenario. In all of these cases, there is considerable variability in the range of parameters that can generate a positive NPV result. This study looked at the mean value of various parameters for trials for which the NPV result is positive and compared this to means values for trials for which the NPV result is negative.

5.4.1 Key Parameters

The sensitivity analysis, Figure 5.26, shows the most important assumptions that give rise to variability for the NPV-Total result. The most important assumptions, in terms of contribution to variance, are:

DP-Cost - the Supply Cost (reference case = $2.80/gram) for Designated Producer in the Status Quo scenario.

PC-INCOME - the Maximum % of Mean Annual Income (for Users) that the Annual Cost of Marihuana Supply can account for (reference case = 15%).

P-ELAS-SQ - the Price Elasticity of Demand (reference case = -0.25) for all users in the Status Quo scenario.

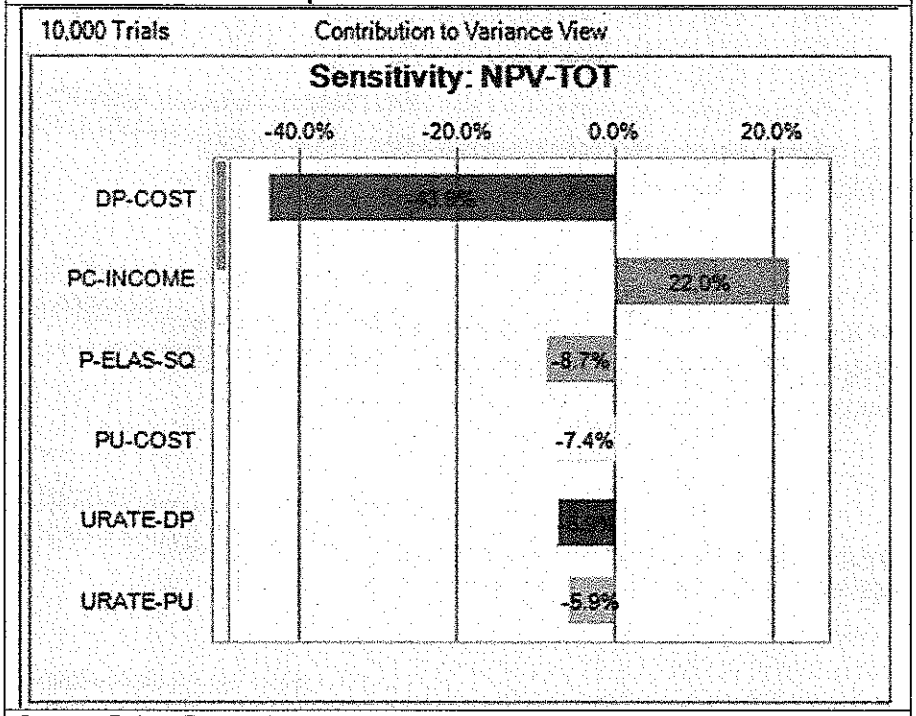
PU-Cost - the Supply Cost (reference case = $1.80/gram) for Personal Use in the Status Quo scenario.

URATE-DP - the Utilization Rate for Designated Persons in the Status Quo scenario, which is a ratio of the estimated actual usage relative to a theoretical maximum quantity based on the Proposed Daily Amount (9.0 grams) included in the ATP application by the user.

[35] More elastic demand in the Status Quo scenario leads (generally) to fewer legal users of Marihuana for Medical Purposes in the Policy scenario.

URATE-PU - the Utilization Rate for Personal Use in the Status Quo, which is a ratio of the estimated actual usage relative to a theoretical maximum quantity based on the Proposed Daily Amount (7.6 grams) included in the ATP application by the user.

Figure 5.26 – NPV-Total Sensitivity Assumption Contribution to Variance



Source: Delsys Research

Further assessment of the sensitivity analysis shows the rank correlation between each of these important assumptions and the NPV result:

DP-Cost	ρ = -.50 to NPV
PC-INCOME	ρ = .35 to NPV
P-ELAS-SQ	ρ = -.22 to NPV
PU Cost	ρ = -.21 to NPV
URATE-DP	ρ = -.20 to NPV
URATE-PU	ρ = -.18 to NPV

5.4.2 Response Functions for Key Parameters

It should be noted that this study examines the impact of a 'change of a change', i.e., as the NPV impact is a change (depending on the change of the variable value) of a change (i.e. Total NPV equals NPV-POL minus NPV-SQ).

There are several reasons why the model exhibits non-linearity in several response functions for key parameters:

1. There are two kinds of constraints: a) the 'affordability' condition of expenditures < 15% of median income; and b) quantity can't fall beyond zero (-100%) for a price elasticity response;

2. There are two avenues for quantity responses from: a) affordability limiting grams per day and b) misuse to reduce the required decrease in Policy users resulting from lower prices; and

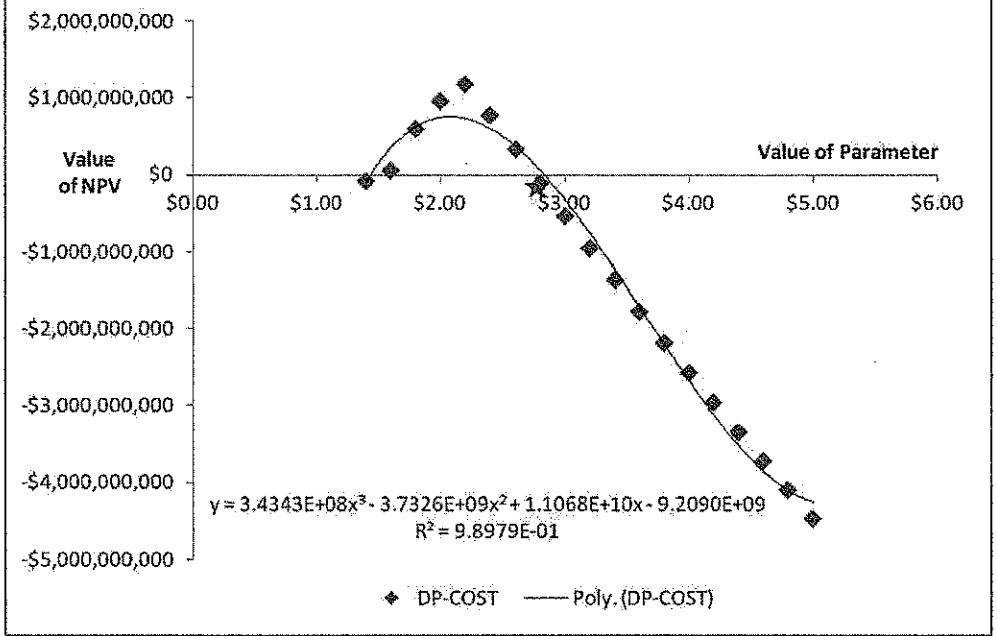
3. There are 'dual' (and opposite effect) uses of the price elasticity of demand to: a) compute the price intercept points which affects Consumer Surplus valuations; and b) affect the transition from the SQ to the Policy scenarios through the User Transition model.

These impacts can be either reinforcing or offsetting.

Designated Person Supply Cost:

The elasticity response to changes in the Designated-Person Supply Cost (DP-COST) is significant. A 1% increase (in the absolute value) of this variable from the Reference Case value of $2.80 (i.e., an increase of $0.028) reduces the NPV by *55%* (ε_v=-55.0). The Reference case sits on the negatively sloped portion of the response curve (Figure 5.27).

Figure 5.27 NPV Response Curve: DP-COST



Source: Delsys Research

For most of the response curve ($2.20 < DP_{cost}): there are two reinforcing effects:

a) Status Quo scenario: The value of CS-SQ rises with a higher DP_{cost} as a result of a higher price intercept of the Status Quo demand curve, which increases the valuation of consumer surplus in the Status Quo scenario; and

b) Policy scenario: The value of CS-POL falls. This effect is caused (at this price level) by the fact that, in the Transition Model, there is no change in the Policy scenario quantity response (as this is dominated by the binding affordability (percentage of income) constraint, which forces the quantity to fall by more than what is required to satisfy the price elasticity effect) while the percentage price change has fallen. This implies that the ELAS-POL is more elastic, so that the price intercept of the Policy demand curve is reduced, which reduces the valuation of consumer surplus in the Policy scenario.

At the middle and high end of the price range, there is no reduction of users in the Policy scenario beyond that from continued misuse, so the overall *negative* NPV impact (from a DP_{cost} increase) comes from the increase in CS-SQ.

At the low end of the price range, the increase in price requires a quantity reduction that can't be accommodated by the continued misuse, and must be achieved from a reduction in Policy users (transitioning from ATP-D). However, a DP_{cost} increase requires a lesser quantity reduction and therefore results in an increase in the number of Policy users. The CS-POL impact is greater than the CS-SQ impact so there is a *positive* NPV impact.

Affordability Constraint (Maximum Percent of Mean Income):

The elasticity response to changes in the Maximum Percentage of Income (PC-INCOME) gets at the issue of 'affordability' and how consumers' budget constraints impact on the quantity consumed and the overall value of the resulting consumer surplus in the Policy scenario. A 1% increase of this variable from the Reference Case value of 15% (i.e. an increase of .15 percentage points) increases the NPV by *42%* (ε_v=42.0).

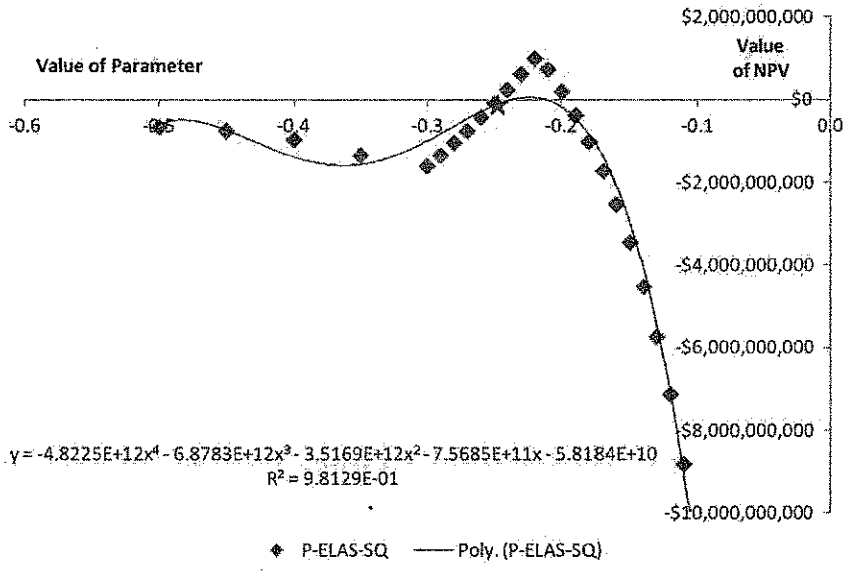
This constraint means that the Grams per Year (and Per Day) will be reduced if the Supply Price increases. In the Policy Transition Model this determines the number of persons who will switch and the level of demand they will exercise in the LP Market.

When the PC-INCOME is lower, this constrains the KG-Demand in the Policy scenario which, despite an increase in the number of Policy Users, reduces the scale of the LP Market and the Consumer Surplus that is generated in the Policy scenario.

Price Elasticity of Demand:

The elasticity response to changes in the Price Elasticity of Demand (P-ELAS-SQ) is significant. A 1% increase (in the absolute value) of this variable from the Reference Case value of -0.25 (i.e. an 'increase' of -.0025, which makes the price elasticity of demand more elastic) reduces the NPV by 23% (ε_v=-23.0). The Reference case sits on a relatively flat position of the response curve (Figure 5.28), where the slope of the response curve is negative.

Figure 5.28 NPV Response Curve: P-ELAS-SQ



Source: Delsys Research

At low (absolute value) levels (-.22 < ε < -.10): The high valuation of CS-SQ overwhelms all other results and generates a high negative NPV, as the inelastic demand generates very high price intercept points for the demand curve in the Status Quo scenario. The same does not occur for the Policy scenario, as the effective price elasticity is more elastic due to the dampening of the pure price elasticity effect caused by the 'opting out' of persons from the former ATP-P/PUPL, due to misuse. This has the effect of making the Reference case ELAS-POL more elastic (-.35 versus -.25 for P-ELAS-SQ), so that the response in terms of the Policy scenario is muted, relative to the response for the Status Quo scenario. Over this range of values, everything is happening in terms of lower CS-SQ with only minor changes to the number of persons in the Policy scenario - but with no change over this range in the *valuation* of the CS-POL, as the effective ELAS-POL remains the same (-.31).

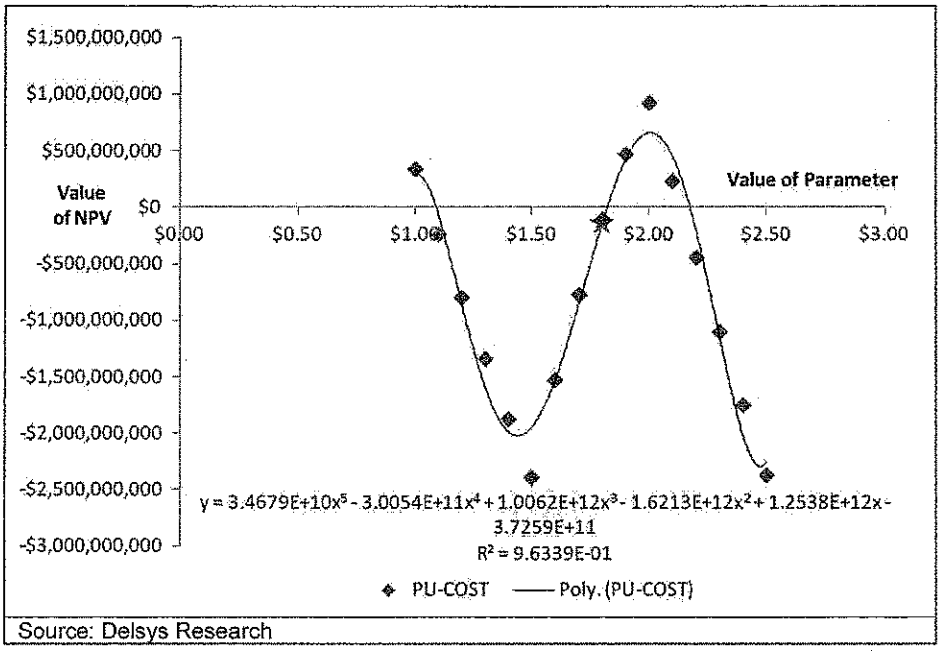
At mid levels (-.32 < ε < -.22): The CS-SQ and CS-POL both fall as the effective price elasticity of demand in the Policy scenario begins to respond to the higher price elasticity in the Status Quo scenario. Over this range of values, the fall in CS-POL is faster than the fall in CS-SQ so that the NPV falls over this range. The Reference case is in this section of the response curve.

At high levels (-.50 < ε < -.32): The fall in CS-POL is slower than the fall in CS-SQ so that the NPV rises over this range.

Personal Use Supply Cost:

The elasticity response to changes in the Designated Person Supply Cost (PU-COST) is significant. A 1% increase (in the absolute value) of this variable from the Reference Case value of $1.80 (i.e., an increase of $0.018) reduces the NPV by *98%* (ε_v=-98.0). The Reference case sits on the positively sloped portion of the response curve (Figure 5.29).

Figure 5.29 NPV Response Curve: PU-COST



Source: Delsys Research

There are three distinct cases of response over the range of PU-CCOST.

1. *High Values* ($2.00 < PU_{cost}): As PU_{cost} increases there is a gain in CS-SQ, resulting from the higher supply cost and price intercept term in the Status Quo scenario; and a reduction in the price intercept term which leads to a fall in CS-POL, which reinforce the overall effect of a decline in the NPV result.

2. *Mid Values* ($1.40 < PU_{cost} < $2.00): As PU_{cost} increases there is a gain in CS-SQ resulting from the higher supply cost and price intercept term in the Status Quo scenario; and a gain in the number of users in the Policy scenario and an increase in the price intercept term which leads to a rise in CS-POL. The change in CS-POL increases at a faster rate than the change in CS-SQ so there is an overall positive slope to the response curve (i.e. the change in CS-POL dominates over the change in CS-SQ).

3. *Low Values* (PU_{cost} < $1.40): As PU_{cost} increases in this range, the increase in CS-SQ is reinforced by a decline in CS-POL which leads to the overall decline in the NPV result.

As PU_{cost} increases (at the low end of the range and at the high end of the range) there are reinforcing impacts:

- an increase in CS-SQ and a reduction in CS-POL which produce the overall negative NPV effect.

As PU_{cost} increases (over the mid range from about $1.50 to $2.00) there are offsetting impacts:

- an increase in CS-SQ and an increase in CS-POL, with the CS-POL effect dominating which produce the overall *positive* NPV effect.

It remains to explain why the mid range has different results – which is determined by the change (or lack of change) of the number of Policy scenario users at the high and low ends of the range.

At the high end of the price range, the reduction in quantity resulting from the binding affordability constraint is more than sufficient to achieve the desired price elasticity effect so that there is no loss of users in the Policy scenario beyond that from continued misuse.

At the middle of the price range, there is a need for the number of Policy users to decrease substantially to achieve the desired price elasticity effect. However, as PU_{cost} increases the required change in users is reduced so the impact on Policy users is decreased and this results in the gain in CS-POL.

At the low end of the price range, the reduction in quantity reaches its limit of -100% as Policy users (transitioning from ATP-P) fall to zero. At this extreme point there is no further loss in CS-POL and the reduction in CS-POL comes from the reduced price intercept.

URATE-PU/URATE-DP:

These parameters affect the quantity of marihuana that is estimated to be consumed in the Status Quo scenario. When these values are higher, the quantity of marihuana consumed is higher and the estimated Consumer Surplus (Status Quo) is higher. As the Consumer Surplus (Status Quo) is higher, and there is little impact of these parameters on the Policy scenario, they have a negative impact on the NPV result.

A 1% increase of the URATE-DP from the Reference Case value of 47% (i.e., an increase of .47 percentage points) decreases the NPV by *37%* (ε_v=-37.0).

A 1% increase of the URATE-PU from the Reference Case value of 55% (i.e., an increase of .55 percentage points) decreases the NPV by *13%* (ε_v=-13.0).

5.4.3 Discussion – Sensitivity Results

The most important finding of the sensitivity analysis is the considerable variation in possible NPV results from realistic parameter values and the complex interactions that are captured in the model.

This variability does not diminish the sense that the Reference case is the single *most likely* result.

The variability does reflect inherent uncertainty of the impacts of the proposed regulatory change. There are several key aspects of this variability, which is another way of reflecting regulatory risk:

1. Rapid Growth of the MMAP;
2. Fundamental Change;
3. Complex Dynamic Behaviour;

4. Establishment of a New Market; and

5. Unknown Outcome.

1. Rapid Growth of the MMAP

The MMAP has grown exponentially at an average annual rate of 40% for more than eight years. While it is believed there is a ceiling (upper limit) to further growth, it is expected that this will not be reached until the end of the forecast period. As a result of this inherent growth, the values involved (e.g., users, KG consumed, Administration Costs, safety and security events) are expected to change substantially. Any time that there are such large growth factors, there is an inherent risk regarding forecast accuracy and confidence levels over the forecast period.

One important qualitative impact, which the literature on drug crime prevention (which forms part of the policy rationale for MMAR Regulatory change) has identified, is that such crime prevention has a higher probability of success when the market is relatively small and emerging. While the illicit marihuana market is mature, the levels of MMAR misuse of residential home cultivation of marihuana are quite small (in FY2012) compared to the levels that are expected to arise by the end of the forecast period (FY2023-24). This suggests the need for reform of the regulatory regime before the scale of legal residential marihuana cultivation grows further. It will be much harder (and possibly less successful) to reduce this activity (once declared illegal as a result of the elimination of PUPLs/DPPLs) if the policy change were delayed for five or ten years.

2. Fundamental Change

Regulatory change modelling is much easier and more certain when reform is incremental in nature. The proposed regulatory change for access to marihuana for medical purposes is more fundamental, especially the elimination of PUPLs/DPPLs which comprise 80% of user supply, in terms of persons, and the bulk (perhaps 97%) of legal KG supply.

It is unreasonable to believe that all residential marihuana cultivation that would have occurred under MMAR (and misuse) will cease as a result of its prohibition. This study has thus modelled a behavioural response that depends on the probability of conviction and builds in an effect which reflects the current inhibition that law enforcement authorities have stated exists with respect to their ability to take investigative police action once a problem resident (association with a MMAR production license) is identified. Once that inhibition is removed (a process of increasing clarity by eliminating the additional evidence required to obtain reasonable and probable grounds to investigate potential misuse), it is anticipated that there will be a *deterrence effect* on misuse associated with residential marihuana cultivation.

This study also anticipates that the effective supply price for legal marihuana will increase as LP Market supply will be more expensive than PUPL/DPPL supply. It is expected that there will be a price elasticity effect that will consequently reduce the quantity of legal marihuana consumed in the Policy scenario LP Market relative to what would have been consumed in the Status Quo. This is the *price effect*.

Both the *deterrence* and *price* effects involve fundamental and large regulatory changes whose outcomes on behavioural change are inherently difficult to predict.

3. Complex Dynamic Behaviour

Human behaviour, in terms of criminal activity, crime prevention, market entrance and market demand), involves complex interactions and options. For the purposes of modelling the regulatory impact, this study assumed a degree of individual rationality and predictability of human behaviour in response to incentives (rewards and penalties).

That production activities which are legal under the current MMAR will, under the proposed regulatory change, become illegal, raises an issue of regulatory compliance. Access to marihuana for medical purposes remains a debated subject of public policy[36]. By some Canadian public opinion evidence, Canadians appear divided on issues regarding the criminality (and morality) of marihuana use. This divided public opinion, and the sense that many Canadians may believe they have a *right* to access marihuana[37], means that the degree of compliance with the proposed regulatory change is uncertain.

4. Establishment of New Market

Most regulatory analysis deals with legal activities for which there is some history and experience in terms of market outcome. In the case of marihuana for medical purposes, the current MMAR regime has three distinct markets, of which only one (the Designated-Person supply market) might reflect a competitive market outcome. However, the market outcome in this case is not observed by Health Canada (as the regulator of participation in the MMAP).

The elimination of PUPLs/DPPLs and the termination of the contract governing the Government Supply market will bring about the establishment of a new LP Market.

This CBA study has attempted to estimate and anticipate likely demand and supply parameters for this market. However, the most important fact is that the LP Market does not exist today and will not be in operation until FY2014-15. This is an inherent source of uncertainty.

Market dynamics, in terms of *entry* of new LP suppliers, the growth of the existing *incumbent* (i.e., Contract Government Supply provider), the response of users to higher prices, and the elimination of legal residential marihuana cultivation, are complex and uncertain.

There is a high degree of financial/business risk that LP Market suppliers will face in the establishment of this new market. There is supply risk an under-supply or over-supply of the initial market in terms of the productive capacity relative to the revealed demand.

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[36] Not to mention the broader policy of marihuana decriminalization, which is outside the scope of the proposed regulatory change and this CBA.

[37] Canadian court decisions, which underpin the MMAR regulatory regime, appear to recognize a right to access a legal supply of marihuana for medical purposes.

5. Unknown Outcome

All of the above factors suggest that the analysis cannot project with any certainty, what the initial post-transition (i.e., phasing out of MMAR authorizations and production licenses) market outcomes will be, nor what these market outcomes will be in FY2023-24.

The broad variability of NPV outcomes, as reflected in the NPV Result distribution, is a simple quantified reflection of the underlying uncertainty and risks inherent in the proposed regulatory change.

5.5 Qualitative Discussion

5.5.0 Reference Case Qualitative Impacts

The Reference case generates a negative Net Present Value result and is based on reasonable assumptions that are inherently uncertain. Note that certain factors (i.e., impacts, behavioural responses) have been excluded from the quantitative CBA as there is insufficient information on which to assess the factor. As such, the quantitative analysis does not tell the full story of the overall impact of the proposed regulations. There are costs and benefits – possibly significant in size – that could not be quantified but which are relevant for public policy purposes.

The following subsections examine the qualitative impacts that are applicable across all of the scenarios considered under the probabilistic analysis, and discuss some core issues and trends which are likely to result from the proposed changes to the regulation (and creation of the new industry). Before these issues are examined in depth, however, it bears examination which qualitative impacts will (or will not) be evident under the Reference case.

Perhaps the most notable impact of the Reference case, and of the program in general, is the introduction of a legal marihuana production and distribution industry (for the use of marihuana for medical purposes) into the Canadian economy. The proposed marihuana access program will create hundreds of new jobs across Canada within the projected ten-year period. As private businesses, the licensed producers/distributors will be subject to scrutiny and attention from the public as well as the media. This process may inhibit marihuana production that operates outside the bounds of the law (i.e., at least as it pertains to marihuana use for medical purposes) and raises questions as to the product safety of using illicitly-obtained marihuana. Just as bootleg whiskey is considered to be more dangerous and more variable in quality in relation to a quality-controlled product available from a regulated industry, so too could a legal regulated marihuana industry make the illicit product less attractive over time.

Under the Reference case, a reduction in the misuse and abuse of marihuana for medical purposes is anticipated. However, not all criminal activity will cease. The proposed regulations provide certain safeguards against illicit diversion from licensed producers: a) the requirements and background checks prescribed by the new regulations are significant; and b) the significantly lower number of entities subject to regulation, enforcement and monitoring by Health Canada should allow for more effective management and greater compliance over time.

The quantitative CBA includes calculations as to the impact of ending personal and designated person production, both of which involve fire hazards, crime risk and concern as to the evidentiary requirements in investigating potential misuse. From a qualitative perspective, this is one of the most noticeable impacts of the new policy structure. Whereas law enforcement

authorities previously encountered difficulty in determining which residences where marihuana was being produced were operating outside the law, the proposed regulations provide certainty that any residence conducting marihuana cultivation will be strictly outside the law and subject to enforcement. This regulatory simplification should increase the effectiveness of law enforcement efforts and result in improvements in compliance dynamics.

The Reference case assumes that the new industry will ramp up and become competitive quickly. While the first six months of the transitional period will be challenging for most new LPs, the already significant and growing demand for product will justify additional investment and short-term staffing/production to smooth over the difficult start-up phase that is likely to be experienced by many new licensed producers.

Once LPs are up and running, additional qualitative factors may come into effect. The regulations specifically will not allow the advertisement of marihuana to the general public .However, the marihuana for medical purposes client base tends to be socially connected and capable of using social networks to quickly spread information informally. While LPs will not be able to advertise their products in a conventional sense there is likely to be a strong incentive for legal marihuana users to share information (e.g., with respect to pricing, delivery, customer service, personal perceptions of the impact of usage, etc.) among themselves, and support the creation of brand identities – even without LPs having the legal ability to manage this process overtly.

This informal branding/advertising structure may have two impacts: a) it will raise awareness of the new system and LP industry; and b) it will provide a means for the regulator and for LPs to conduct market research on consumer attitudes, word-of-mouth response with respect to all products and LPs in the market.

The first effect is akin to restaurant reviews using social networking which will increase the power of the word-of-mouth dynamic for branding and product differentiation.

The second impact is akin to an early warning system and provides customer informal feedback and customer preference indicators with respect to product/service characteristics (e.g. price responsiveness, product perception, service experiences, customer problems) which provides the opportunity for product/service adaptation and improvement.

The Reference case projects the continued growth of marihuana for medical purposes usage in Canada and assumes that medical professionals will continue to expand their support of patient access. The Reference case projects that the average cost of a gram of marihuana will increase under the new regime over the average supply price under the existing MMAR regime, largely due to the elimination of lower cost personal-use and designated-person production. From a qualitative perspective, there are two price-response factors that can be identified: a) the legal supply price (for marihuana for medical purposes) is expected to remain below the illicit street price for marihuana (for retail quantities); and b) market dynamic forces may lead to product improvement over time from R&D and, potentially, investment in science to meet the Health Canada requirement for authorization as a therapeutic drug.

The expected LP price will likely be less than that of the illicit market. Persons wanting to access marihuana for medical purposes are therefore, it is suggested, unlikely to want to access their product from the illicit street supply. It is anticipated that the market demand for marihuana for medical purposes usage is driven by a perception that this is an effective means of treating certain health conditions. An increase in the 'legal supply' price (i.e., the price for the legal LP

market is expected to be above that for the legal MMAR supply markets) may result in users (and potential future users) considering alternative treatment options and/or in using less of the legal marihuana product. Assuming that the projected increase in the Status Quo for use of marihuana for medical purposes is fully reflective of legitimate health conditions, there will be no diminution of the underlying demand for idiosyncratic pain relief or other perceived benefits to individuals.

The complex relationships and interactions between price, access, quality and demand in the Status Quo scenario, Policy scenario and (implicitly) in the illegal market, are captured to a large degree in the Reference case of the CBA where a large and growing number of users remain "willing to pay" for marihuana for medical purposes from LPs in the Policy scenario despite the higher price compared with the Status Quo scenario.

It is anticipated that LPs may have an incentive to invest in R&D and scientific study of the use of marihuana products/delivery methods as recognized medical therapy. This will especially be the case if profitability is high and market growth remains strong. The potential for strong profitability (given regulatory and commercial entry requirements) can spur innovation, which has not been factored into the CBA results.

These are some of the key qualitative impacts of the Reference case pertaining to market dynamics. The following subsections examine other potential impacts.

5.5.1 Safety and Security

A major objective of the regulatory proposal is to enhance public and personal safety and security, respect for the Canadian legal system and the effectiveness of law enforcement against illicit marihuana cultivation in Canadian residential communities. The benefits of achieving this objective are captured to a large degree in the quantified CBA through the variable addressing the increased clarity for law enforcement in investigating potential misuse, which, in the Status Quo scenario, reduces the probability of police action that would be directed at MMAR misuse involving PUPL/DPPL residential marihuana cultivation.

This variable is used to compare the safety impacts of the current MMAR Status Quo scenario with the safety impacts of the Policy scenario, from the perspective of the risks and consequences of residential fires resulting from faulty electrical wiring, overloading of electrical circuits, tampering with electrical usage monitoring and other electrical system malfunction arising from indoor marihuana cultivation.

The literature review, stakeholder consultations and other sources indicate some additional benefits regarding public and personal safety and security and respect for the Canadian legal and system. These additional benefits are more difficult to quantify and monetize because of the absence of data relevant to the Canadian context. For example, additional improvements in health, quality of life, and the environment will result from the reduced presence and health/safety risks of mould, chemical contamination and problems that are associated with production of marihuana in small, enclosed spaces in private residences.

Improvements in the quality of life and the physical environment are likely to lead to higher residential and other property values. It may also lead to lower home insurance costs for households and businesses in the communities which experience a decrease in the legal production and misuse of personal use and designated production now taking place under the

MMAR regime (that, in the Status Quo scenario, are expected to expand significantly through the horizon period to 2024-25). The improvement in law enforcement clarity and effectiveness of police resources could allow for better law enforcement outcomes and greater deterrence effect from drug crime policing. Such a qualitative impact was not captured in the CBA monetized results.

5.5.2 Reduced Information, Administration and Related Transaction Costs

The regulatory proposal is designed to reduce the information, administration, and related transaction costs of enrolment and 'gatekeeping' of individual access to a legal supply of marihuana for medical purposes. Compared with the Status Quo scenario, the regulatory proposal (Policy scenario) involves less costly administrative requirements for users/patients and physicians to access a legal supply of marihuana for medical purposes. While the administrative burden facing Health Canada has been reflected in the CBA results these patient/health professional benefits have not been included. The time and effort savings under the Policy scenario from a shorter form, reduced processing steps (e.g., no application to Health Canada, no requirement for medical specialist consult) are difficult to quantify but are recognized to be real and tangible.

It is possible that less costly and more timely access could result in greater use uptake than has been forecast and reflected in the CBA results. In particular, removing the government from the physician-patient interaction, eliminating the categories of conditions or symptoms for which an individual may possess marihuana for medical purposes under the MMAR, removing the requirement for some individuals to consult with and obtain permission from a specialist, and simplifying the form to be filled out by the doctor should:

(i) reduce the information and transactions costs and related delays and risks of both physicians and their patients, and

(ii) make the interaction quite similar to doctor/patient discussions on other drug and medical therapies.

Physicians and patients that may have been discouraged from participation in the access program in the Status Quo scenario could have some of these impediments overcome by the proposed regulatory changes. This could expand market demand and result in additional incremental benefits of the Policy scenario.

Information was provided through stakeholder consultations with Health Canada regarding administrative and other cost savings, including for certain municipal government functions. The Policy scenario could lead to lower costs and/or greater effectiveness of municipal law enforcement, fire protection and related services (e.g. by law enforcement) as a consequence of reduced fire risk and reduced misuse associated with residential marihuana production.

5.5.3 Establishment of a Competitive and Innovative Industry

The regulatory proposal will eliminate personal-use and designated-person production (and the current government contracted supply) of legal marihuana. It is anticipated that the legal regulated LP market will grow to be reasonably large (e.g., sales >$1 Billion per year), competitive (perhaps ~50 suppliers) and profitable – which over time has the potential to lead to

innovation. The LP market has the incentives, resources, ability and competitive pressures to undertake (over time) investment in R&D and product, process and organizational innovations that could result in the following[38]:

(i) Economies of scale and scope, accumulated learning, and related internal and external efficiencies;

(ii) Higher yields; lower production, overhead, handling, shipping and other costs; and higher quality products, better strains and greater product variety that better meet the diverse needs of their customers (i.e., some of these dynamics could lead, over time, to reduced product prices [Hazekamp (2006, 2007)];

(iii) User social-networking that will result in shared information and learning between LPs, Health Canada and other government agencies that may lead, over time, to lower compliance, administration and related regulatory costs that will achieve desired regulatory objectives; and

(iv) Industry research and public research to expand the scientific knowledge base regarding the medical efficacy and toxicity of marihuana products and ingestion methods as potentially approved therapies

5.5.4 Potential Benefits and Risks of Reverse Diversion from the Illicit Marijuana Industry and Other Legal and Illegal Substances to the Marihuana for Medical Purposes Industry under the Policy Scenario

An extensive body of literature on cannabis/marihuana use suggests the possibility of an unintended consequence of a legal marihuana supply. Over time, a legal regulated market could be characterized by: monopolistic competition based on product differentiation and lesser price elasticity; and a product substitute for persons seeking alternative methods for alleviating pain and other condition symptoms.

Furthermore, the existence of legal marihuana supply at a price below the illicit street price raises the potential for what may be referred to as "reverse diversion." This term refers to the desire to substitute illicit marihuana supply with less expensive legal marihuana supply for reasons other than medical purposes. The potential demand for access to a legal supply of marihuana may be greater than projected in the CBA[39].

The literature review and stakeholder consultation process both indicated that "reverse diversion" could lead to net incremental benefits. Lower quality-adjusted prices are possible, over time, under dynamic market behaviours. These could generate greater consumer surplus for each user (i.e., infra-marginal gain) as well as greater consumer surplus from induced users (i.e., extra-marginal gain).

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[38] The diagram Annex I section 5 uses comparative statics analysis to illustrate how user demand and consumer surplus could increase in the future through the combined effects of these dynamic factors. The potential for greater consumer surplus, higher producer surplus, and other economic and societal benefits from the dynamic industry and market changes associated with the Policy scenario over the longer term is the consequence of a number of the pro-competition and pro-innovation features of the Policy scenario compared with the Status Quo scenario.

[39] It is also possible that the rapid expansion of the existing MMAP (and its projected future growth in the Status Quo scenario) is also a result of similar desire to access marihuana for other than medical purposes.

The literature suggests that, over the long term, growth in market size, market competitiveness and market innovation capabilities (aided by "reverse diversion" and other processes) could result in decreased abuse of alcohol, marihuana, hard drugs and certain prescription drugs for relieving pain that are reportedly causing problems. As a consequence, additional user and societal benefits could result from the reduction in the addiction, abuse, crime, health, and other problems and government and social costs that are currently associated with alcohol, hard drugs and certain prescription drugs [Payne (2012) and Kilmer et al (2010)].

The process of "reverse diversion" is not without certain costs and risks, however. The illicit drug market has a reputation for responding flexibly, aggressively, and (sometimes) effectively to various market, legal and other risks that threaten its customer base, revenues and profits. Producers, importers and dealers in the illicit market may respond with violence, intimidation, sabotage, theft and other criminal acts when faced with the risk of losing customers to the legal supply market for marihuana for medical purposes. They could also engage in standard economic responses such as predatory pricing, non-price predation and other anti-competitive conduct directed at participants in the legal market and industry [Becker et al (2006) and Rhodes et al (2000)].

The potential for "reverse diversion" is a risk to the undermining of public confidence in the proposed regulatory regime. The public might perceive rapid growth based (in part) on reverse diversion as an abuse of the proposed regulatory regime that was intended to be restricted to persons seeking alleviation of medical conditions under physician or other health care practitioner supervision.

5.5.5 Concluding Comment on Qualitative Benefits, Costs and Risks

The current Status Quo scenario under the MMAR is based on lower-cost household production and a government subsidy for access to the legal contracted Government Supply. Major attributes of the Status Quo scenario are: relatively low production costs (for PUPL/DPPL users), relatively low regulatory costs for each individual participant and designated producer with negligible handling and shipping costs, e.g., likely in the same community.

In contrast, the proposed regulatory regime involves licensed production in comparatively fewer locations, whereby registered clients will absorb all production costs (including fixed and variable costs), regulatory costs, the handling and shipping costs for small quantities of marihuana that would be shipped separately to each consumer, as well as the costs of GST/HST and other business taxes and fees.

It is not surprising that the replacement of residentially-grown, local and/or subsidized production with low regulatory costs under the MMAR, with regulated and quality-controlled commercial production from a comparatively few locations under the proposed regulatory regime, results in a negative net benefit stream for the quantitative CBA.

Under these circumstances, the quantified CBA results should not be taken as primary evidence against the regulatory proposal but as an indication that the government is faced with a policy decision in which certain factors can be subject to monetization of their benefits and costs, and other factors cannot. These qualitative impacts of the regulatory proposal could be important in relation to the quantitative benefits assessed in the CBA results.

5.5.6 Limitation of Cost-Benefit Analysis

This CBA is intended to quantify the most likely Reference case Net Present Value result, as well as a sensitivity analysis of the NPV Result distribution. The associated qualitative analysis adds further context to the quantitative CBA results.

It is widely known that Government policy decision-making often is based on factors, judgments and priorities that are unlikely to be reflected in a CBA study. Practitioners of CBA are aware of this reality and have been guided to recognize the limitations of their tools, data and analysis.

This CBA study is a fair and reasonable reflection of quantitative and qualitative measures to evaluate the proposed regulatory changes to access to marihuana for medical purposes. It is offered in full accordance with Treasury Board Secretariat Guidelines for Cost-Benefit Analysis.

The order of magnitude of the quantitative CBA results are accurate and reasonably account for the most important aspects of the policy rationale related to MMAR regulatory change. These CBA results may not, however, reflect the weight, priority and valuation of factors that resulted in the Government decision to introduce the proposed MMAR regulatory change. The CBA results are one form of regulatory analysis, among others, that have been undertaken in accordance with the Federal Government regulatory impact assessment requirements.

CHAPTER SIX

6. Conclusions

The monetized CBA results, in terms of Discounted Net Present Value, show that the expected benefits and costs of the proposed Regulatory change fall onto different stakeholders in varying degrees of impact.

There is no clearly Pareto superior result that supports a statement that one scenario (i.e., Status Quo or Policy) is superior to the other. The fact that the Reference case NPV is negative (-$109 Million) indicates that the sum of benefit and cost changes across all stakeholders is negative. The sensitivity analysis of the NPV result clearly shows a wide range of possible outcomes with a central tendency that is not statistically different from zero.

The analysis of the Reference case by stakeholder group shows that one class of stakeholder bears a cost in terms of NPV impact - namely the users of marihuana for medical purposes - while the remaining stakeholders (e.g., the general public, government, commercial producers) are made better off. This is a classic result that demonstrates there is no Pareto superior outcome and that economic analysis methods (such as Cost-Benefit Analysis) cannot, unequivocally, state that one option is better than the other. In such cases it is traditional to rely on priority judgements by policy makers to indicate which option is superior in terms of social welfare.

The CBA results are qualified, in terms of the NPV measure, by highlighting some of the many methodological difficulties that were faced in the study. These include:

a) rapid program uptake and continued growth;

b) the fundamental nature of the regulatory change;

c) the complex dynamic behavioural changes that could occur as a result of the elimination of residential marihuana cultivation and its replacement by higher cost commercial supply;

d) the uncertainty surrounding the establishment of a new industry and market; and

e) the inherently unknown final outcome of the regulatory change after ten years.

It is important to bear in mind that while, from an economic perspective, user benefit is measured from the consumption of legal marihuana for medical purposes in terms of consumer surplus, the available scientific evidence does not support the authorization of marihuana use for therapeutic purposes under the *Food and Drugs Act and Regulations*. Canadian courts have ruled that individuals have a legal right to possess marihuana for medical purposes and that the Government of Canada has an obligation to provide reasonable access to a legal supply of marihuana for such medical purposes.

The consumer surplus measure of user benefit does not purport to show, and should not be taken as evidence, that there is any quantifiable medical benefit attributed to the consumption of marihuana for medical purposes.

Policy makers, apparently, have attributed much more weight to the negative impacts on social welfare that have been shown to arise from higher safety and security risks attributable to residential marihuana cultivation, and to the much higher program administration costs that would fall on Health Canada if the Status Quo were maintained and significant future growth in MMAP participation were to be accommodated. These have been monetized and quantified as best as possible and they are significant in number and value. While the Reference case does not show these to outweigh the loss of consumer surplus, it may be that the application of a social valuation to these impacts (from an economic perspective) may not adequately reflect a social valuation of the maintenance of public safety and security.

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ANNEX 1 – Consumer & Producer Surplus with Subsidy

1. Consumer & Producer Surplus – Impact of Subsidy

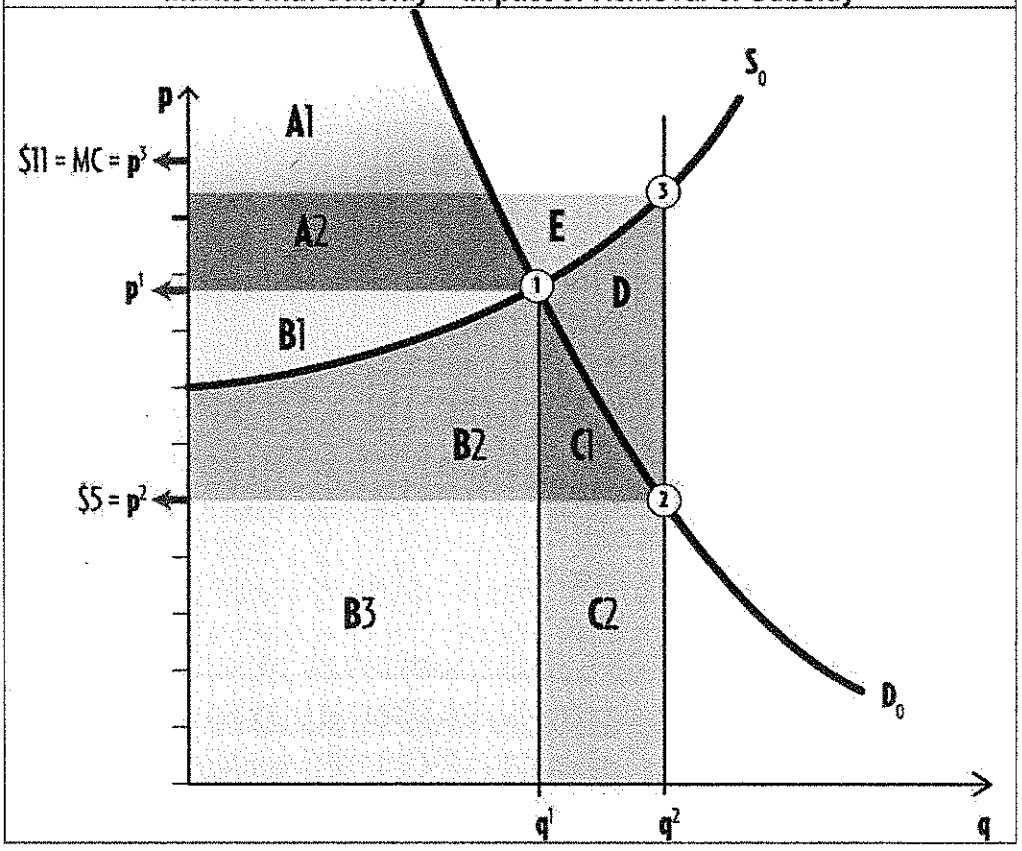
The graphic calculation of Consumer Surplus (CS) and Producer Surplus (PS) is described in a market with an upward sloping Supply curve (S_0) and a downward sloping Demand curve (D_0) that intersect at point 1. This is seen in Figure A-1.

Figure A-1 is used to assess the social welfare consequences of an introduction of a subsidy. First, the outcome of a market without a subsidy is viewed; then changes are observed when a subsidy is introduced.

Equilibrium – No Subsidy (Figure A-1)

The market equilibrium in the absence of any subsidy is found at the intersection of the Supply and Demand curves at point 1 and involves price p^1 and quantity q^1. In a perfectly competitive market the marginal cost of production is equal to p^1 (where the Supply curve shows rising marginal cost as quantity increases in the market) and the marginal willingness-to-pay is also equal to p^1 (where the Demand curve shows falling marginal willingness-to-pay as quantity increases in the market). Total market revenue is $p^1 * q^1$ and is equal to the sum of areas B1+B2+B3 in Figure A1.

Figure A-1 – Consumer & Producer Surplus
Market with Subsidy – Impact of Removal of Subsidy



Consumer Surplus is the area below and to the left of the Demand curve and above the price line at p^1. This equals the sum of areas A1+A2. It represents the amount of consumer willingness-to-pay that exceeds the out-of-pocket expense to secure quantity q^1 in the market. It is a benefit to consumers that is not captured in the market transaction through the price of the good.

Producer Surplus is the area above and to the left of the Supply curve and below the price line at p^1. This equals the area B1. It represents the amount of producer revenue that exceeds the total variable cost to produce quantity q^1 in the market. It is a benefit to producers that is captured in the market transaction through the price of the good.

Equilibrium – With Subsidy (Figure A1)

An allowance is now made for the existence of a price subsidy. The form of the subsidy (i.e. how it is paid) is less important than its existence and impact on market behaviour. The subsidy means that consumers can purchase the good at a price that is below what producers receive for providing the good. The quantity produced and sold in the subsidized market q^2 will be larger than the equilibrium quantity in the absence of the subsidy q^1.

In Figure A-1, consumers will effectively be at some point 2, such that at the traded quantity q^2 the price they face is p^2 and is less than the equilibrium price p^1 without the subsidy. Producers will conversely be at some point 3, such that at the traded quantity q^2 the price they receive is p^3. The subsidy s (per unit of output) is equal to the difference between the two prices (p^3-p^2 = s) and the quantity demanded equals the quantity supplied at q^2.

While the operation of the market in terms of prices at the quantity q^2 has been explained, the actual market operation is in the reverse order. The existence of the subsidy per unit s generates a subsidy wedge and the subsidized market equilibrium quantity q^2 is determined where the quantity demanded equals the quantity supplied for the given value of the subsidy s.

The subsidy value is the value s * q^2 and is represented in Figure A-1 by the sum of the areas A2+B1+B2+C1+D+E.

The treatment of what is Consumer Surplus and Producer Surplus is complicated by the existence of the subsidy.

The logic used above, which took the Consumer Surplus to be the area below and to the left of the Demand curve and above the price line at p^2, would lead one to believe that this can be measured by the sum of the areas A1+A2+B1+B2+C1. This is obviously larger than in the market equilibrium case. However, the existence of the subsidy does not allow us to associate that area with Consumer Surplus.

The logic used above, which took the Producer Surplus to be the area above and to the left of the Supply curve and below the price line (i.e. at p^3), would lead one to believe that this can be measured by the sum of the areas B1+A2+E. However, the existence of the subsidy does not allow us to associate that area with Producer Surplus.

A new concept, Deadweight Loss, is used to refer to the value of resources consumed in production that exceed (at the margin) the value associated with consumer willingness-to-pay. In the subsidized market, this is the area above the Demand curve and below the Supply curve to the right of the marketing equilibrium point 1 (i.e. in the absence of the subsidy). This is the area D in Figure A-1. This Deadweight Loss is a social loss of productive resources that have been allocated to a use (the production of the good) for which the cost of the resources exceeds the marginal value ascribed to them by consumers (i.e. in their transformed state of the good produced and consumed).

For the purposes of ascertaining Producer Surplus, the lower price p^2 is effectively taken as the appropriate measure of the marginal social valuation of the use of the good. There is, therefore, no Producer Surplus in the subsidized market equilibrium.

Conversely, when measuring Consumer Surplus, the higher price p^3 is effectively taken as the appropriate measure of the margin social cost of the resources used in the production of the good. Therefore, the Consumer Surplus is the area A1 in Figure A-1.

Table A-1 summarizes the impacts on price, quantity and this study's welfare measures of Consumer Surplus, Producer Surplus and Deadweight Loss.

Table A-1 - Consumer Surplus, Producer Surplus & Deadweight Loss In a Market with a Subsidy (Figure 1) Showing Various Results With No Subsidy and With a Subsidy

Variable	No Subsidy	Subsidy
Price to Seller	p^1	p^3
Price to Buyer	p^1	p^2
Subsidy (per unit)	zero	$s = p^3 - p^2 > 0$
Equilibrium Quantity	q^1	q^2
Value of Subsidy or Value of Transfer	zero	sum of area A2+E+B1+B2+C1+D
Consumer Surplus	sum of area A1+A2	area A1
Producer Surplus	area B1	zero
Deadweight Loss	zero	area D

The introduction of a subsidy involves:

- an increase in quantity demanded and supplied (i.e. $q^2 - q^1$);
- the transfer of value to producers and consumers (usually from taxpayers) equal to the sum of the areas A2+E+B1+B2+C1+D and which equals $s * q^2$ in value;
- the Deadweight Loss equal to area D;
- the elimination of Producer Surplus equal to area B1; and
- the reduction in Consumer Surplus equal to area A2.

In terms of a Cost-Benefit Analysis (CBA) measure of social welfare change, the transfer enters as a transfer and is neither a gain nor a loss. It is considered a transfer of resources from one owner (perhaps the taxpayer) to another owner (consumers and/or producers).

The only changes that are meaningful from a CBA measure of social welfare, involve the Deadweight Loss (area D), the elimination of Producer Surplus (area B1) and the reduction in Consumer Surplus (area A2). As all these involve a *loss* of social welfare, it suggests that the introduction of a subsidy in the market for this good resulted in the following Social Welfare Change:

$$(3.1) \quad \Delta\text{Social Welfare} = \Delta\text{Consumer Surplus} + \Delta\text{Producer Surplus} - \text{Deadweight Loss}$$

$$= (-\text{ area A2}) + (-\text{ area B1}) - (\text{area D}) < 0$$

The introduction of a subsidy involves social welfare loss as a result of economic distortions and misallocation of resources from their 'best use' as determined in a market equilibrium without subsidy.

2. Consumer & Producer Surplus – Impact of Shift of the Supply Curve

It is now necessary to assess the social welfare consequences of a shift of the Supply curve in terms of the impact on market equilibrium. This is shown in Figure A-2. In Figure A-2, it is assumed that some change in the structure of the market results in a *downward shift* in the supply curve from S_0 to S_1.

A downward shift in the Supply curve could result from improvement in technology, reduction of regulatory impediments to efficiency or some other cause. The result is that at any quantity to be supplied in the market the marginal cost (per unit) of production is lower, so that S_1 lies below S_0. As the market can now (i.e. after the shift to supply curve S_1) be supplied more efficiently, a resulting social welfare gain is expected.

First the outcome of a market with Supply curve S_0 is examined; then any changes are observed when the market is supplied by the more efficient (lower marginal cost) Supply curve S_1.

Equilibrium – Supply Curve S_0 (Figure A-2) – Higher Marginal Cost

The market equilibrium is found at the intersection of the Supply curve S_0 and the Demand curve D_0 at point 1 and involves price p^1 and quantity supplied and bought q^1.

As there are more horizontal and vertical lines and points of reference in Figure A-2, some of the areas that were defined in Figure 1 have been broken up into components so that the labelling format for distinct areas of the graphic are more complicated. The relationship between areas is shown in Figure A-2 (versus corresponding areas in Figure A-1) using suffix numbers.

Total market revenue is $p^1 * q^1$ and is equal to the sum of areas (B1.1+B1.2) + (B2.1+B2.2+B2.3) + B3 in Figure 2 (i.e. corresponding to the sum of areas B1+B2+B3 in Figure A-1).

Consumer Surplus is the area below and to the left of the Demand curve D_0 and above the price line at p^1. This equals the sum of areas A1+A2 (i.e. as in Figure A-1).

Producer Surplus is the area above and to the left of the Supply curve S_0 and below the price line at p^1. This equals the sum of the areas (B1.1+B1.2) (i.e. corresponding to area B1 Figure A-1).

Equilibrium – Supply Curve S_1 (Figure A-2) – Lower Marginal Cost

The market equilibrium is found at the intersection of the Supply curve S_1 and the Demand curve D_0 at point 3 and involves price p^3 and quantity supplied and bought q^3.

As marginal cost (per unit produced) is lower along Supply curve S_1 than for Supply curve S_2 the market equilibrium price has fallen (i.e. $p^1 > p^3$) and with the downward sloping Demand curve D_0 the quantity supplied and bought has increased (i.e. $q^3 > q^1$).

Total market revenue is $p^3 * q^3$ and is equal to the sum of areas (B1.2 + B2.2 + C1.2 + B2.3 + C1.3 + B3 + C2.1) in Figure A-2.

Consumer Surplus is the area below and to the left of the Demand curve D_0 and above the price line at p^3. This equals the sum of areas (A1 + A2 + B1.1 + B2.1 + C1.1) in Figure A-2.

Producer Surplus is the area above and to the left of the Supply curve S_1 and below the price line at p^3. This equals the sum of the areas (B1.2+B2.2+C1.2) in Figure A-2.

Figure A-2 – Consumer & Producer Surplus
Market with Subsidy

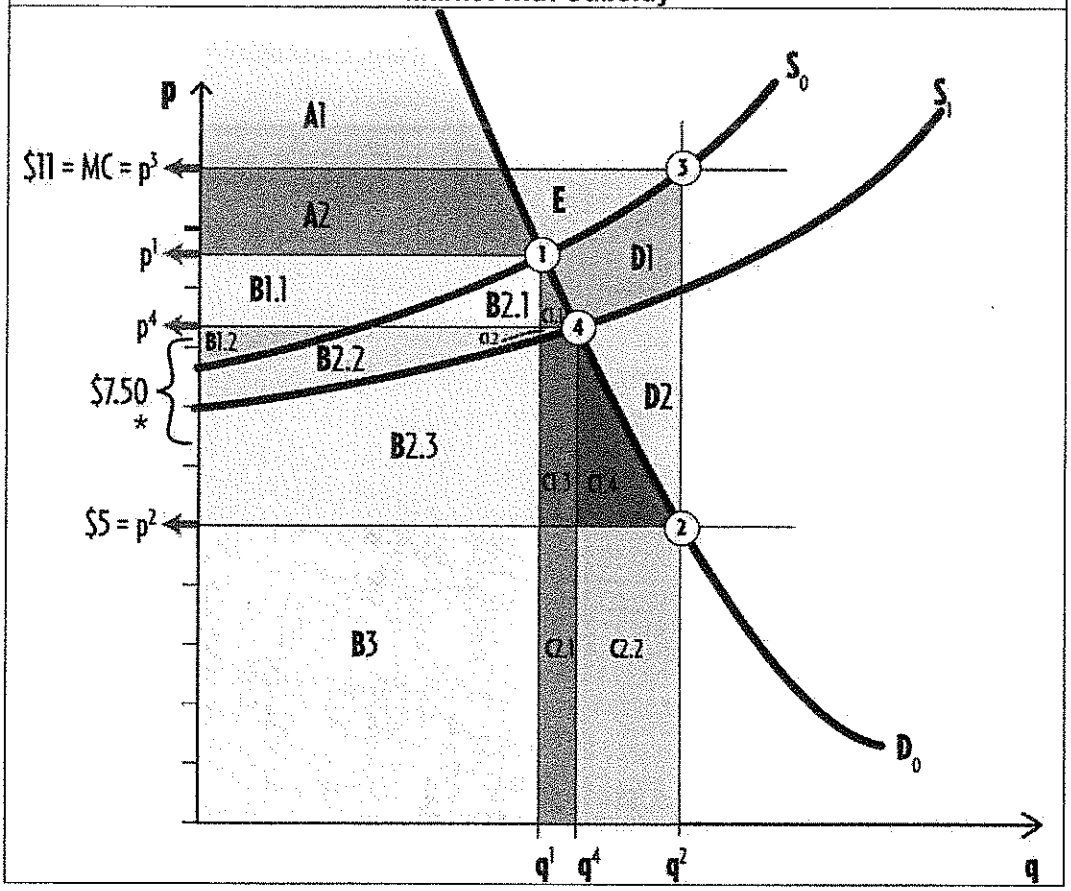


Table A-2 summarizes the impacts on price, quantity and this study's welfare measures of Consumer Surplus and Producer Surplus. As there is no subsidy involved in the shift in Supply curves there is no Deadweight Loss issue.

Table A-2 - Consumer Surplus, Producer Surplus & Deadweight Loss In a Market with a Shift of the Supply Curve (Figure 2) Showing Various Results With Supply Curve S_0 and S_1 (lower cost)		
Variable	**Supply S_0 (higher cost)**	**Supply S_1 (lower cost)**
Price to Seller	p^1	p^3
Price to Buyer	p^1	p^3
Subsidy (per unit)	zero	zero
Equilibrium Quantity	q^1	q^3
Value of Subsidy or Value of Transfer	zero	zero
Consumer Surplus	sum of area A1+A2	sum of area A1+A2+B1.1+B2.1+C1.1
Producer Surplus	sum of area B1.1+B1.2	sum of area B1.2+B2.2+C1.2
Deadweight Loss	zero	zero

As can be seen in Table A-2, the value of Consumer Surplus has increased as a result of the shift to a lower marginal cost Supply curve. The change in Consumer Surplus is larger by the sum of the areas B1.1+B2.1+C1.1 in Figure A-2. In deriving the change in Consumer Surplus, the net difference between the two situations was assessed.

For the purposes of ascertaining the change in Producer Surplus, this study will not look at the net difference between the two situations. It is widely accepted in economics (since Schumpeter and the concept of creative destruction) that technological advances create losers and that society is still better off as a result of improvements in technology. Therefore, from the perspective of social welfare change, the elimination of the original Producer Surplus (associated with Supply curve S_0) is not a social welfare loss. The study therefore does not take the difference between in Producer Surplus as the measure of social welfare gain. The measure of social welfare gain is the Producer Surplus associated with the more efficient (lower marginal cost) Supply curve S_1. The Producer Surplus is the sum of the areas B1.2+B2.2+C1.2 in Figure A-2.

The meaningful changes in terms of a CBA measure of social welfare, involve the Producer Surplus (areas B1.2+B2.2+C1.2) and the gain in Consumer Surplus (areas B1.1+B2.1+C1.1). As all these involve a *gain* of social welfare, it suggests that the shift in Supply curve resulting from more efficient production in the market for this good resulted in the following Social Welfare Change:

$$(3.2) \quad \Delta\text{Social Welfare} = \Delta\text{Consumer Surplus} + \text{Producer Surplus}$$

$$= (\text{areas B1.1+B2.1+C1.1}) + (\text{areas B1.2+B2.2+C1.2}) > 0$$

3. Consumer & Producer Surplus – Combined Effect

To look at the combined effect of the elimination of a subsidy and a shift in Supply curve involving more efficient (lower marginal cost) production, it is necessary to combine (i.e. sum) the two effects that considered above. These can all be seen in Figure A-2 provided that accommodation is made to the break-up of areas into components in the transition from Figure A-1 to Figure A-2.

Table A-3 summarizes the impacts on price, quantity and the welfare measures of Consumer Surplus, Producer Surplus and Deadweight Loss. This combined the results from Tables A-1 and A-2 above.

Table A-3 - Consumer Surplus, Producer Surplus & Deadweight Loss
Combined Effect of a) Elimination of Subsidy and b) More Efficient Supply

Variable	Subsidy Supply S_0	No Subsidy Supply S_0	Lower Cost Supply S_1
Price to Seller	p^3	p^1	p^3
Price to Buyer	p^2	p^1	p^3
Subsidy (per unit)	$s = p^3 - p^2 > 0$	zero	zero
Equilibrium Quantity	q^2	q^1	q^3
Value of Subsidy or Value of Transfer	sum of area A2+E+B1.1+B1.2 +B2.1+B2.2+B2.3 +C1.1+C1.2+C1.3+C1.4 +D1+D2	zero	zero
Consumer Surplus	area A1	sum of area A1+A2	sum of area A1+A2+B1.1+B2.1+C1.1
Producer Surplus	zero	sum of area B1.1+B1.2	sum of area B1.2+B2.2+C1.2
Deadweight Loss	area D	zero	zero

The social welfare consequences of a move from the subsidy case with Supply curve S_0 to a market equilibrium with Supply curve S_1 is the additive impact of the two equations developed above – to allow the addition the combined effects of a) the move from the subsidized to the non-subsidized market equilibrium associated with Supply curve S_0 (as captured in equation 1); and b) the move from higher cost Supply curve S_0 to the lower cost Supply curve S_1 (as captured in equation 2).

The meaningful changes in terms of a CBA measure of social welfare are reflected in the following Social Welfare Change:

$$(3.1) \quad \Delta\text{Social Welfare} = -\Delta\text{Social Welfare(1)} + \Delta\text{Social Welfare(2)}$$

$$= (A2+B1.1+B1.2+D1+D2) + (B1.1+B2.1+C1.1+B1.2+B2.2+C1.2)$$

$$= A2 + B1.1 + B1.2 + B2.1 + B2.2 + C1.1 + C1.2 + D1 + D2 > 0$$

Note that the ΔSocial Welfare(1) is measured for the introduction of the subsidy so the effect of removal of the subsidy is the negative of this value. Also note that there is no 'double-counting' the same area twice if it appears as a benefit for both the removal of the subsidy and the more efficient Supply curve.

In terms of trying to understand the net social welfare gain it is useful to break this up into three components along the lines of equation 1 above:

(3.2) ΔSocial Welfare = ΔConsumer Surplus + ΔProducer Surplus + ΔDeadweight Loss

= (A2+B1.1+B2.1+C1.1) + (B1.2+B2.2+C1.2) + (D1+D2)

This simply rearranges the results from equation 3.1.

The social welfare gain is derived from:

1. The increase in Consumer Surplus as a result of increased consumption of the good (relative to the Consumer Surplus associated with point 3 in Figure A-2 involving price p^3);

2. the Producer Surplus at the final position associated with the more efficient Supply curve S_1 at point 4 and price p^4; and

3. the elimination of the Deadweight Loss associated with the subsidy at point 3.

4. **Consumer & Producer Surplus – Estimation**

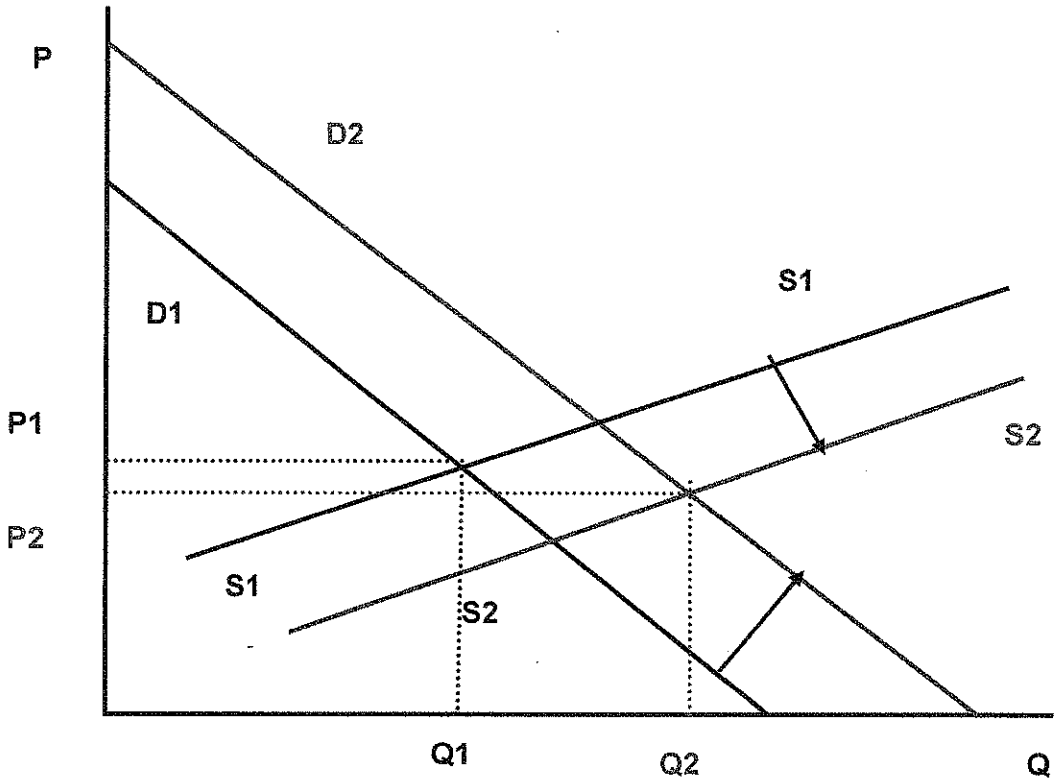
Generally, in order to operationalize this analysis, it is customary to assume linear forms of the Demand and Supply curves and to estimate the area sizes using geometric relationships. Linear forms mean that all the relevant areas are triangles whose area is ½ the value of the corresponding rectangle.

5. **Possible Responses of User Demand and Consumer Surplus to a More Competitive and Innovative Industry**

The following diagram uses comparative statics analysis in order to illustrate how user demand and consumer surplus could increase in the future through the combined effects of the dynamic factors discussed in section 5.5.3 of the Qualitative Discussion. The demand curve moves outward to the right from D1 in black to D2 in red because the consumer/user of marihuana for medical purposes is willing to pay more for a higher quality and more innovative and reliable legal product that is more accessible and has proven its ability to provide health, quality of life and related benefits.

The supply curve moves downward and to the right from S1 in black to S2 in red because of economies of scale and scope, learning effects, internal and external efficiencies, and reductions in fixed/compliance and variable/administrative regulatory costs.

The combined effects of the changes in position of the demand and supply curves are: higher quantities supplied, demanded and consumed at a lower actual price, resulting in greater consumer surplus for each and every consumer/user of marihuana for medical purposes (as the market equilibrium moves from P1Q1 in black to P2Q2 in red.



The supply and demand relationships illustrated in the above diagram are fully consistent with the dynamic growth experienced by many new industries and markets that have emerged over the past many decades as a consequence of technological, policy, regulatory, institutional and other transformative and fundamental changes as described in the work of Marshall, Arrow, Romer and the many endogenous growth theorists over the past century.