

# Foreign Ownership in the Canadian Oil Sands: A General Equilibrium approach

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**Abstract:**

In this paper a general equilibrium model approach is used to provide an economic framework to the debate of foreign ownership in the Canadian oil sands. The concern has been raised that inadequate benefit is distributed to domestic consumers. Generally, consumers benefit from oil resources through the collection of royalty revenues as well as company profits. In Canada these companies are privately owned. By examining changes in firm composition we establish that domestic consumers benefit from increased foreign operations and are adequately compensated through increased royalty rates.

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## 1. Introduction:

The importance of the energy sector in Canada has grown steadily over the past few decades. It now accounts for 3% of Canada's total GDP<sup>1</sup>. The estimated wealth of Canada's natural resource sector is \$1.4 trillion in potential earnings<sup>1</sup>. The Government of Canada has a responsibility to manage this sector, ensuring that it has a well secured future in Canada's continued economic development.

The oil sands are one of the largest reserves in the world, estimated to contain 170.4 billion currently recoverable barrels of oil<sup>3</sup>. The oil sands account for roughly 11% of the total global oil reserves; putting Canada in a desirable position as one of the world's global suppliers.

The recent takeover of the Canadian Company Nexen by China's National Offshore Oil Company has raised questions about how foreign ownership should be handled with respect to the oil sand resource. The increase in operations of state owned foreign firms within Canada reduces the amount by which Canadians can invest in the oil sands because they can no longer buy shares in those companies. The Government of Canada has declared that these foreign takeovers will be assessed on a case by case basis and will only be approved when they align with Canada's national interests<sup>4</sup>. The Government of Canada suggests that the successful acquisition of Nexen is the exception rather than the rule by which they will handle future foreign acquisitions.

Using a General Equilibrium framework I construct a model to demonstrate how foreign investment affects the oil sands. The royalty revenue and domestic firm profit are two ways in which the domestic consumers benefit from the oil sands. By examining changes in firm

composition and the resulting changes in these two factors we can determine if the domestic consumer is better or worse off from the operation of foreign owned firms.

The model assumes open capital markets, competitive markets, and firms are profit maximizing. Capital markets refer to the lack of restrictions on global trade and investment. Competitive markets allow for Pareto optimal outcomes in the absence of externalities, public goods, or asymmetric information. Profit maximizing firms are also reasonable to assume in this model and are assumed for all scenarios.

The first case compares two scenarios. In the first scenario both domestic and foreign private firms produce oil. In the second scenario a single domestic firm produces oil. The two cases are compared examining the resulting impacts on the domestic consumer. The model shows that domestic consumers are better off without the foreign firm operating within Canada when the price of oil is endogenously determined.

The second case involved setting the price of oil fixed and comparing the same two scenarios. This is a better representation of the world because the price of oil is set on a global market. The model shows that the domestic consumers are worse off when foreign firms are barred from entry.

The third case examines extensions to the model, including the addition of an external cost associated with the production of the oil sands as well as an adaptation of Becker's theory of consumer discrimination.

The conclusions gathered from the model suggest that the operation of foreign owned enterprises within Canada should not have any negative impacts upon the Canadian economy given that the price of oil is determined globally. By reducing the amount of firms operating in

Canada there is a corresponding decrease in output. The decline in output leads to declining royalty revenue because the sector is less productive. Accordingly, a lower royalty rate is charged. The model shows that by increasing the number of firms, the royalty rate paid to domestic consumers can adequately compensate Canadian consumers for the use of their resource. The result being that all consumers are better off when foreign firms operate within Canada.

## **2. Previous Literature:**

The related literature falls into a number of categories. The first paper I examine focuses on the fiscal resource revenue distribution within Canada. The second provides a general background of the primary political economic concerns associated with the oil industry. The third covers the policy framework associated with successful hydrocarbon development.

With respect to Canada in particular the first paper, "Evaluating the efficiency and equity of Federal Fiscal Equalization," by David Albouy (2012) evaluates the resource revenue distribution policies active in Canada. The problem in Canada's fiscal equalization scheme is that the redistribution has a disproportionate focus to lower paid areas. Albouy argues that redistribution should instead target location independent characteristics. The current redistribution only takes into account the value of the local wage and is not adjusted to the relative price levels of the area. The relevant insight Albouy provides is that a further problem exists, Canada's fiscal equalization fails to redistribute income from source based revenues, such as oil sand royalties. This failure creates an imbalanced and inefficient outcome, resulting in an overpopulation of the Prairie Provinces by 30%. While it is implied in my model that royalty

revenues will not have any adverse effects to Canadian consumers, the reality is that distribution problems exist and can lead to inefficient outcomes.

To provide a general overview of some of the problems associated with National Oil Companies (NOC's) the paper, "The Rentier State and National Oil Companies: An economic and political perspective," by Donald Losman (2010) was examined. The rentier state is characterised by the excessive dependence on oil revenues such that it makes up the majority of government income. The Government primarily governs through the use of subsidies leaving citizens untaxed. This results in an almost free reign structure, where citizens are unconcerned about Government actions as long as the substantial benefits are still being offered. The primary focus of NOCs in rentier states are to justify their regime, in that they try to perpetuate their existence. Losman outlines how NOCs suffer from non-profit maximizing behaviour by highlighting that they are political instruments. Objectives of NOC's are often subjected to political agenda's which may not be in the best interest of cost minimization. The overall effect of NOCs lead countries to pursue short-term resource rent activities over investments in technological advances. The argument is made that more focus is put on the distribution of resource rents than the production. This leads to insufficient economic development. The implication for Canada is that the operation of NOCs in the oil sands may have negative consequences for Canadians. Namely, they may pursue political objectives rather than profit maximization ones.

A different approach using NOCs is known as the Norwegian Model. The model is reviewed in the article, "Exporting the 'Norwegian Model': The effect of administrative design on oil sector performance" by, Mark Thurber et al. (2011). The Norwegian Model is characterized by the separation of the oil sector into 3 distinct entities. The first entity is the

NOC itself and carries out commercial operations. The second entity is the government ministry responsible for the pursuit of sector goals. The third entity is an overseeing body which provides regulation and technical advice. This segmentation allows for efficient commercial operations, pursuit of sector goals and prevention of conflicts of interest. The creation of autonomous policy and regulatory bodies improves the ability of Governments to monitor and benchmark the NOC and other players in the sector thereby improving performance. The paper tests the performance of the hydrocarbon industries in ten different countries to see if the segmentation design found in Norway was a pre-requisite to success. Thurber finds that it is not necessary but mostly has beneficial effects. Furthermore, the strength of the segmentation depends upon the institutional structure within each country. Countries without structured and well developed institutions do not benefit and in some cases actually falter from the segmentation of NOCs from policy bodies. The conclusion is that while the Norwegian Model may be the ‘best practice’, it is not a perfect mandate for all countries.

### **3. Public concerns:**

In recent years there has been considerable concern raised about the development of the oil sand resource. In addition to the environmental opposition faced there has been further concern raised about the distribution of wealth of the oil sand resource.

The Canadian Government accounts for roughly 8% of total domestic investment in the oil sand resource<sup>1</sup>. By contrast, in most countries with reserves a National Oil Company is present and holds direct operations within their respective oil sectors. National Oil companies control roughly 85% of the world’s reserves, and account for 55% of global production<sup>5</sup>.

National Oil Companies are generally in place to assure the country's presence in the development of their resource.

Usually, consumers benefit in two ways from owning oil resources. Firstly, they receive a royalty rate from the use of the resource. Secondly, if a state owned company is operating in the oil sector the consumers receive an increase in government funding because the profits generated by the state owned companies are redirected to public funds. In Canada however, there is no state owned company operating in the oil sands. The private composition of enterprises in Canada means Canadians benefit only from the collection of royalty revenues. Shareholders of the private companies also benefit from the profits of the companies. In Canada, royalty rates are calculated based upon production quantities and oil prices. They are essentially a special kind of tax in place for resources. The current framework places a maximum royalty rate at 40%<sup>6</sup>. An independent review was done in 2007 assessing Alberta's royalty revenue framework and concludes that the rate should be increased to roughly 60%<sup>7</sup>. Canadians are not receiving an equitable royalty return on the oil sands. This concern is not addressed in this paper as it is assumed that royalty rates are set at the optimal level. Instead the focus is to establish the effects on domestic consumers from barring the operation of foreign firms.

The foreign owned share of assets in the Canadian oil sector is roughly 27%<sup>1</sup>. This raises concerns for Canadians about the distribution of profits from the oil sand sector. As noted previously, Canadian citizens have become increasingly worried about the presence of foreign owned companies operating within the oil sand resource. The operation of any company in the natural resource sector causes a depletion of reserves. This inherently causes a depletion of a country's asset. This then becomes of public concern because each citizen should be entitled to reap the benefits that result from this extraction process.

Domestic consumers are assumed to hold shares in the domestic private firm, while foreign consumers are assumed to hold shares in the foreign private firm. From this division of profit shares, we can examine if domestic consumers are better or worse off when foreign firms are allowed to operate. The main concern of domestic consumers is that by allowing foreign firms to operate the benefits go solely to the foreign consumers.

The model results show that these concerns are not justified. The oil sand resource benefits from an increase in the number of firms operating within it. The royalty revenue can be expected to increase as the number of firms increase. This is due to the increase in demand for the resource. Domestic consumers are made better off from the operation of foreign firms if the increase in royalty revenue offsets the decrease in domestic profits.

## **4. Economic Model:**

### **4.1 Overview:**

The General equilibrium model is chosen to establish the effects foreign investment has on the overall welfare of consumers. General Equilibrium modelling uses micro foundations and as such is appropriate to investigate changes in firm composition at the firm level.

The General Equilibrium model which I construct is a 2 good model. The good of interest is oil represented by good X in this model. All other goods are represented by good Y. The inputs are capital denoted K and land denoted L. The land parameter can be thought of as the oil sand resource. Therefore the price paid to that input can be described as the royalty revenue received from the use of the oil sands. Domestic consumers own both capital and land,

as the oil sand resource resides within their borders. The foreign consumers however, only have inputs of capital. The X good requires both capital and land, whereas the Y good requires only capital. The usual labour input is left out because it unnecessarily complicates the model.

There are 2 consumers in this model; domestic and foreign. Both consumers have quasi-linear utility functions in good X.

$$U_i(x_i, y_i) = x_i^\gamma + y_i$$

Where  $\gamma$  represents each consumer's preference towards good x and  $i = D, F$ . Let D denote Domestic and F denote Foreign.

Quasi-linear preferences in good X are chosen to allow for an easier interpretation of results; this is a standard assumption in micro-economics and is useful because it eliminates the income effect which accompanies the usual Cobb-Douglas preferences.

There are 2 firms which produce good X; domestically owned and foreign owned firms. There is a single firm which produces good Y. The profits of each firm go to their respective owners while the profit from firm Y is split between the 2 consumers. The domestic consumer's budget constraint is then given by:

$$\theta_D \pi_y + \pi_{x_D} + \rho L_D + r K_D = p_x x_D + p_y y_D$$

Where  $\theta_D$  is the share of profits received by the domestic consumer from firm Y and  $\rho, r$  are the royalty and rental rates paid to domestic consumers for their land and capital respectively.

Similarly, the foreign consumer's budget constraint is given by:

$$\theta_F \pi_Y + \pi_{x_F} + rK_F = p_x x_F + p_y y_F$$

Where  $\theta_F$  is the share of profits received by the foreign consumer from firm Y. Note that foreign consumers do not receive royalties.

Prices of good X and good Y are denoted,  $p_x, p_y$  respectively. For simplicity, good Y is set as the numaire good:  $p_y = 1$ .

The distinction is made between capital and profits in this model and is a crucial assumption underlying the following results. Capital in this model is simply a resource; it is an input into the production function and accordingly does not correspond to the shares of profit received by the consumer. The consumer is simply paid a rental rate for each unit of capital they supply. We can expect the rental rate to be the same across all firms because there is capital integration across sectors. The profits each consumer receives from the production of their respective firms is entirely set into the model, i.e. no matter how little capital, or how much capital each consumer employs to their respective X firm, the share of the profits received do not differ. In this way, we can examine the impact to the domestic and foreign consumers through the changes in income that result from changes in firm composition in the model.

The Marshallian demand for good X is the same for both consumers, depending only on the price of good X and their preference towards good X.

$$x_i^* = \left( \frac{P_x}{\gamma} \right)^{\frac{1}{\gamma-1}}$$

The Marshallian demand for good Y is a function of both income and prices.

The domestic and foreign demands for good Y are as follows:

$$y_D^* = (\theta_D \pi_y + \pi_{x_D} + \rho L_D + r K_D) - P_x^{\frac{\gamma}{\gamma-1}} * \left(\frac{1}{\gamma}\right)^{\frac{1}{\gamma-1}}$$

$$y_F^* = (\theta_F \pi_y + \pi_{x_F} + r K_F) - P_x^{\frac{\gamma}{\gamma-1}} * \left(\frac{1}{\gamma}\right)^{\frac{1}{\gamma-1}}$$

There will be different amounts of good Y demanded by each consumer because of the different incomes they receive.

The domestic and foreign firms use Cobb-Douglas production functions with decreasing returns to scale.

$$f_{xi}(L_i, K_{xi}) = L_i^\alpha K_{xi}^\beta = X_i$$

Where i is indexed as before. And let  $\alpha + \beta < 1$ . For the first case scenario  $\alpha_D = \alpha_F$  and  $\beta_D = \beta_F$ . Firms with decreasing returns to scale in production have increasing cost functions, accordingly a sector will produce less when there are less firms operating in that sector. The cost function can be shown from first order conditions as:

$$c(x, r, X_i) = \left(\frac{\rho}{\alpha}\right)^{\frac{\alpha}{\alpha+\beta}} * \left(\frac{r}{\beta}\right)^{\frac{\beta}{\alpha+\beta}} X_i(\alpha + \beta)$$

Maximizing the profit function of:

$$\pi_{xi} = P_x X_i - c(x, r, X_i)$$

allows us to find the optimal level of good X supplied by each firm which is:

$$X_D^* = X_F^* = P_x^{\frac{\alpha+\beta}{1-(\alpha+\beta)}} \left(\frac{\alpha}{\rho}\right)^{\frac{\alpha}{1-(\alpha+\beta)}} \left(\frac{\beta}{r}\right)^{\frac{\beta}{1-(\alpha+\beta)}}$$

Each firm will produce exactly half of the production of Good X in the original specification. Their profit can be determined by:

$$\pi_D = \pi_F = (1 - (\alpha + \beta)) p_x \frac{1}{1 - (\alpha + \beta)} \left( \frac{\alpha}{\rho} \right)^{\frac{\alpha}{1 - (\alpha + \beta)}} \left( \frac{\beta}{r} \right)^{\frac{\beta}{1 - (\alpha + \beta)}}$$

Using Hotelling's lemma the optimal amount of capital supplied to each firm is:

$$K_D = K_F = p_x \frac{1}{1 - (\alpha + \beta)} \left( \frac{\alpha}{\rho} \right)^{\frac{\alpha}{1 - (\alpha + \beta)}} \left( \frac{\beta}{r} \right)^{\frac{1 - \alpha}{1 - (\alpha + \beta)}}$$

Likewise, the optimal amount of labour supplied to each firm is:

$$L_D = L_F = p_x \frac{1}{1 - (\alpha + \beta)} \left( \frac{\alpha}{\rho} \right)^{\frac{1 - \beta}{1 - (\alpha + \beta)}} \left( \frac{\beta}{r} \right)^{\frac{\beta}{1 - (\alpha + \beta)}}$$

The production function of firm Y is a simple Cobb-Douglas production function, requiring just a single input, and therefore only a single cost. With the restriction of the exponent,  $\delta < 1$ .

$$f_y(K_y) = K_y^\delta = Y$$

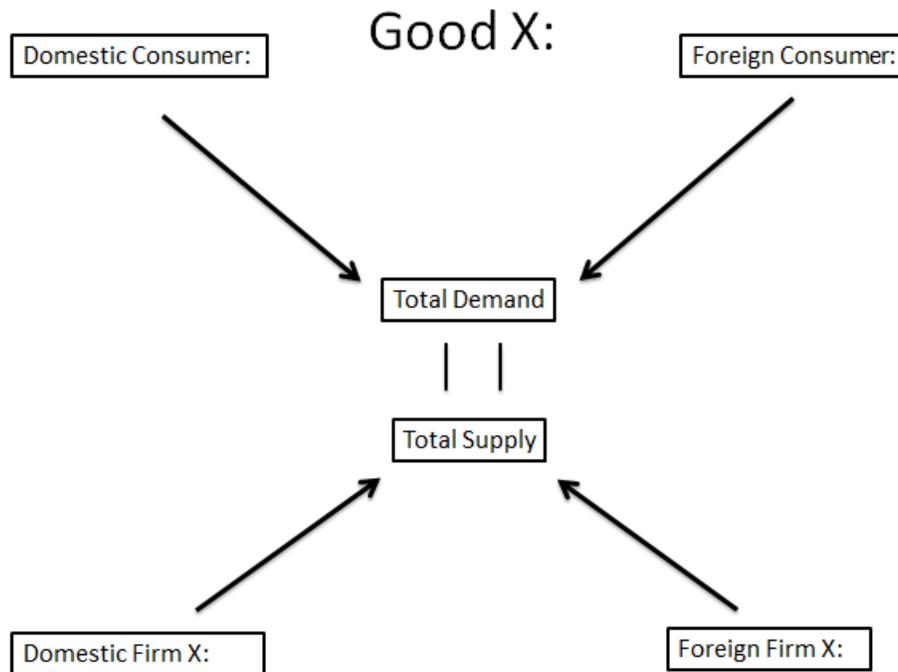
The optimal amount of capital allocated to Good Y is:

$$K_y = \left( \frac{r}{\delta p_y} \right)^{\frac{1}{\delta - 1}}$$

The profit of firm Y is:

$$\pi_y = r^{\frac{\delta}{\delta - 1}} * \left( \delta^{\frac{\delta}{1 - \delta}} - \delta^{\frac{1}{1 - \delta}} \right)$$

A diagrammatical specification of the different markets and how the actors within each interact can be shown as follows:



**Figure 1: Good X market structure.**

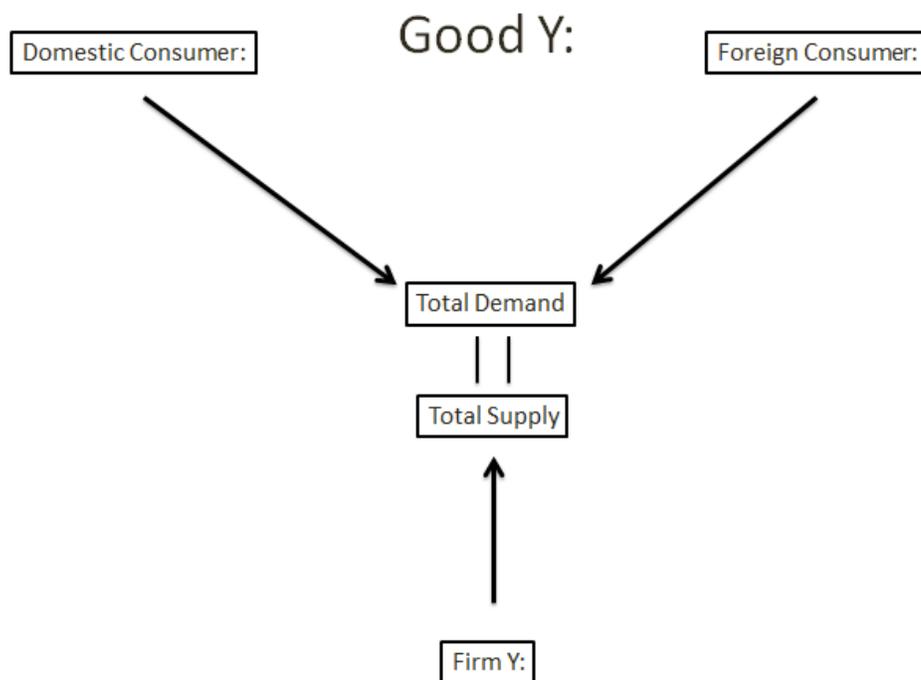


Figure 2: Good Y market structure.

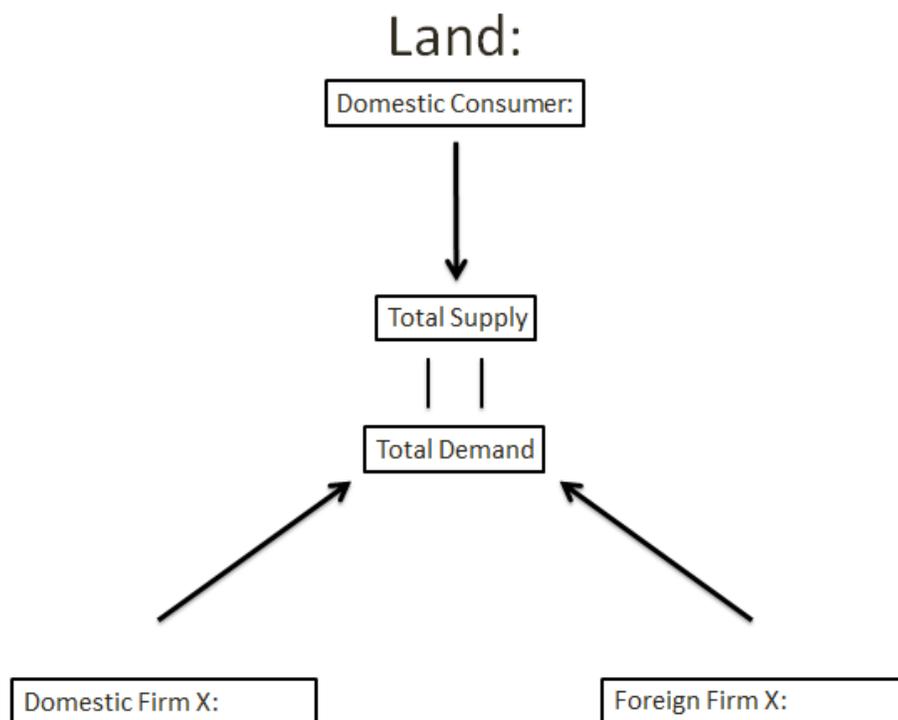


Figure 3: Land market structure.

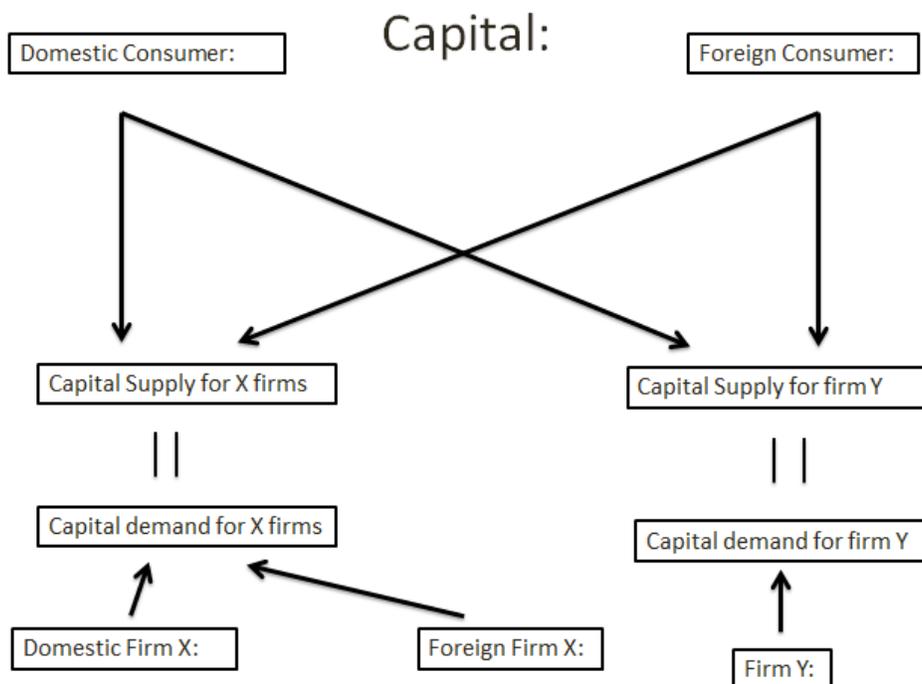


Figure 4: Capital market structure.

## 5. Results:

### 5.1 Benchmark results:

The model is solved with the use of the General Algebraic Modeling Software (GAMS) program. The market structures are depicted in the above figures 1-4, these provide an overview of the supply and demand relationships which the model solves.

Table 1 shows the exogenous variables chosen when executing the model.

Parameter:	Value:
Alpha Domestic, $\alpha_D$	0.4
Beta Domestic, $\beta_D$	0.4
Alpha Foreign, $\alpha_F$	0.4
Beta Foreign, $\beta_F$	0.4
Delta, $\delta$	0.5

Gamma Domestic, $\gamma_D$	0.5
Gamma Foreign, $\gamma_F$	0.5
Total Land supplied, $\bar{L}$	2
Capital endowment Domestic, $K_D$	2
Capital endowment Foreign, $K_F$	2
Share of profits from Firm Y to Domestic Consumer, $\theta_D$	0.5
Share of profits from Firm Y to Foreign Consumers, $\theta_F$	0.5

**Table 1: Exogenous variable values specified in the model.**

The results are sensitive to the parameter values chosen for the exogenous variables. The biggest impact to the model results from exogenous changes in the parameter values of alphas, betas, and delta. A change in these values simulates a change in technologies, or improvements in efficiency. As such, to simulate the proposed benefits of foreign investment, the alpha and beta foreign parameters could be increased to simulate improved technologies foreign companies possess. They have been assumed to be the same for all examples in this model because Canada is a developed country, and the technologies present in Canada can be expected to be similar across firms. This specification however might be useful if this model were to be extended to investigate a developing country.

As can be seen in figure 5 below, the domestic consumer in this model is better off than the foreign consumer given that the domestic and foreign companies are the same. This is because the domestic consumer is endowed with additional resources to spend in the form of land. This increases the total income at the domestic consumer's disposal and therefore increases the amount of goods which they can consume.

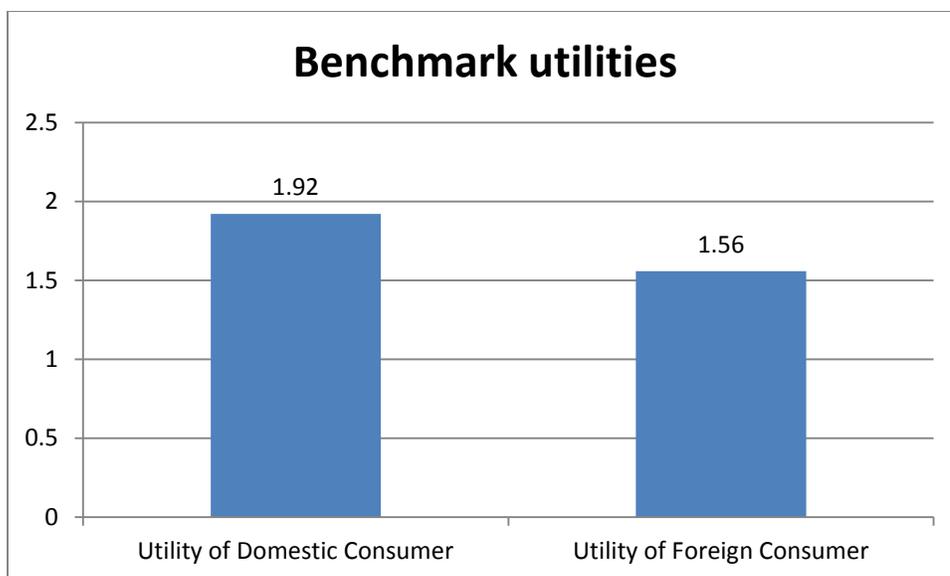


Figure 5: Benchmark utilities of consumers.

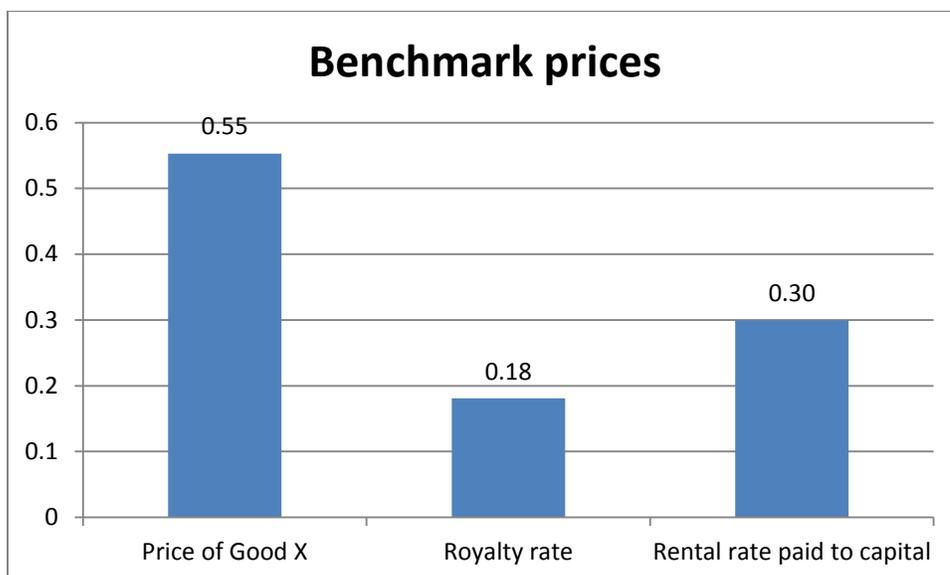
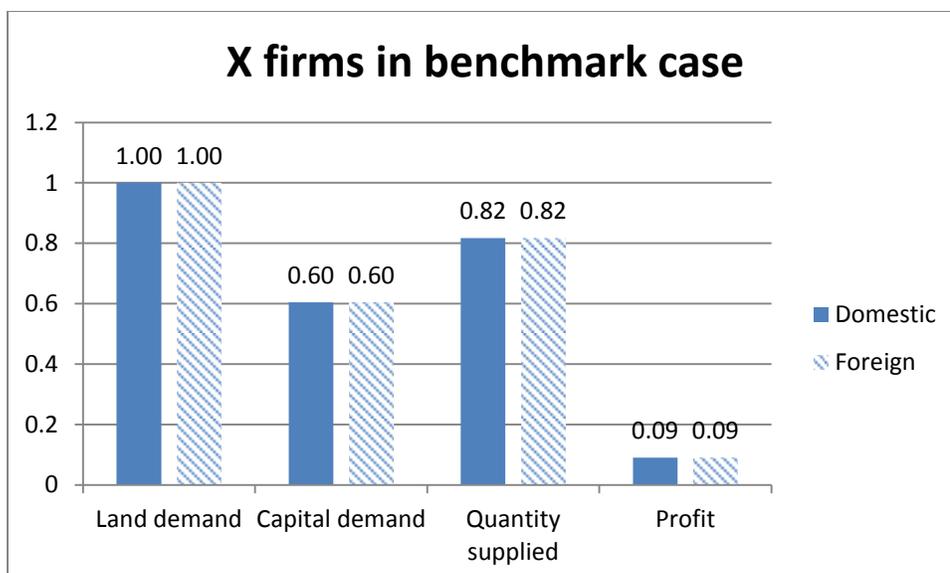


Figure 6: Benchmark price of good X, the royalty rate and the rental rate paid to capital.

Notably, the value of capital is much more than the value collected as royalties. This is because there is a greater demand for capital than for land as it is used in both sectors whereas land is simply employed in one.



**Figure 7: Domestic and foreign X firms inputs and outputs for the benchmark case.**

The results between the X firms are symmetric because of the exogenous variables chosen, as such each X firm demands the same amount of capital and labour as well as supplies the same amount of good X. Therefore the profits given to each consumer from their respective X firms will be the same for this initial solution. Additionally, each consumer demands the same amount of good X because their preferences are identical.

## 5.2 No foreign firm case results:

To investigate the effects that foreign firms have on the oil sector, the absence of foreign firms is examined. The model is restructured so that the foreign firms are now absent in the market structure. The corresponding alterations are made to the land and capital markets. The X firms still operate competitively because the single domestic production function can be thought of as representing many homogenous domestic X firms. As such we will assume they operate

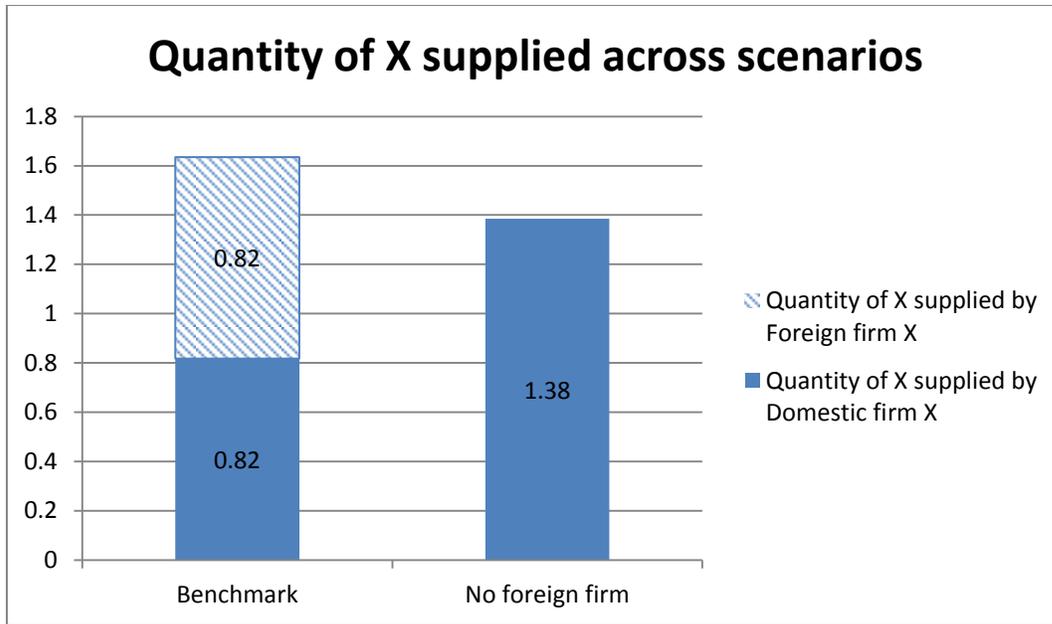
competitively without the presence of the foreign firms. This ensures an efficient use of resources.

If it were impossible to add a foreign firm into the model, this model specification would be Pareto efficient. All market resources are reallocated to meet the change in demand that results from the absence of the foreign firm. The X firm still operates competitively and therefore all resources are used efficiently. The solution meets all of the standard requirements of efficiency, and importantly no one can be made better off by a reallocation of resources given that it is impossible to add a foreign firm.

### **5.3 Comparing the two scenarios:**

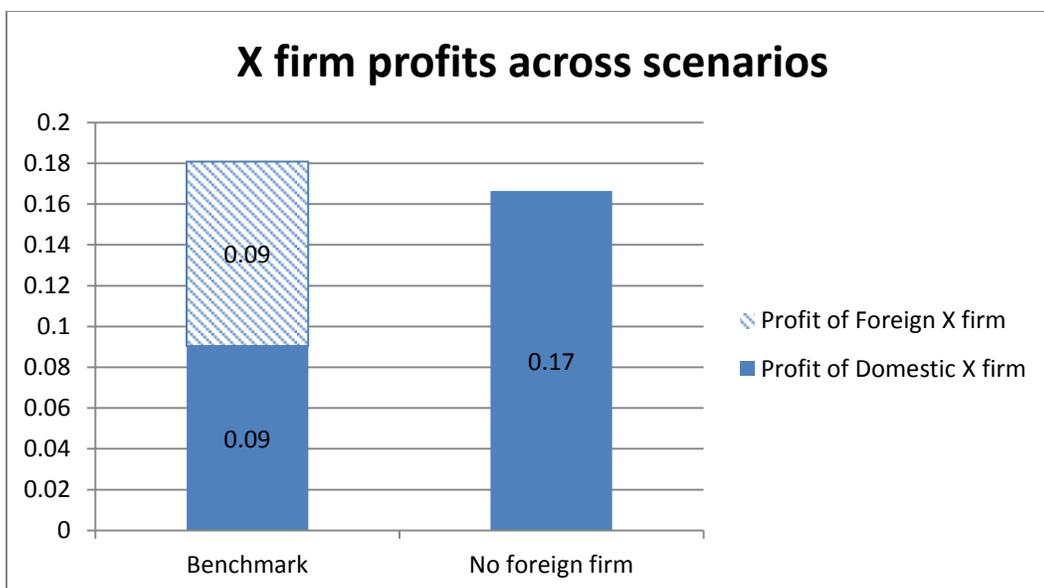
In order to establish the effects of changing firm composition, the two scenarios need to be compared. The important results will be highlighted here while table 4 in the appendix will report all value changes.

The domestic X firm now produces all of good X, but produces less than if there were two firms as is shown in figure 8. This is a result of the model specification. Specifically the decreasing returns to scale property in the production functions.



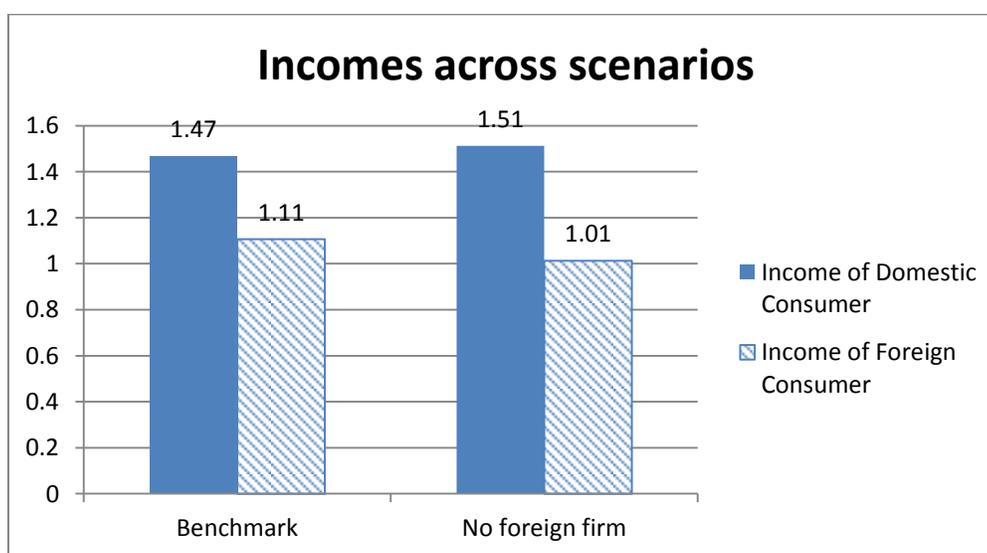
**Figure 8: Quantity of X supplied across scenarios.**

This is one of the driving forces behind the conclusion. The implication of this result is that when prices are endogenously solved for the price will increase. This leads to an increase in profits for the domestic firm through two ways. Firstly, the domestic firm captures the entire X market. Secondly, the domestic firm charges a higher price. This greatly benefits domestic consumers because they receive all profits from the domestic X firm.



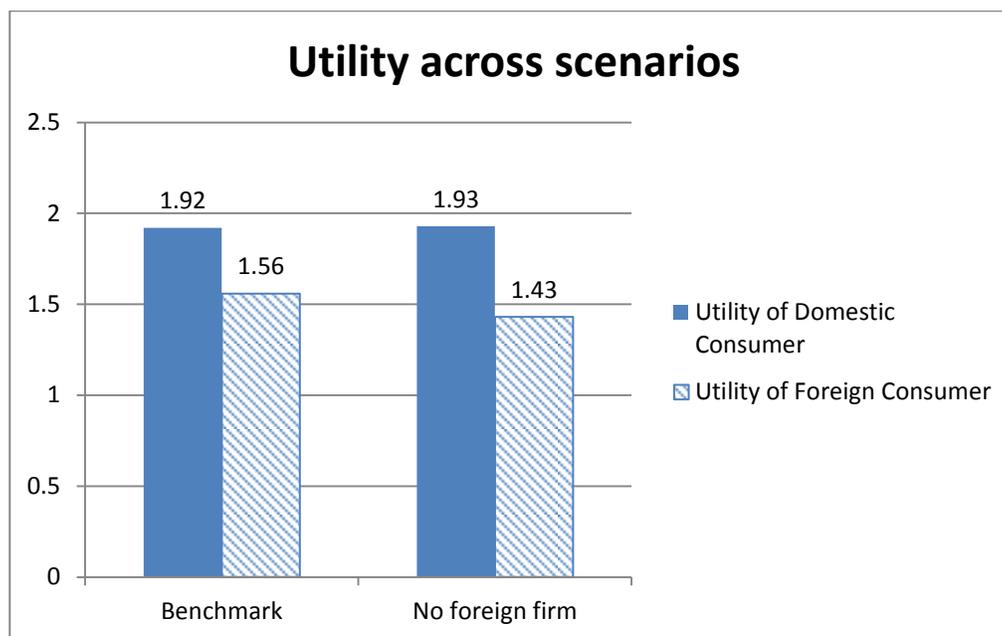
**Figure 9: X firm profits across scenarios.**

Domestic consumers also face diminished royalty rates because of the decrease in demand for the land input. This results in a decrease in consumer income, although not by a large magnitude. The net effects of increasing profit and decreasing rental rates are that domestic consumers experience an increase in income while foreign consumers experience a decrease.



**Figure 10: consumer incomes across scenarios.**

The increase in income is rather small but still plays a role in increasing the domestic consumer's utility. Accordingly, the domestic consumer's utility is only marginally higher under the absence of the foreign firm, whereas the foreign consumer's utility is much lower.



**Figure 11: consumer utilities across scenarios.**

The key factor driving this result is the increase in income associated with the increase in profits to the domestic firm. The domestic consumers are almost indifferent between the two scenarios, whereas the foreign consumer would much prefer the benchmark scenario. The foreign consumer is made much worse off than the consumer is made better off from the barring of foreign firms. Therefore it is conceivable that a contract could be constructed where foreign consumers would pay domestic consumers to be able to operate the foreign X firm. The construction of this contract would make all consumers better off. In this sense, the absent foreign firm case is not Pareto efficient because there is a contract which could be constructed which makes both parties better off. Relating back to the concerns of domestic consumers about

the distribution of profits received by foreign consumers, if the contracted lump sum paid to domestic consumers is too low then domestic consumers will be better off in the absence of foreign firms. In this sense, domestic consumers should not only be compensated for the extraction of their resource through royal rates, but also should be paid a lump sum when foreign firms enter into the market.

These results however, have one implicit assumption which weakens the strength of the overall conclusion. The price of X here is endogenously solved. This means that domestic firms benefit from the lack of X production because they receive a higher price for every unit of X which they produce. This increase in price ultimately drives the results, increasing the profits received by the X firm. Using the model we next examine the effects a fixed price has on domestic consumers.

#### **5.4 Global Price of Oil:**

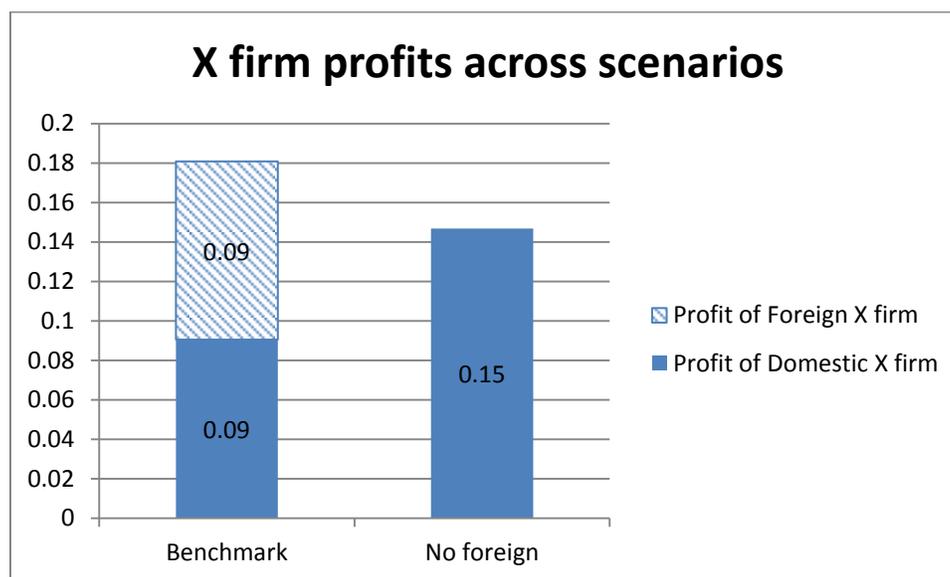
In the previous scenarios, the price of oil was solved endogenously. This implies that Canada has a large enough market share to influence the price of oil. While Canada does contain a large portion of oil reserves it is not the only country capable of supplying oil and is probably unable to determine the price through supply decisions. A more realistic assumption is made that the price of oil is set on a global level.

The scenarios are the same as before except the price of good X is now exogenously given. We can assume Canada is a price taker in the supply of oil and that the price of X is determined by the global market, i.e. Canada's production will have no bearing on the world production levels. As such, the decrease in firm output now will not result in an increase in price.

Setting the equilibrium price of good X has consequences for the solution of the model. The good X market will no longer clear. The additional assumption is made that demand and supply will clear on the global market, but not necessarily clear for the domestic market.

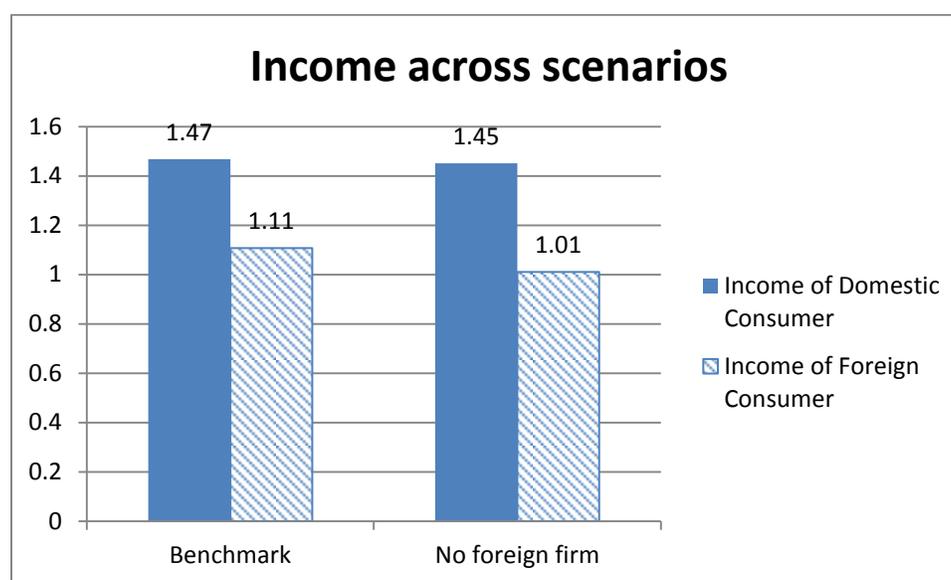
The results are similar to the results found in the previous case. As before, the quantity of X supplied decreases. This time however, profits are more adversely affected by the decrease in output. The domestic X firm no longer benefits from an increase in price that was associated with a decline in production. As such, the profits of the X firm only increase by 62% instead of the 84% which occurred under an endogenously determined X price.

Domestic consumers also suffer from a decrease in royalties. The decrease in output implies that the land is now less productive than it was when the foreign X firm was present in the market. Accordingly, the reduced productivity of the land corresponds with a reduced royalty rate paid to domestic consumers.



**Figure 12: X firm profits across scenarios when price is exogenously determined.**

As before, the domestic consumer's income is affected by both the increase in profits of the domestic firm, as well as the reduced royalty fee paid to consumers. This time instead of the gain of profits outweighing the cost of reduced royalties, the reduced royalties have a greater impact and overall income is reduced for domestic consumers.



**Figure 13: consumer's income across scenarios when price is exogenously determined.**

Similar to previous results, the domestic consumer's income only marginally decreases while the foreign consumer's income decreases by a greater amount. The reduced income will have negative effect on both of the consumers' utilities. However, domestic consumers are only marginally worse off, while foreign consumers are much worse off.

Again, it is conceivable that a contract could be created between the domestic and foreign consumers to allow the operation of a foreign firm within the X sector. The nature of the contract will differ though because the domestic consumer already prefers the scenario where the foreign firm operates in the X sector. As such, the domestic consumer should be willing to accept the operation of the foreign firm without a lump sum payment.

## 5.5 Adaptations:

### 5.5.1 Inclusion of externalities:

Several adaptations are made to this model in order to simulate different scenarios. The first adaptation allows for the inclusion of external costs. One criticism of the oil sand industry has been that there are large external environmental costs associated with the production of the resource. The oil which is locked within the oil sands is incredibly energy, water and capital intensive to extract. This leads to some undesirable consequences. The oil sands currently produce 7% of Canada's CO<sub>2</sub> emissions and are expected to increase to 14% by the year 2020<sup>11</sup>. The use of water in the extraction process creates tailing ponds which are filled with toxic pollutants with potential to leech into the surrounding environment contaminating local rivers and lakes. The populations of the local communities also expand at dramatic rates leading to problems of inadequate public facilities. This generally results in increasing crime rates and rising social problems such as an increase in drug use and domestic violence.

These are some of the external problem associated with the production. For the purposes of this model only the local externalities will be taken into consideration, as such they will only affect the domestic consumer.

The domestic consumer's utility function will now be given by:

$$U_D(x_D, y_D) = x_D^y + y - \phi \sum_{i=D,F} X_i$$

Where  $\phi$  can be shown to be the Marginal External Cost (MEC) of the production of good X. To correct for this externality, the ideal policy is a Pigouvian tax set at the MEC. Accordingly, the Marshallian demand functions are altered.

$$q_i^* = \left( \frac{(1+t)P_x}{\gamma} \right)^{\frac{1}{\gamma-1}}$$

Where  $t$  is the tax rate. When  $t = \phi$  the external cost will be internalized in the market, as such a Pareto efficient result will follow.

The results of this model specification are the same when there has not been a tax implemented. This is expected as the external cost is not internalized in the market. The only difference is that domestic consumers are now aware of the externality and the welfare measure associated with this allocation is now lower.

When the price of good X is solved endogenously, domestic consumers are made better off from the reduction of foreign firms. Domestic consumers are positively impacted from the reduction of foreign firms, partly due to the income generated by profits in the domestic X sector as before, but now the reduced production of good X has two positive effects associated with it. First, the income generated from owning the entire X sector outweighs the loss of royalty revenue. Second, the reduction of production of X increases the domestic consumer's utility because the externality being placed on the domestic consumer decreases when the production of X decreases. The end result is that domestic consumers are better off while foreign consumers are worse off. The domestic consumers are slightly better off than they were before because of the reduction of the externality which is now taken into account. The foreign consumers remain as worse off as they were earlier. Conceivably, a contract could be struck between the parties

which would make both parties better off as before. The foreign consumers would now have to compensate the domestic consumers more than in the previous scenarios.

When the price of good X is given exogenously, domestic consumers are made worse off from the reduction of foreign firms. Again the same factors are at work here. The loss in productivity of the land resource leads to a decrease in royalty revenue collected. The decrease in royalty revenue collected outweighs the increase in profits from the domestic X firm. This results in a loss of income, and a subsequent decrease in utility. The decrease in utility from the decrease in income however is slightly offset by the lower X production. The overall impact is the same as in the original model, with both domestic consumers and foreign consumers becoming worse off when the foreign firm is absent. The foreign consumers are again worse off than the domestic consumers.

### 5.5.2 Consumer discrimination:

An additional adaptation which was done involved altering Gary Becker's model of consumer discrimination. The model is structured by assuming that domestic consumers have distaste for oil produced by foreign companies. As such, domestic consumers' willingness to pay is lower for oil produced by foreign companies. It can be described as:

$$\text{Willingness to pay} = p_x(1 - I * \varepsilon)$$

Where  $p_x$  is the price of good x,  $I$  is a variable with set values of 0 or 1, and  $\varepsilon$  is the coefficient of consumer discrimination. The  $I$  variable is denoted 1 when the foreign company produces good X and 0 otherwise. The  $\varepsilon$  variable then captures the consumer's distaste for

foreign produced oil. When  $\varepsilon$  approaches  $\infty$  the domestic consumer will pay an infinite amount to avoid foreign produced oil. When  $\varepsilon$  is equal to 0, the domestic consumer is indifferent between domestically produced oil and foreign produced oil.

The case which I investigate is when the  $\varepsilon$  variable approaches infinity. Essentially, this segments the market so that domestic consumers only purchase domestically produced oil and foreign consumers are forced to purchase foreign produced oil. This is a result which relies on the symmetry of the model. The demand for good X is symmetric across consumers, as is the supply. Therefore, each firm can produce exactly enough to meet the needs of their respective consumers. The result being that domestic consumers consume all of the domestic supply, while the foreign consumers consume all of the foreign supply.

The results of the non-symmetric case become extremely messy, extremely quickly. The results are driven almost entirely from assumptions. If the assumption is made that domestic consumers represent the majority of market demand, then the product is effectively discriminated against, such that the domestic consumers view the products as two separate products and two different prices can be applied to each. The foreign produced oil is sold at a lower price. This affects the foreign firm forcing it to reduce output or alternatively shut down altogether. In either case, we can expect a reduction in demand for the land resource because of the decrease in productivity; as such domestic consumer's income will be negatively impacted.

Correspondingly, the profits from the domestic X firm increase from the increase in supply by the X firm. The end results are extremely sensitive to the specific assumptions made as well as exogenous parameters.

## 6. Discussion:

If the price of oil is endogenously determined, domestic consumers face a trade-off between collecting higher royalty rates or higher profits. From this model specification the domestic consumer is almost indifferent between either maximization. However, this preference could change if the exogenous parameters for the model were altered. Conceivably there is a case where domestic consumers would much prefer to collect higher royalty revenue over increasing domestic firm profits. For example, if the alpha parameters were increased, the demand for land would increase and the subsequent royalty rates would rise to account for this.

The assumption of endogenously determined prices assumes Canada's production capacity is large enough to influence prices. This is unlikely because Canada only holds a small portion of total reserves. This may however be a reasonable assumption if there was some form of collusion, or a cartel formation across various oil producing countries such that they would have the capacity to determine the price of oil through the control of the majority of supply.

In the more likely case where prices are exogenously determined by global markets, domestic consumers now face a similar trade-off. They can either allow the foreign firms to operate within Canada and receive higher royalty rates, or they can bar foreign firms from operating within Canada and receive higher domestic firm profits. The difference now though, is that the profits received by the operation of the domestic firm do not outweigh the loss of royalty income incurred from barring foreign firms. This is because domestic firms can no longer receive higher prices from a reduced production, and therefore will generate less profit than when prices were endogenously determined.

This is a more realistic assumption because as stated above, Canada is only a small supplier in the oil industry and as such, cannot influence the price of oil through supply decisions. As such, domestic consumers should prefer to allow the operation of foreign owned firms within Canada because they will receive higher royalty rates which outweigh the benefits of having a single domestic oil firm operating within Canada.

One political constraint which is not focused on in this model is the feasibility of choosing the optimal royalty rate. The assumption was made at the beginning of the paper that the royalty rate in place would always be the ideal amount. Empirically, the royalty rate has been shown that Alberta could benefit from increasing the current royalty rate. The political barriers to doing so are high and the likelihood of an increase is slim. In fact, recent reforms have even decreased the royalty rates pushing them further below the optimum level<sup>6</sup>.

If domestic consumers are unable to be adequately compensated for the use of the oil sands through the royalty rate mechanism, then it could be conceivable that domestic consumers could be better off without the operation of foreign firms. Therefore, the results depend upon the royalty rate being able to capture the increase in demand for the resource. If the royalty rate does not increase sufficiently because of political barriers then domestic consumers may indeed be cheated out of the gains made from increasing the amount of firms operating within Canada.

## **7. Conclusion:**

The model in this paper shows that the concerns domestic consumers raise over the distribution of profits is not justified. Given that the price of oil is set in the global market and

that Canada is a relatively small supplier unable to affect the price of oil, domestic consumers can be adequately compensated for the use of their resource through royalties. Domestic consumers receive more benefits when foreign firms operate in Canada because of higher royalty rates. Therefore, domestic consumers should encourage foreign firms to operate in Canada.

Additional research can be explored by adapting this model. One factor which could be explored is the operation of state owned firms. All firms are assumed to be private entities and as such they can be expected to operate in a similar manner, regardless of ownership. State owned enterprises however are not necessarily bounded to the same profit maximization operation. While it is likely they undergo cost minimization it may not be to the same degree as under a private firm because of the different structure of the firm. State owned enterprises may instead focus on government objectives such as securing fuel and energy for development purposes rather than on optimizing the returns to shareholders that private companies pursue.

## 8. Appendix:

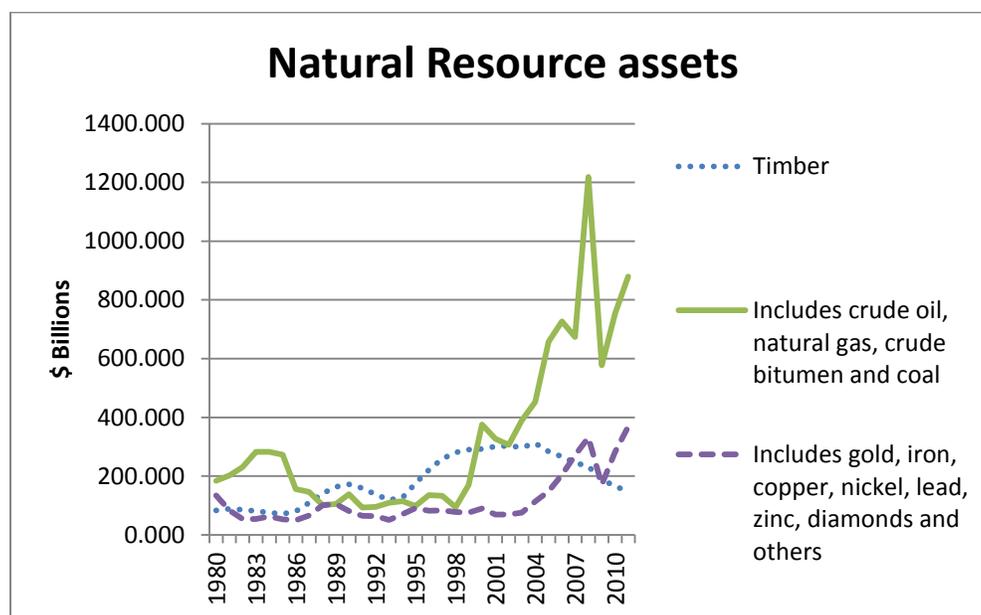
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## 8.2 Resource sector magnitude:

The oil sand resource has grown to be a considerable asset, increasing at a pace of roughly 10% per year from 1998 onwards<sup>2</sup>. As shown in figure 14, it has over taken timber as the primary natural resource asset in Canada. The pace of its development appears to demonstrate its future presence in our resource portfolio as shown in figure 15.



**Figure 14: Natural Resource Assets in Canada. Statistics Canada, n.d., CANSIM tables 378-0005 ,379-0027 and 179-0004. Estimated using Present Value calculation using current resource price and current recoverable reserves.**

## Relative Importance of the Resource Sector over time

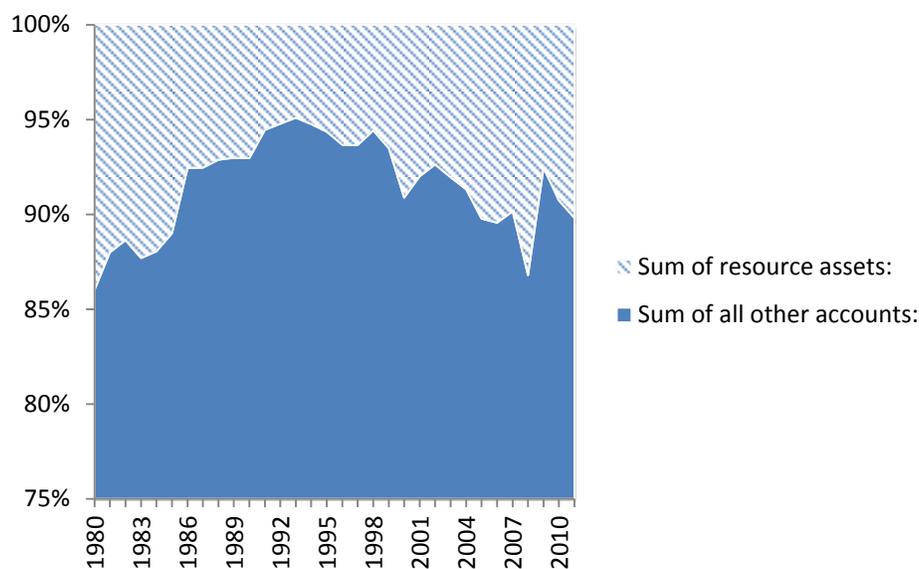


Figure 15: Natural Resource Assets in Canada. Statistics Canada, n.d., CANSIM table 378-0005 ,379-0027.

### 8.3 Algebraic Solving software:

The model is solved with the use of the General Algebraic Modeling Software (GAMS) program using non-linear problem (NLP) solvers. The two solvers which were used are CONOPT and MINOS. The model is solved by first clearing 3 markets, the labour, capital and good X market. The reason it is not necessary to clear all 4 markets is because of Walras' law which states that in a series of N markets; only N-1 of them must be solved to get a complete solution. Taking good Y as the Nth equilibrium condition the remainder can be solved and all markets will be in equilibrium. The result of solving the 3 previous markets gives the equilibrium prices for labour, capital and good X. These prices are then used to calculate firm profits, consumer income, consumer demand for good Y and consumer utility.

## 8.4 Solve results:

The original solve results are shown below in table 2:

Parameter:	Value:
Alpha Domestic, $\alpha_D$	0.4
Beta Domestic, $\beta_D$	0.4
Alpha Foreign, $\alpha_F$	0.4
Beta Foreign, $\beta_F$	0.4
Delta, $\delta$	0.5
Gamma Domestic, $\gamma_D$	0.5
Gamma Foreign, $\gamma_F$	0.5
Total Land supplied, $\bar{L}$	2
Capital endowment Domestic, $K_D$	2
Capital endowment Foreign, $K_F$	2
Share of profits from Firm Y to Domestic Consumer, $\theta_D$	0.5
Share of profits from Firm Y to Foreign Consumers, $\theta_F$	0.5
Land demanded by Domestic firm X, $L_D^*$	1
Land demanded by Foreign firm X, $L_F^*$	1
Capital demanded by Domestic X firm, $K_D^*$	0.604257
Capital demanded by Foreign X firm, $K_F^*$	0.604257
Capital Supplied to X firms from Domestic Consumer, $K_{xD}$	1.208515
Capital supplied to X firms from Foreign Consumer, $K_{xF}$	0
Capital supplied to Y firm from Domestic Consumer, $K_{yD}$	0.791485
Capital supplied to Y firm from Foreign Consumer, $K_{yF}$	2
Quantity of X supplied by Domestic firm X, $X_D^*$	0.817502
Quantity of X supplied by Foreign firm X, $X_F^*$	0.817502
Quantity of X demanded by Domestic Consumer, $x_D^*$	0.817502
Quantity of X demanded by Foreign Consumer, $x_F^*$	0.817502
Quantity of Y demanded from Domestic Consumer, $y_D^*$	1.016218
Quantity of Y demanded from Foreign Consumer, $y_F^*$	0.654555
Profit of Domestic X firm, $\pi_{xD}$	0.090416
Profit of Foreign X firm, $\pi_{xF}$	0.090416
Profit of Y firm, $\pi_y$	0.835387
Utility of Domestic Consumer, $U_D$	1.920376
Utility of Foreign Consumer, $U_F$	1.558713
Price of Good X, $P_x$	0.553
Royalty rate, $\rho$	0.180832
Rental rate paid to capital, $r$	0.299263

Table 2: Base case solve of the General Equilibrium model.

The results from an absent foreign firm are shown in table 3:

Parameter:	Value:
Alpha Domestic, $\alpha_D$	0.4
Beta Domestic, $\beta_D$	0.4
Alpha Foreign, $\alpha_F$	0.4
Beta Foreign, $\beta_F$	0.4
Delta, $\delta$	0.5
Gamma Domestic, $\gamma_D$	0.5
Gamma Foreign, $\gamma_F$	0.5
Total Land supplied, $\bar{L}$	2
Capital endowment Domestic, $K_D$	2
Capital endowment Foreign, $K_F$	2
Share of profits from Firm Y to Domestic Consumer, $\theta_D$	0.5
Share of profits from Firm Y to Foreign Consumers, $\theta_F$	0.5
Land demanded by Domestic firm X, $L_D^*$	2
Land demanded by Foreign firm X, $L_F^*$	N/A
Capital demanded by Domestic X firm, $K_D^*$	1.128068
Capital demanded by Foreign X firm, $K_F^*$	N/A
Capital Supplied to X firms from Domestic Consumer, $K_{xD}$	1.128068
Capital supplied to X firms from Foreign Consumer, $K_{xF}$	0
Capital supplied to Y firm from Domestic Consumer, $K_{yD}$	0.871932
Capital supplied to Y firm from Foreign Consumer, $K_{yF}$	2
Quantity of X supplied by Domestic firm X, $X_D^*$	1.384669
Quantity of X supplied by Foreign firm X, $X_F^*$	N/A
Quantity of X demanded by Domestic Consumer, $x_D^*$	0.692335
Quantity of X demanded by Foreign Consumer, $x_F^*$	0.692335
Quantity of Y demanded from Domestic Consumer, $y_D^*$	1.096959
Quantity of Y demanded from Foreign Consumer, $y_F^*$	0.597719
Profit of Domestic X firm, $\pi_{xD}$	0.166413
Profit of Foreign X firm, $\pi_{xF}$	N/A
Profit of Y firm, $\pi_y$	0.847339
Utility of Domestic Consumer, $U_D$	1.929025
Utility of Foreign Consumer, $U_F$	1.429785
Price of Good X, $P_x$	0.600913
Royalty rate, $\rho$	0.166413
Rental rate paid to capital, $r$	0.295041

Table 3: No foreign firm case solve of the General Equilibrium model.

Table 4 shows the results from the previous solutions tables with the % change corresponding to the changes from the benchmark scenario.

Parameter:	Benchmark	No foreign firm	% Change:
Alpha Domestic, $\alpha_D$	0.4	0.4	0.00%
Beta Domestic, $\beta_D$	0.4	0.4	0.00%
Alpha Foreign, $\alpha_F$	0.4	0.4	0.00%
Beta Foreign, $\beta_F$	0.4	0.4	0.00%
Delta, $\delta$	0.5	0.5	0.00%
Gamma Domestic, $\gamma_D$	0.5	0.5	0.00%
Gamma Foreign, $\gamma_F$	0.5	0.5	0.00%
Total Land supplied, $\bar{L}$	2	2	0.00%
Capital endowment Domestic, $K_D$	2	2	0.00%
Capital endowment Foreign, $K_F$	2	2	0.00%
Share of profits from Firm Y to Domestic Consumer, $\theta_D$	0.5	0.5	0.00%
Share of profits from Firm Y to Foreign Consumers, $\theta_F$	0.5	0.5	0.00%
Land demanded by Domestic firm X, $L_D^*$	1	2	100.00%
Land demanded by Foreign firm X, $L_F^*$	1	N/A	-100.00%
Capital demanded by Domestic X firm, $K_D^*$	0.604257	1.128068	86.69%
Capital demanded by Foreign X firm, $K_F^*$	0.604257	N/A	-100.00%
Capital Supplied to X firms from Domestic Consumer, $K_{xD}$	1.208515	1.128068	-6.66%
Capital supplied to X firms from Foreign Consumer, $K_{xF}$	0	0	0.00%
Capital supplied to Y firm from Domestic Consumer, $K_{yD}$	0.791485	0.871932	10.16%
Capital supplied to Y firm from Foreign Consumer, $K_{yF}$	2	2	0.00%
Quantity of X supplied by Domestic firm X, $X_D^*$	0.817502	1.384669	69.38%
Quantity of X supplied by Foreign firm X, $X_F^*$	0.817502	N/A	-100.00%
Quantity of X demanded by Domestic Consumer, $x_D^*$	0.817502	0.692335	-15.31%
Quantity of X demanded by Foreign Consumer, $x_F^*$	0.817502	0.692335	-15.31%
Quantity of Y demanded from Domestic Consumer, $y_D^*$	1.016218	1.096959	7.95%
Quantity of Y demanded from Foreign Consumer, $y_F^*$	0.654555	0.597719	-8.68%
Profit of Domestic X firm, $\pi_{xD}$	0.090416	0.166413	84.05%
Profit of Foreign X firm, $\pi_{xF}$	0.090416	N/A	-100.00%
Profit of Y firm, $\pi_y$	0.835387	0.847339	1.43%
Utility of Domestic Consumer, $U_D$	1.920376	1.929025	0.45%
Utility of Foreign Consumer, $U_F$	1.558713	1.429785	-8.27%
Price of Good X, $P_x$	0.553	0.600913	8.66%
Royalty rate, $\rho$	0.180832	0.166413	-7.97%
Rental rate paid to capital, $r$	0.299263	0.295041	-1.41%

Table 4: Comparison of previous scenarios.

Table 5 shows the comparison of the earlier scenarios when the price of oil is exogenously solved.

Parameter:	Benchmark	No foreign	% Change
Alpha Domestic, $\alpha_D$	0.4	0.4	0.00%
Beta Domestic, $\beta_D$	0.4	0.4	0.00%
Alpha Foreign, $\alpha_F$	0.4	0.4	0.00%
Beta Foreign, $\beta_F$	0.4	0.4	0.00%
Delta, $\delta$	0.5	0.5	0.00%
Gamma Domestic, $\gamma_D$	0.5	0.5	0.00%
Gamma Foreign, $\gamma_F$	0.5	0.5	0.00%
Total Land supplied, $\bar{L}$	2	2	0.00%
Capital endowment Domestic, $K_D$	2	2	0.00%
Capital endowment Foreign, $K_F$	2	2	0.00%
Share of profits from Firm Y to Domestic Consumer, $\theta_D$	0.5	0.5	0.00%
Share of profits from Firm Y to Foreign Consumers, $\theta_F$	0.5	0.5	0.00%
Land demanded by Domestic firm X, $L_D^*$	1	2	100.00%
Land demanded by Foreign firm X, $L_F^*$	1	N/A	-100.00%
Capital demanded by Domestic X firm, $K_D^*$	0.604257	1.014454	67.88%
Capital demanded by Foreign X firm, $K_F^*$	0.604257	N/A	-100.00%
Capital Supplied to X firms from Domestic Consumer, $K_{xD}$	1.208515	1.014454	-16.06%
Capital supplied to X firms from Foreign Consumer, $K_{xF}$	0	0	0.00%
Capital supplied to Y firm from Domestic Consumer, $K_{yD}$	0.791485	0.985546	24.52%
Capital supplied to Y firm from Foreign Consumer, $K_{yF}$	2	2	0.00%
Quantity of X supplied by Domestic firm X, $X_D^*$	0.817502	1.327104	62.34%
Quantity of X supplied by Foreign firm X, $X_F^*$	0.817502	N/A	-100.00%
Quantity of X demanded by Domestic Consumer, $x_D^*$	0.817502	0.817502	0.00%
Quantity of X demanded by Foreign Consumer, $x_F^*$	0.817502	0.817502	0.00%
Quantity of Y demanded from Domestic Consumer, $y_D^*$	1.016218	0.998969	-1.70%
Quantity of Y demanded from Foreign Consumer, $y_F^*$	0.654555	0.558635	-14.65%
Profit of Domestic X firm, $\pi_{xD}$	0.090416	0.146778	62.34%
Profit of Foreign X firm, $\pi_{xF}$	0.090416	N/A	-100.00%
Profit of Y firm, $\pi_y$	0.835387	0.863937	3.42%
Utility of Domestic Consumer, $U_D$	1.920377	1.903127	-0.90%
Utility of Foreign Consumer, $U_F$	1.558713	1.462794	-6.15%
Exogenously fixed Price of Good X, $P_x$	0.553	0.553	0.00%
Royalty rate, $\rho$	0.180832	0.146778	-18.83%
Rental rate paid to capital, $r$	0.299263	0.289373	-3.30%

Table 5: Comparison of scenarios using an exogenously given price of good X.

Table 6 shows the results done from the adaptation of incorporating an externality.

	Endogenous Solve				Exogenous Solve			
	No Tax imposed		Tax Imposed		No tax imposed		Tax Imposed	
	Base result	No foreign firm	Base Result	No Foreign firm	Base Case	No foreign	Base Case	No foreign firm
Quantity of X supplied by Domestic firm X	0.82	1.38	0.76	1.28	0.82	1.33	0.82	1.33
Quantity of X supplied by Foreign firm X	0.82	N/A	0.76	N/A	0.82	N/A	0.82	N/A
Quantity of X demanded by Domestic Consumer	0.82	0.69	0.76	0.64	0.82	0.82	0.57	0.57
Quantity of X demanded by Foreign Consumer	0.82	0.69	0.76	0.64	0.82	0.82	0.57	0.57
Quantity of Y demanded from Domestic Consumer	1.02	1.10	0.75	0.83	1.02	1.00	0.93	0.91
Quantity of Y demanded from Foreign Consumer	0.65	0.60	0.46	0.43	0.65	0.56	0.56	0.47
Capital demanded by Domestic X firm	0.60	1.13	0.50	0.94	0.60	1.01	0.60	1.01
Capital demanded by Foreign X firm	0.60	N/A	0.50	N/A	0.60	N/A	0.60	N/A
Capital supplied to firm Y	2.79	2.87	2.99	3.06	2.79	2.99	2.79	2.99
Income of Domestic Consumer	1.47	1.51	1.37	1.41	1.47	1.45	1.47	1.45
Income of Foreign Consumer	1.11	1.01	1.08	1.01	1.11	1.01	1.11	1.01
Utility of Domestic Consumer accounting for Externality	1.59	1.65	1.31	1.38	1.92	1.90	1.45	1.43
Utility of Foreign Consumer	1.56	1.43	1.33	1.23	1.56	1.46	1.32	1.22
Price of Good X	0.55	0.60	0.48	0.52	0.55	0.55	0.55	0.55
Wage paid to labor	0.18	0.17	0.15	0.13	0.18	0.15	0.18	0.15
Rental rate paid to capital	0.30	0.30	0.29	0.29	0.30	0.29	0.30	0.29

Table 6: Results from the externality adaptation.

Table 7 shows the results done from the adaptation of Gary Becker's consumer discrimination.

Parameter:	Benchmark	Consumer Discrimination
Alpha Domestic, $\alpha_D$	0.4	0.4
Beta Domestic, $\beta_D$	0.4	0.4
Alpha Foreign, $\alpha_F$	0.4	0.4
Beta Foreign, $\beta_F$	0.4	0.4

Delta, $\delta$	0.5	0.5
Gamma Domestic, $\gamma_D$	0.5	0.5
Gamma Foreign, $\gamma_F$	0.5	0.5
Total Land supplied, $\bar{L}$	2	2
Capital endowment Domestic, $K_D$	2	2
Capital endowment Foreign, $K_F$	2	2
Share of profits from Firm Y to Domestic Consumer, $\theta_D$	0.5	0.5
Share of profits from Firm Y to Foreign Consumers, $\theta_F$	0.5	0.5
Land demanded by Domestic firm X, $L_D^*$	1	1
Land demanded by Foreign firm X, $L_F^*$	1	1
Capital demanded by Domestic X firm, $K_D^*$	0.604257	0.604258
Capital demanded by Foreign X firm, $K_F^*$	0.604257	0.604258
Capital Supplied to X firms from Domestic Consumer, $K_{xD}$	1.208515	1.208515
Capital supplied to X firms from Foreign Consumer, $K_{xF}$	0	0
Capital supplied to Y firm from Domestic Consumer, $K_{yD}$	0.791485	0.791485
Capital supplied to Y firm from Foreign Consumer, $K_{yF}$	2	2
Quantity of X supplied by Domestic firm X, $X_D^*$	0.817502	0.817502
Quantity of X supplied by Foreign firm X, $X_F^*$	0.817502	0.817502
Quantity of X demanded by Domestic Consumer, $x_D^*$	0.817502	0.817502
Quantity of X demanded by Foreign Consumer, $x_F^*$	0.817502	0.817502
Quantity of Y demanded from Domestic Consumer, $y_D^*$	1.016218	1.016219
Quantity of Y demanded from Foreign Consumer, $y_F^*$	0.654555	0.654555
Profit of Domestic X firm, $\pi_{xD}$	0.090416	0.090416
Profit of Foreign X firm, $\pi_{xF}$	0.090416	0.090416
Profit of Y firm, $\pi_y$	0.835387	0.835387
Utility of Domestic Consumer, $U_D$	1.920376	1.920377
Utility of Foreign Consumer, $U_F$	1.558713	1.558713
Price of Good X, $P_x$	0.553	0.553001
Royalty rate, $\rho$	0.180832	0.180832
Rental rate paid to capital, $r$	0.299263	0.299262

Table 7: Results from the discrimination adaptation.