MAIN FEATURES AND STRUCTURE OF THE BI-REGIONAL CGE MODEL FOR QUÉBEC AND THE REST-OF-CANADA

by

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4 The General Equilibrium Model is the property of the Ministry of Finance of Québec (MFQ). However, opinions expressed in this paper are those of the authors, who are solely responsible for them.

PREFACE

Because they are capable of tracking complex economic interactions, as well as their effects on agents' behavior, general equilibrium models are extremely powerful tools for the analysis of economic and fiscal policy.

In the spring of 2000, the Ministry of Finance of Québec decided to acquire such an analytical tool. So it mandated the Centre de Recherche en Économie et Finance Appliquées (CRÉFA) at Laval University to develop a general equilibrium model adapted to the specific features of the Québec economy. The Institut de la Statistique du Québec (ISQ) contributed to the success of the project by agreeing to participate actively in developing the model, and assumed the task of constructing the underlying social accounting matrix.

To ensure that the model responds to the needs of the Ministry of Finance of Québec, the CRÉFA team, led by Bernard Decaluwé, André Lemelin and Véronique Robichaud, and the ISQ team, under Camille Courchesne, David Bahan and Danielle Bilodeau, worked in cooperation with Ministry of Finance staff, especially Brian Girard, Éric Genest-Laplante and Xavier Brosseau.

In the hands of Ministry of Finance of Québec, the computable general equilibrium model is a highly efficient tool to better understand the complex implications of economic and fiscal policy, with the aim of better decision-making.

This analysis is based on the general equilibrium model of the Ministry of Finance of Québec and on the social accounting matrix constructed by the ISQ. However the authors are solely responsible for the interpretation of these data.

ABSTRACT

The model is a static, computable general equilibrium, multi-sector model. This means, in particular, that supply and demand reflect choice-theoretic behaviour on the part of economic agents, and that equilibrium is achieved through market-price adjustment mechanisms. The model is also adapted to fully reflect the situation of the Québec economy in the Canadian and World context. Specifically, given that Québec is part of Canada, the model is a bi-regional one. Hence, not only is the Québec economy modelled in detail, but so is the economy of the Rest-of-Canada, as well as their mutual relations, and their relations with the rest of the world. Spillover and feedback effects between the two economies are thus built into the model. In particular, above and beyond the direct effects on the Québec and Rest-of-Canada economies of provincial and federal government policies, the model shows their indirect effects, that is to say, effects that are felt on Québec through direct effects on the Rest-of-Canada and vice-versa.

This paper describes the structure of the model and comments on the main equation specifications. With the help of diagrams, the presentation describes :

_ the production, supply and demand linkages within each of the two regions

_ the interregional and international trade linkages

_ the flows of income, savings and expenditure to and from agents

_ price determination

GENERAL APPROACH

The bi-regional computable general equilibrium (CGE) model for Québec and the Rest-of-Canada (hereafter RoC) is a static, multi-sector model. It belongs to the CGE family of models, which means, in particular, that supply and demand reflect choice-theoretic behaviour on the part of economic agents, and that equilibrium is achieved through market-price adjustment mechanisms. The model is also designed to fully reflect the situation of the Québec economy in the Canadian and World context. Specifically, given that Québec is part of Canada, the model is a bi-regional one. Hence, not only is the Québec economy modelled in detail, but so is the economy of the Rest-of-Canada, as well as their mutual relations, and their relations with the rest of the world. Spillover and feedback effects between the two economies are thus built into the model. In particular, above and beyond the direct effects on the Québec and RoC economies of provincial and federal government policies, the model shows their indirect effects, that is to say, effects that are felt on Québec through direct effects on the RoC and vice-versa.

In the model, economic agents are classified into four categories : enterprises, households, governments and the Rest-of-the-World (henceforth RoW). All agents are price-takers. But while the behavior of enterprises and households is the result of optimization, such is not the case for governments and the RoW agent. All are nonetheless subject to their budget constraints.

The model is a very large one, where the classification of activities and of goods and services is close to Statistics Canada's M-level input-output classification. As was mentioned above, the RoC economy is just as detailed in the model as the Québec one, save for governments. In the case of governments, all provincial and territorial governments in the RoC are aggregated into a single agent, and all local and regional governments of the RoC are likewise aggregated, without consideration for the subdivisions within the RoC. In each region, there are : 56 industries, 121 categories of goods and services, and 48 personal consumption expenditure categories. Investments are distributed among 13 categories. There are 150 household types in Québec, and 155 in the RoC; households are classified according to household composition, income

level, and age group [5]. Such a fine classification of households makes it possible to evaluate the social impact of fiscal policies, following the representative household approach, according to which all agents in a given category are supposed to share the same characteristics and to behave identically (this implies, in particular, that the variance of income within groups is zero). Labor demand is defined in each region for 11 types of labor; this is an aggregation of the major groups of the standard occupational classification of 1980. Finally, the model has two types of capital, corresponding to two enterprise agents : corporations and individual enterprises.

What the model is *not*, however, is dynamic. Absent, therefore, are capital accumulation, as well as the demographics and evolution of the labor force.

The model is based on a social accounting matrix (SAM), which describes the structure of the Québec-Canada economic system for reference year 1996. This SAM was elaborated by the team at the *Institut de la Statistique du Québec* and it has been presented in paper MSS/29.1. The model parameters were calibrated using this SAM.

This paper will describe the structure of the model and comment on the main equation specifications. With the help of diagrams, the presentation will describe :

_ the production, supply and demand linkages within each of the two regions

_ the interregional and international trade linkages

_ the flows of income, savings and expenditure to and from agents

_ price determination

SPECIAL CHARACTERISTICS OF OUR MODEL

Some of the special characteristics of our model already appear in the structure of the underlying SAM. Here, we shall point out three : the bi-regional nature of the model, the use of « supra-regional » accounts, and the decision to record purchases at consumer, or buyers' prices, rather than at producer, or sellers' prices.

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[5] There are 5 types that do not exist in Québec. The household's age group is defined by the age of what Statistics Canada calls « the reference person ».

A bi-regional model

The bi-regional character of the model is quite evident in the SAM. There are two parallel series of accounts : one represents the Québec economy, and the other, the RoC. Québec-RoC trade appears in the parts of the matrix where Québec account columns cross RoC account rows, and vice-versa. In these parts of the SAM, there are three pairs of non empty cells :

- Wages and salaries paid by each region to residents of the other region ;
- Imports of each region from the other (which are, by definition identical to the exports of the other region.

The supra-regional level

One of the specificities of the model is the introduction of supra-regional accounts, in order to take account of transactions that cannot be tied to a territorial definition [6]. The supra-regional accounts are : interest and dividend accounts, the Rest-of-the-World account (hereafter RoW), the accounts related to the consolidated federal government, and the accumulation account.

INTEREST AND DIVIDEND ACCOUNTS

During the construction of the SAM, it became clear that the available data made it possible to estimate interest and dividend income received by households in each region, and interest and dividend payments made by enterprises of each region, but that it would be impossible to convincingly estimate the region of origin of interests and dividends received or the region of destination of interests and dividends paid. These gaps in the data naturally reflect the high degree of integration of financial markets in Canada. To take this into account, it was decided to create two supra-regional accounts, not assigned to any region in particular, one for interests, and the other for dividends. So all interests and dividends paid go to these accounts, and all interests and dividends received come from them. It is obvious that, given the mode of construction of the SAM, the sum of interests and dividends paid is equal to the sum received.

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6 This technique was pioneered by R. I. Round. See Round (1988) «Incorporating the International, Regional, and Spatial Dimension into a SAM ; Some Methods and Applications», dans : Harrigan, F. et McGregor, P. G. (éd.), *Recent Advances in Regional Economic Modelling*, London Papers in Regional Science 19, Pion.

THE REST-OF-THE-WORLD (ROW) ACCOUNT

There is a single RoW agent account, from which are purchased all international imports, to Québec as well as to the Rest-of-Canada (RoC). Similarly, exports from Québec and the RoC are sold to this agent; nonetheless, demands for exports from Québec and from the RoC are represented by distinct functions. Moreover, these demand functions are not infinitely elastic relative to price. This reflects several key real-world features :

- Québec and the RoC share the same currency, so that, internationally, all that matters is the current account balance for the whole of Canada.
- The demand for international imports by Canada (including Québec) doesn't carry enough weight to influence world prices. This is equivalent, for imports, to the « small country » hypothesis in international trade theory : as importers, Québec and Canada are on world markets in the position of perfect competitors, who have no influence on prices and face a supply curve that is perfectly elastic at existing equilibrium prices. At these prices, they will find suppliers willing to deliver whatever quantity they may want.
- On the other hand, Québec and the RoC cannot be considered as « small countries » as exporters. Because, in particular, of the specialization and concentration on certain markets of their exports, increasing these exports usually requires a competitive effort, which is reflected in a demand curve that is not perfectly elastic at going world prices. To increase their market share, Québécois and Canadian exporters have to lower their prices.
- Moreover, even if one were to consider Canada as a whole as a « small country », producers in Québec and those in the RoC are imperfect competitors with respect to one another on international markets, so that each of them faces a downward-sloping international demand curve for its products.

THE CONSOLIDATED FEDERAL GOVERNMENT ACCOUNTS

In the model, the federal government plays the three essential roles of any government : it produces goods and services, in Québec as well as in the RoC, it levies tax revenue from the various agents, and finally, it makes transfers between agents. As a producer of services, it is of some importance to be able to distinguish federal government activity according to whether it takes place in Québec or in the RoC. But at the same time,

account must be taken of the fact that it is a single agent. That's why we have discarded the idea of having two perfectly distinct agent accounts to represent the federal government, one in Québec and the other in the RoC. Instead, the federal government in Québec appears separately in the SAM, but as a subsidiary, so to speak, of the « Consolidated federal government ».

The agent « Federal government in Québec » thus receives tax revenue levied on Québec territory, and to it are imputed federal expenditures in Québec [7]. The surplus or deficit of the federal government in Québec is then absorbed by the Consolidated federal government.

The consolidated federal government accounts represent all the other transactions of the federal government. The savings of the consolidated federal government (including the balance of federal government operations in Québec) go to the supra-regional accumulation account.

THE ACCUMULATION ACCOUNT

Given the mobility of capital within Canada, it would make little sense to have separate accumulation accounts for Québec and the RoC. All savings therefore go to the supra-regional accumulation account, from which is financed all of the investment expenditure, be it in Québec or in the RoC.

Nonetheless, savings flows from Québec and investment expenditures in Québec are perfectly distinct from corresponding flows in the RoC, so that it is possible to calculate *ex post* the amount of positive or negative savings-investment gap for Québec or for the RoC. A surplus of investment over savings in Québec should be mirrored in an equal deficit of the trade balance of Québec with the RoC ; inversely, a savings surplus in Québec should be mirrored in a trade surplus with the RoC. We wrote « should be mirrored », because some flows between surpa-regional accounts cannot be assigned to any region in particular. These are : (1) investment income (interest and dividends) from foreign sources, (2) international transfers from the consolidated federal government,

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7 This means that the distribution of federal spending between Québec and the RoC is territorial. This method of distribution does not allow to distribute benefits received by citizens. For example, salaries of civil servants working in Québec are paid by the agent « Federal government in Québec », no matter who are the beneficiaries of these civil servants' activity ; the same rule applies to defence spending. In this respect, our model is different from the Finance Canada model, where households consume the services produced by public administrations.

and (3) interest, dividends and net incomes of unincorporated enterprise paid to foreigners.

Producer prices and consumer prices

From the very start, the SAM design depends on the choice that is made between two methods of valuation of expenditure flows. In the Québec CGE model, expenditures are recorded at *consumer prices*, that is, at prices paid by purchasers, inclusive of all taxes and margins, rather than at *producer prices* (prices received by sellers or suppliers, exclusive of taxes and margins). From this choice follows the way indirect taxes and transport and commerce margins are treated.

In the ISQ input-output model as well, expenditures are recorded at consumer prices. In Statistics Canada input-output tables, on the contrary, expenditures are recorded at producer prices. Following this method would imply, among other things, that indirect taxes related to purchases of intermediate inputs be levied from the purchasing industry, as an aggregate amount. Margins would be similarly treated, *mutatis mutandis*. Luckily, Statistics Canada input-output tables are completed by tax and margin tables that made it possible to apportion intermediate input taxes and margins among the different goods and services. So, in the SAM, indirect taxes and margins associated with intermediate input purchases are levied from the commodity accounts, together with the indirect taxes and margins associated to other domestic demand purchases.

Why have we made this choice ? Because, in general, the rates of indirect taxes depend on the nature of the commodity, rather than on the identity of the buyer. The favoured approach is therefore well adapted to the simulation of tax changes whereby certain products would be exempt, or taxes at a different rate. On the other hand, the Statistics Canada method would be better adapted to the simulation of tax changes whereby certain activities or agents would be exempt or subject to a different rate. So, to try to achieve the best of both worlds, it is possible for the indirect tax on any commodity to be levied at different rates according to whether the buyers are households, investors or productive activities (for intermediate consumption).

STRUCTURE OF THE MODEL

Although it closely follows traditional approaches in CGE modelling, the structure of the model is much more complex, since it has to reflect the bi-regional and federal characteristics of the economy.

The structure of the model described here is represented in a series of four flowcharts :

- Chart 1 : Production and demand flows
- Chart 2 : Interprovincial and international trade flows
- Chart 3 : Income, savings and expenditures of agents
- Chart 4 : Price determination

Parts of the charts are reproduced and included in the following description. These excerpts from the charts are identified by the number of the chart from which they are taken, followed by a letter. To help the reader locate the excerpts in the global charts, the configuration of elements relative to one another has been preserved as much as possible.

Industries and production

In each industry of each region, there is a large number of establishments, whose behavior follows the representative production unit. The representative unit maximizes profit by optimally combining factors and inputs, given their market prices, and by producing the most profitable combination of goods and services, given its production technology and market prices; moreover, products are sold in the local domestic market and exported to the other region or the RoW in proportions that maximize their overall value, given the different market prices and the limits in the transformation possibilities.

In each industry, a constant returns production technology uses capital, labor, and intermediate inputs. The production function is modelled as a two-level process. At the upper level, value added and intermediate consumption are combined according to Leontief fixed-proportions technologies to produce output. Intermediate consumption constitutes of goods and services, also combined according to Leontief fixed-proportions technologies. Value added, on the other hand, is produced following a Cobb-Douglas technology from capital and the different types of labor; at the second level.

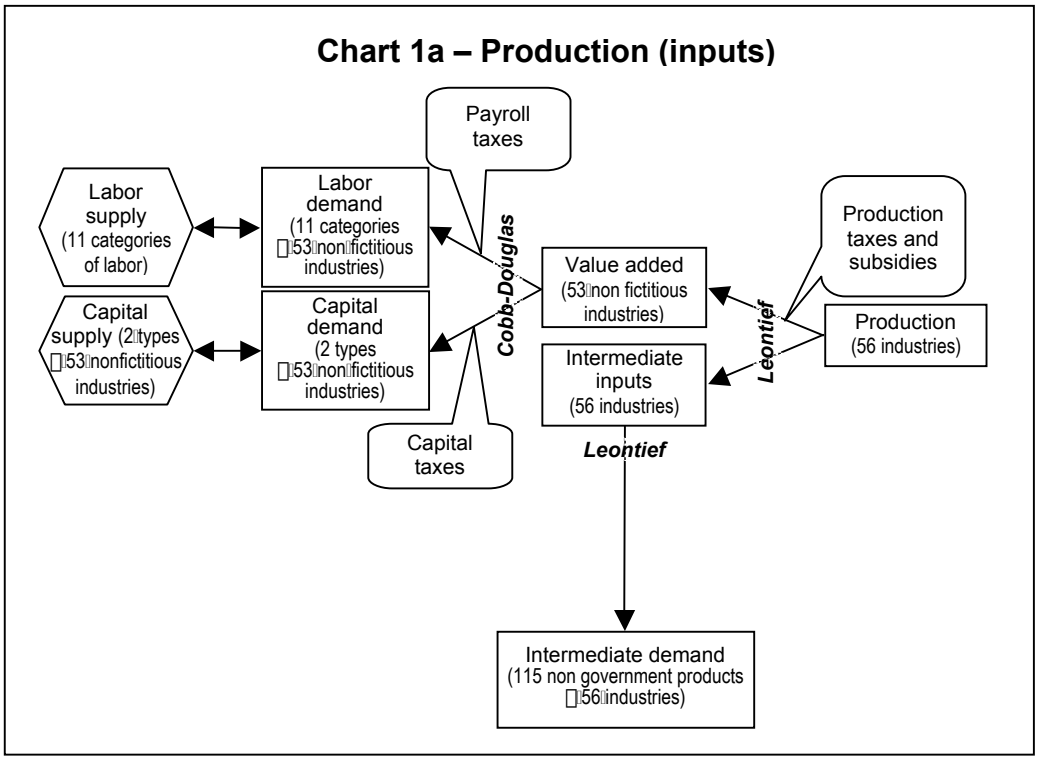


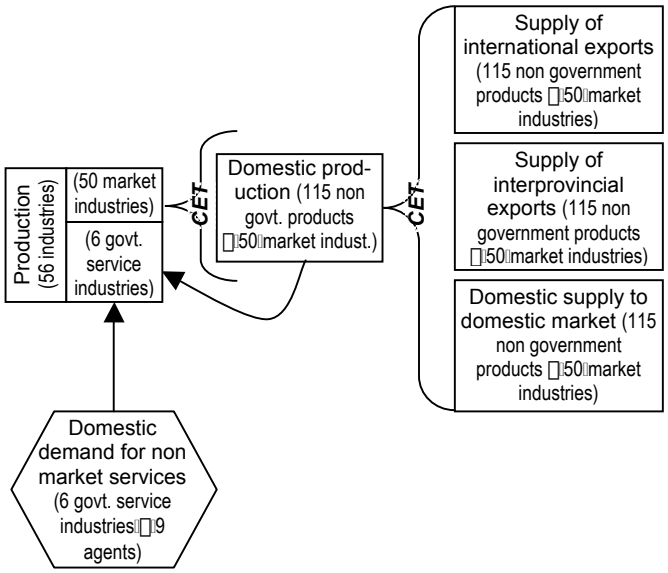
Chart 1a – Production (inputs)
Payroll taxes
Labor supply (11 categories of labor)
Labor demand (11 categories 53 non fictitious industries)
Capital supply (2 types 53 nonfictitious industries)
Capital demand (2 types 53 non fictitious industries)
Cobb-Douglas
Value added (53 non fictitious industries)
Intermediate inputs (56 industries)
Leontief
Production taxes and subsidies
Production (56 industries)
Leontief
Capital taxes
Intermediate demand (115 non government products 56 industries)

Labor demand is derived from the Cobb-Douglas value-added function. In the base model, workers of each type of labor are mobile between industries within a region, but not between regions. Capital, on the other hand, is specific to each industry of each region and its supply is fixed in the short run. This hypothesis on capital is realistic from a short term perspective because of adjustment costs which reduce the mobility of that factor between industries and regions. It is also consistent with the static character of the model, since capital, once in place, is not easily moved in general.

The retribution of capital is derived from the Cobb-Douglas value-added function. It is then distributed in fixed shares, mostly to the enterprise agents, after depreciation has been directly shifted to savings. The only part of capital retribution that goes to governments are duties paid on natural resources.

The outcome of the production process just described is an aggregate of the various goods and services produced by the industry. Except for the six government services industries, constant elasticity of transformation (CET) functions capture the imperfect substitutability, from the production point of view, first between different goods and services, and then between goods produced for the domestic market, those produced for export to the other region, and those produced for export to the RoW. Thus, on the first level, the industry's composite output is a combination of its various products; on the second level, each product is an aggregate of like goods directed at the three sales markets : the domestic market, the other-region export market (the RoC for Québec, and Québec for the RoC), and the international export market.

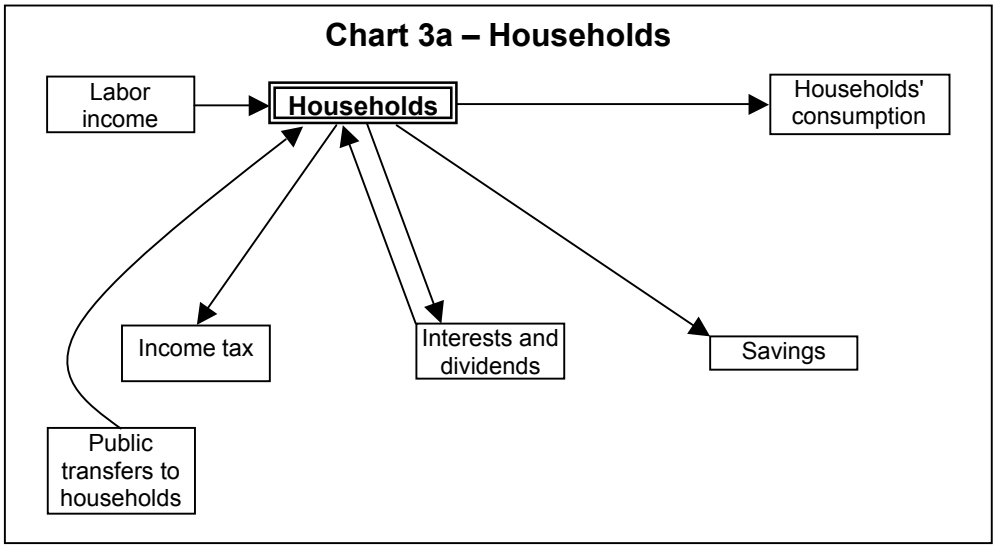
Chart 1b – Production (supply)



For government services industries, the specification is simpler. Each industry's output is the sum of its products, and its supply of each product is equal to government demand. In the base-year SAM, government services industries also produce small quantities of non government goods; their supply of these products on each market is treated as fixed.

Households

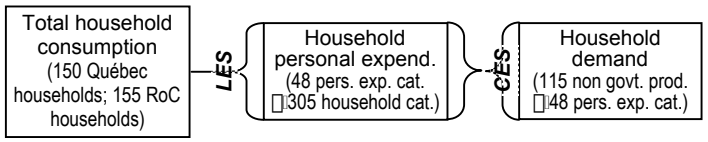
Household income consists of wages and salaries, interests and dividends, and net transfers from government and the RoW. Labor income generated in productive activities is distributed among household types in fixed, exogenous shares. However, although households own the enterprises, they don't receive capital income directly : capital income is paid to enterprises, which pay interests and dividends to the corresponding supra-regional accounts; it is from theses supra-regional accounts that investment income is distributed, in fixed shares, among the different types of households.



Household behavior is modelled following the representative agent approach for each household type in each region. The way households use their income is a multi-stage process :

- Each type of household first distributes its total income between income taxes, savings, consumption, and transfers.
  - Households income taxes are fixed proportions of total income, after subtracting non taxable transfers received. Of course, households also pay indirect taxes on their consumption expenditure, but such taxes are included in the amount paid for each good (purchases recorded at buyers' prices).
  - Once income taxes are paid, each household type dedicates a fixed share of disposable income to savings.
  - Transfers from households, including the transfer part of interest on consumer loans, are fixed, exogenous amounts.
  - The remainder for each household type is total consumption expenditure.
- Next, each representative household type distributes its total consumption expenditure among 47 personal expenditure categories in such a way as to maximize utility, according to a Stone-Geary linear expenditure system (LES). The final, 48th category, « Net foreign expenditure », is treated differently : consumption of the 48th category is fixed in volume, and equal to minimum consumption.
- Finally, for each of the personal expenditure categories, except for the 48th, the amounts spent by all household types in a given region are added up, and then optimally distributed among goods and services according to a constant-elasticity-of-substitution (CES) function. As for the sum of « Net foreign expenditure » of all household types, it is made up of fixed, exogenous quantities of the various goods and services.

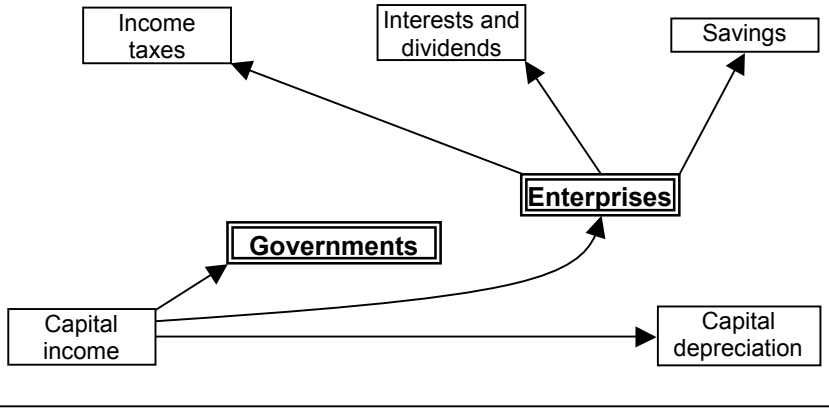
Chart 1c – Household consumption



Enterprises

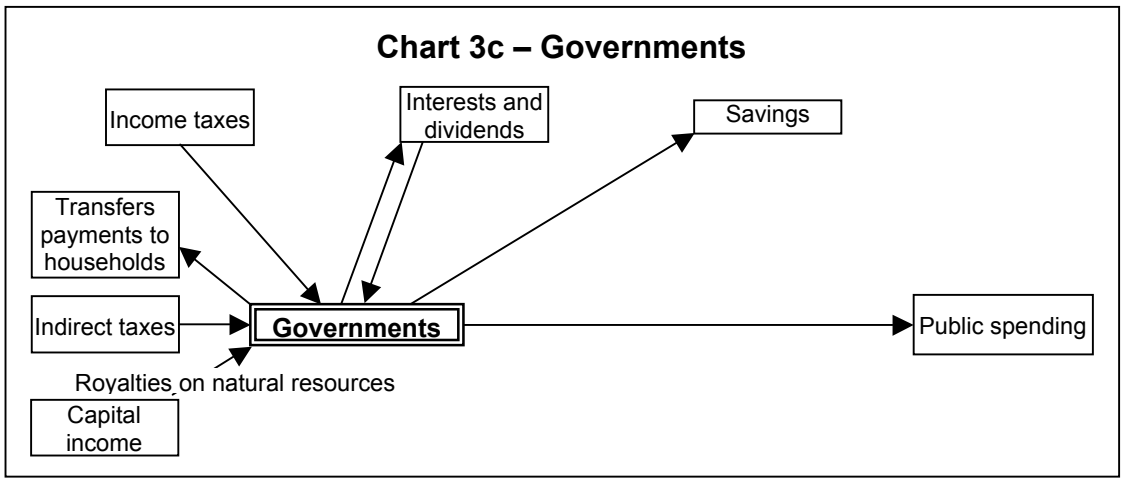
Enterprises receive most of capital income paid by production, after depreciation has been directly shifted to savings. The part of capital income that corresponds to duties paid on natural resources is paid to government. Enterprises pay income tax to government, and they pay interests and dividends to the corresponding supra-regional accounts. The remainder (undistributed profits after interests and dividends) goes to savings.

Chart 3b – Enterprises



Governments

There are three levels of government in the model : federal, provincial, and local (municipal, metropolitan, etc.). But the model doesn't take account of any subdivision within the RoC, so the nine provincial and two territorial governments in the RoC are aggregated into a single agent, and so are all the local governments in the RoC.



Contrary to productive activities and households, governments as agents do not have any optimiziing behavior. However, the production of government services is modelled in the same way as the production of all other goods and services : production costs are minimized by the representative unit. Governments raise tax revenue and spend. Government revenue comes from income taxes and indirect taxes. Government spending consists of current expenses, constant in real terms, and of transfers to households and to other governments, constant in nominal terms. Governments purchase the output of government services industries (non market goods). Public investments, like all investment, are financed from the savings pool (see below); they are not, therefore, isolated from private investments. Each government agent finances its deficit (excess of current spending over revenue) by borrowing from the savings pool; likewise, any surplus (excess of revenue over spending) goes to the savings pool; in the particular case of the « Federal government in Québec », any surplus or deficit is first consolidated with the « Consolidated federal government ».

Chart 1d – Government public spending

Particular care was taken to model taxation. Each tax is applied in the model to a flow that represents, as closely as possible, the corresponding tax base. This is true in particular of the indirect taxes, which apply, so to speak, in layers one over the other. Moreover, the model structure allows indirect tax rates to differ according to whether they apply to household consumption expenditures, investment, or intermediate consumption. We will come back to indirect taxes when we examine price determination.

Only the federal government raises import duties. In a model designed for fiscal simulation such as this one, income tax rates and indirect tax rates (mainly GST and QST) will be exogenous simulation parameters. Modifying one or the other of these rates has implications for the behavior of households and productive activities who respond to changes in relative prices. And, of course, these changes and the responses they trigger necessarily impact on government budgets.

However, the model is not a micro-simulation model, where household type would include several cases : here, households of each type appear as a single representative household, just as establishments in each industry appear as a single representative firm. Thus, the accuracy with which taxation can be modelled depends on the degree of detail in the classification of households and productive activities.

Savings and investment

The savings pool receives the savings of all agents (households, enterprises and governments) of both regions, as well as net foreign savings (current account deficit). The pooling of savings in a single account is meant to reflect the freedom of movement that results from the integration of capital markets in Canada. According to Walras' Law, the total amount of investment must be equal to the total amount of available savings. The closure rule adopted for the base model is that total investment is endogenous, determined by savings. Inventory variation is exogenous, fixed in real terms. After subtracting the value of inventory change from total savings, the remainder is distributed among the 13 investment categories following fixed value shares. Within each category, a fixed amount is levied for permits paid to governments, then the rest is distributed in fixed value shares between regions and among goods and services.

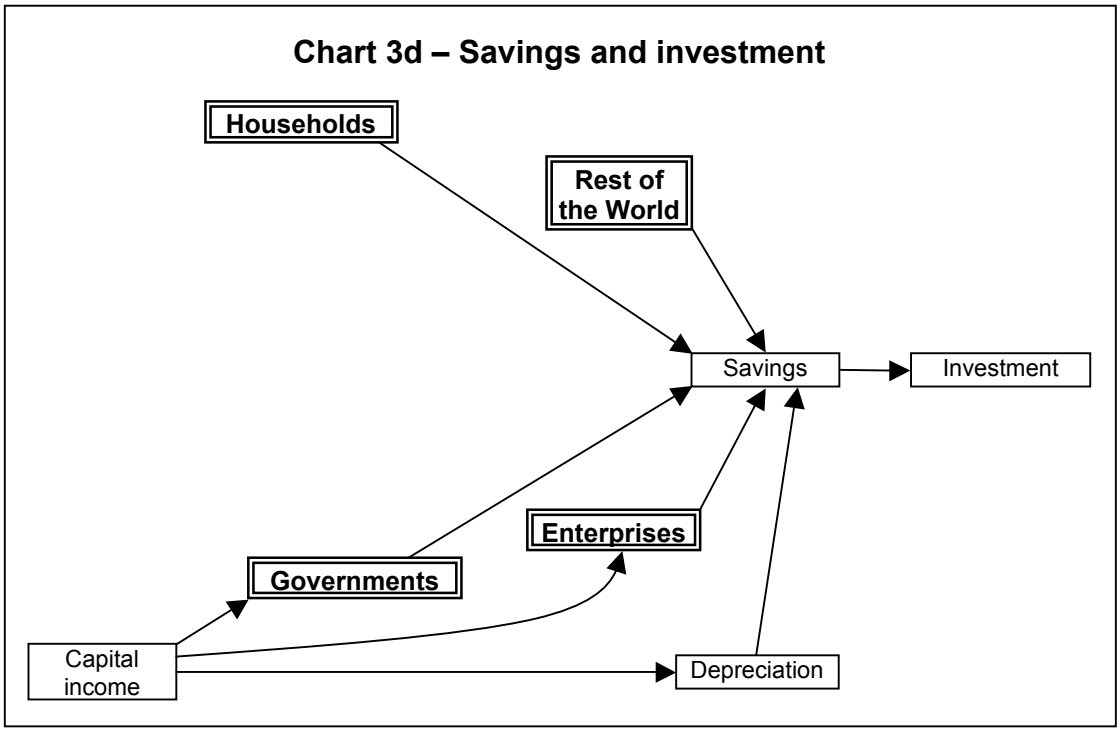


Chart 3d – Savings and investment
Households
Rest of the World
Savings
Investment
Enterprises
Governments
Capital income
Depreciation

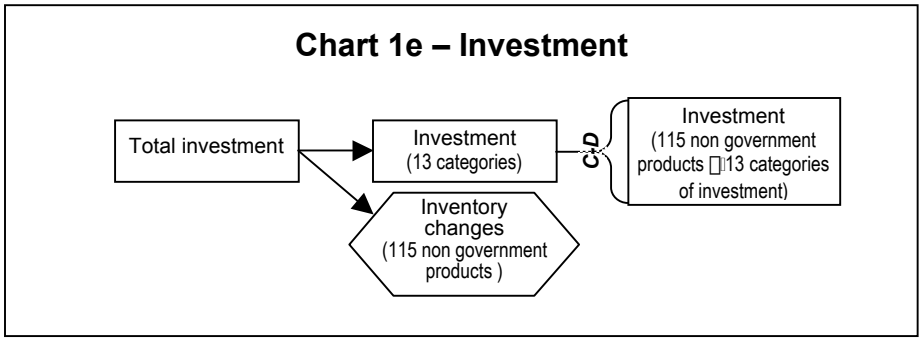
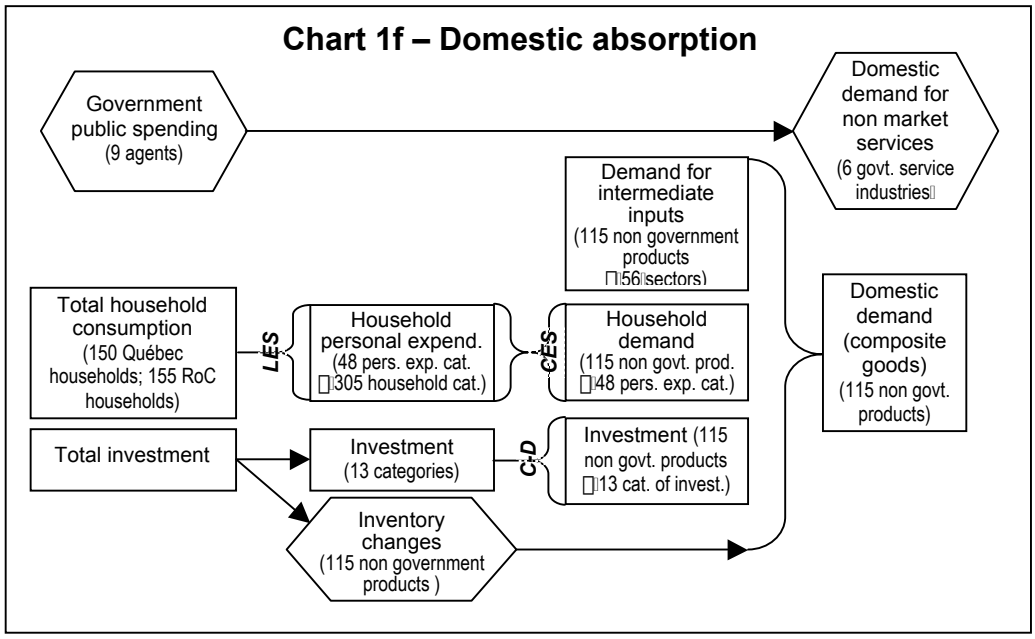


Chart 1e – Investment
Total investment
Investment (13 categories)
C-D
Investment (115 non government products □13 categories of investment)
Inventory changes (115 non government products)

Product demand by region

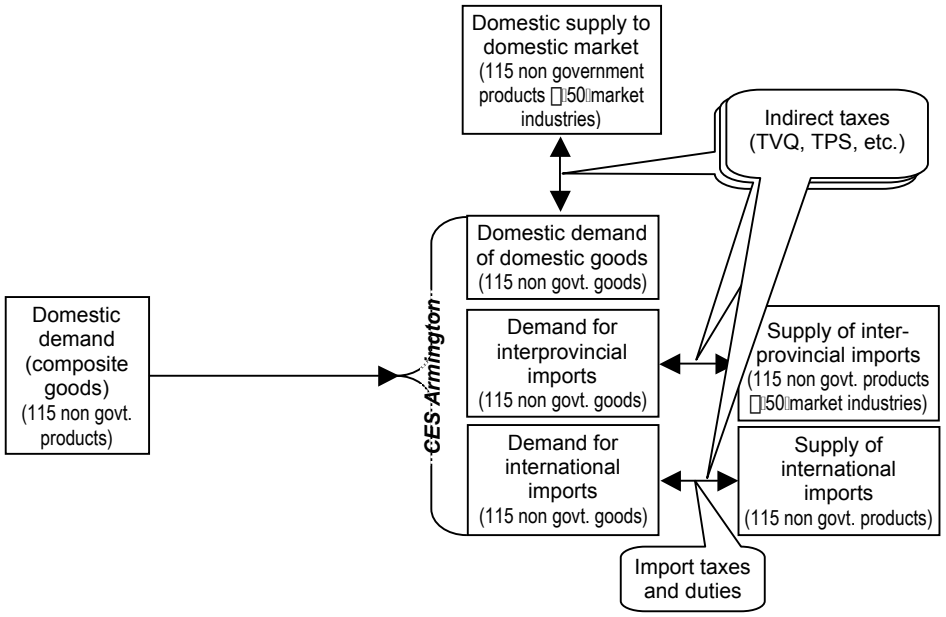
Domestic absorption of each good is the sum of quantities demanded by households, enterprises and governments for final consumption, investment and intermediate consumption. In most cases, a good or service can be supplied by more than one domestic industry, or it can be imported from the other region or from the RoW. The assumption is made that, from the buyers' point of view, products of the same category, but originating from different domestic activities, are perfect substitutes.



International and Québec-RoC trade

While, from the buyers' point of view, products of the same category originating from different domestic activities are perfect substitutes, such is not the case for locally produced goods and services relative to those imported from the other region or from the RoW. So the quantity demanded of each good is a composite of local and imported products. The distribution of demand between the three competing supply sources (local, other-region imports, and RoW imports) is commanded by a CES function. The assumption that local products and imports are not perfect substitutes takes the form of a non infinite elasticity, in accordance with the widely followed Armington (1969) approach. Thus, the shares of the three supply sources in the composite goods are determined by minimizing the cost of acquisition of the demanded quantity; and thanks to the homotheticity property of the CES function, the composite good price follows. One advantage of this approach to modelling imports is that it is possible to apply different taxes according to the origin of goods (such is the case of import duties, which are only levied on imports).

Chart 1g – Domestic absorption and imports



The supply of international imports is perfectly elastic at world prices. This reflects the view that Québec and the RoC are « small countries » in the sense given to that expression in the theory of international trade.

As for trade between the two regions, on the other hand, the Québec and the RoC economy are both explicitly modelled, so that the supply of imports from region *A* in the domestic market of region *B* is identical to the joint supply of exports towards *B* by producers in *A*. And since mutual export supplies and import demands depend on relative prices within and between regions, the prices that apply to interregional trade are necessarily endogenous.

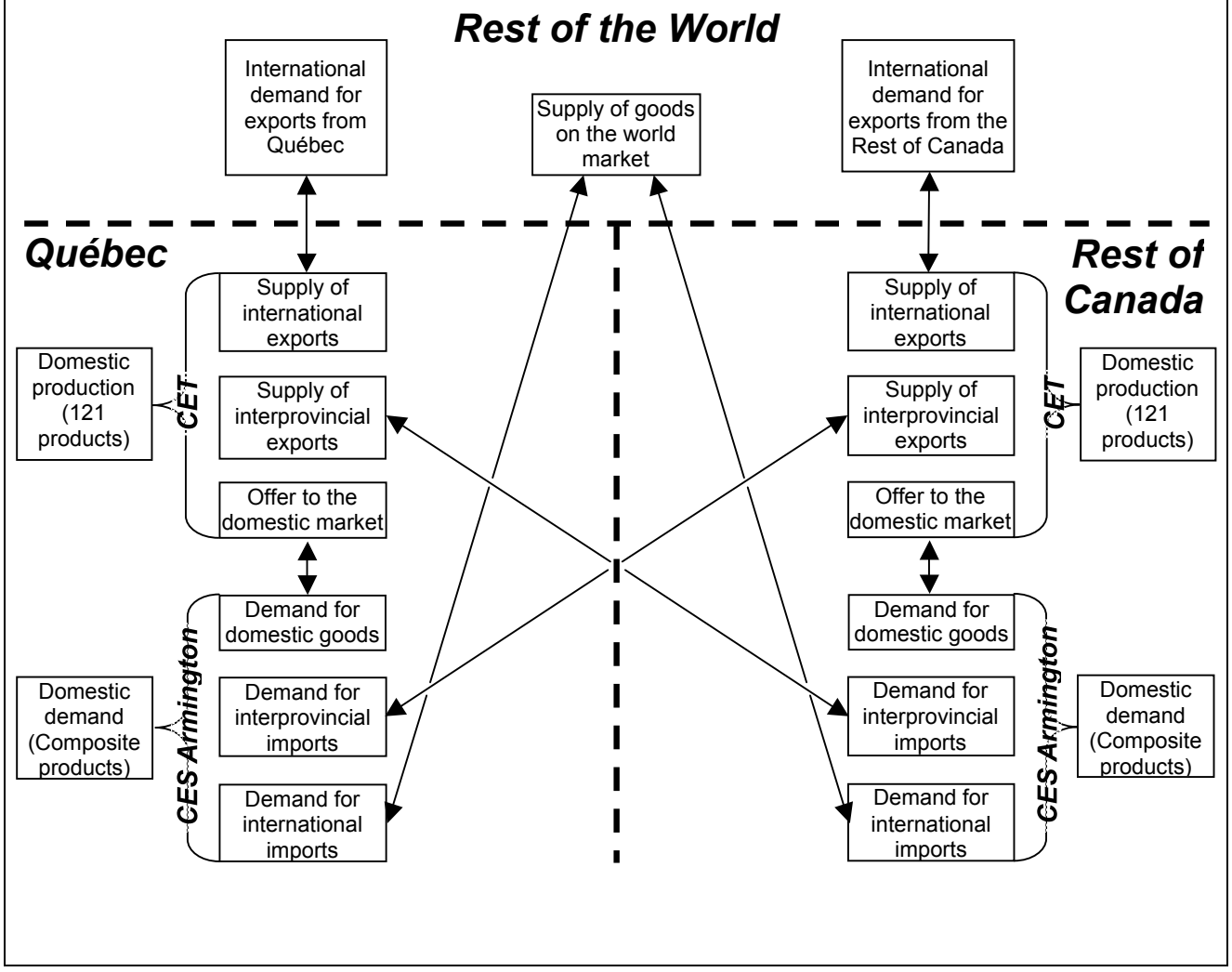
We have already discussed the export supply behavior of individual producers in each region (both towards the other region and towards the RoW), so it is unnecessary to reiterate this here.

The aggregate supply of exports (to the other region or the RoW) by a region is simply the sum of all industries' supplies. This reflects the assumption that, in the eyes of buyers of the other region or of the RoW, the same good produced by different industries is perfectly substitutable.

On the demand side of international exports, one might be tempted to consider Québec and the RoC as « small countries » relative to the RoW : that would imply that the demand for international exports be, like the supply of international imports, as perfectly elastic at the world price (practically speaking, the U.S. price). In reality, however, any increase in exports requires a competitive effort. So the model takes that into account by specifying a non infinite price-elasticity for the foreign demand of exports from Québec and the RoC; thus, international export (and reexport) prices are endogenous.

The consolidated trade deficit between Canada (Québec plus RoC) and the RoW is the amount of net foreign savings (or, if the current account shows a surplus, it is a drain on the savings pool). In the base model, closure rules are that the current trade account balance is fixed, and that foreign trade equilibrium is achieved by changes in the real exchange rate, given that the nominal exchange rate is taken as the numéraire.

Chart 2 – Interprovincial and international trade

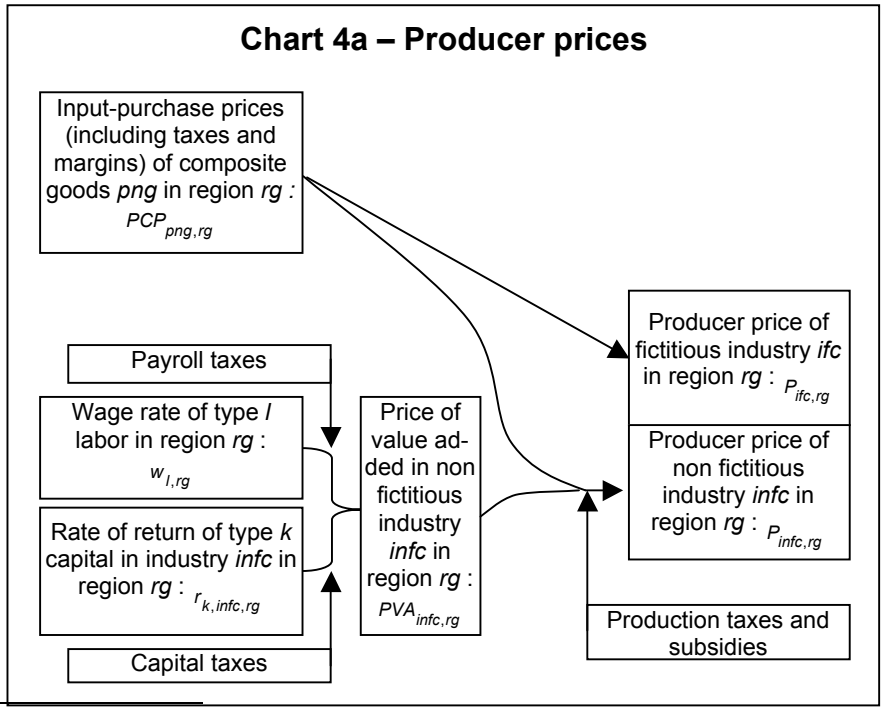


Price determination

The model being a general equilibrium one, prices influence the behavior of agents and are determined simultaneously with quantities. The price determination model is thus, as it should be, the dual of the real flows model.

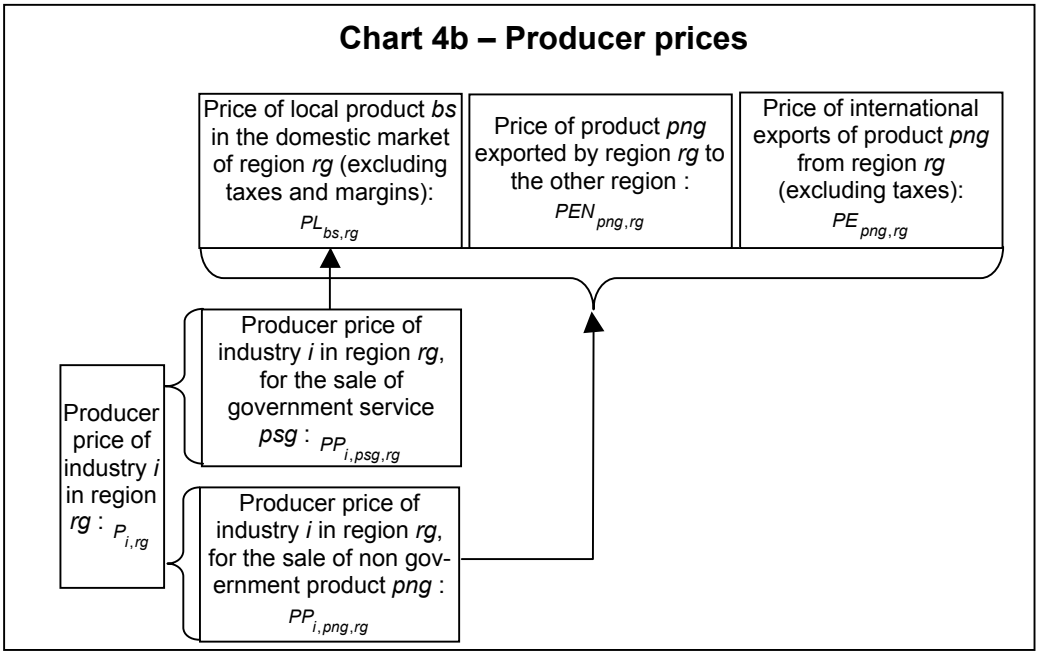
In competitive general equilibrium, producer prices are equal to production costs. So the producer prices of the 53 non-fictitious [8] industries are determined as a Leontief-type combination of intermediate input prices and the value-added price; producer prices for the three fictitious industries (which do not use value added) are equal to the cost of their intermediate consumption. As for the price of value added in each of the 53 non-fictitious industries, it is derived according to the Cobb-Douglas value added specification from the underlying factor prices : capital (2 types, each specific to each branch), and labor (11 categories). The model also defines a GDP deflator, a weighted average of industry value-added prices.

Chart 4a – Producer prices



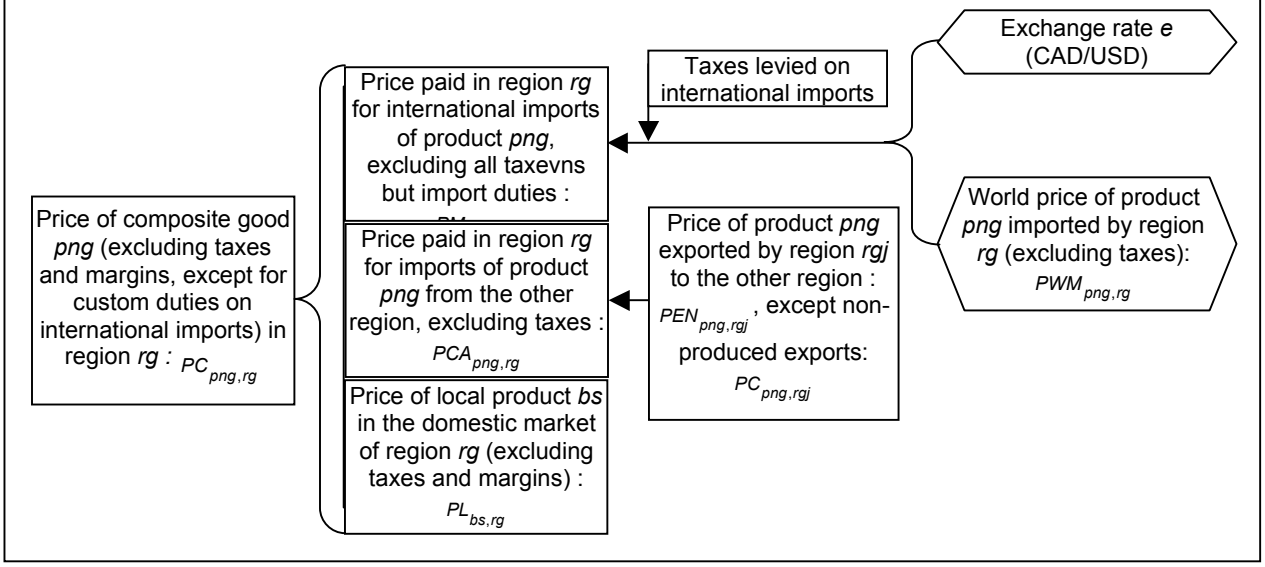
8 « Fictitious » industries are an artefact of input-output tables to consolidate demand for certain heterogeneous goods, in order to afterwards distribute the demand among the different goods and services of which the heterogeneous goods consist. The fictitious industries are : *Operating, Office, cafeteria and laboratory supplies* ; *Travel, entertainment, advertising and promotion expenses* ; and *Transport margins*.

On the supply side, we have already seen that each industry distributes its production, first between the various products, and then between the domestic market and exports to the other region or to the RoW, according to two levels of nested CET functions. Given the homotheticity property of CET functions, the producer price of industry output is a weighted average of its products' prices, while the price of each product of a given industry is a weighted average of the equilibrium prices on the three sales markets (domestic, other region and RoW). For non-market goods (government services), there are no exports and the producer price is simply equal to the domestic price.



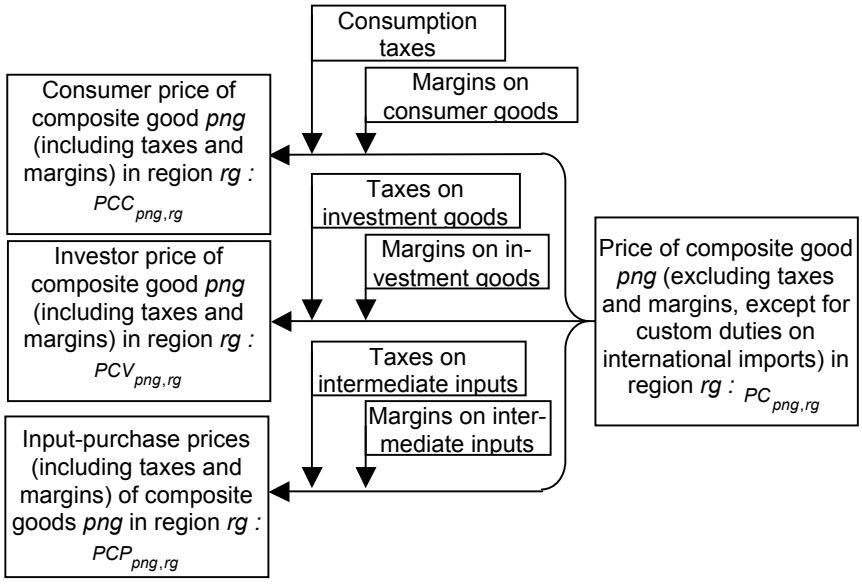
On the domestic market, local production has to compete with imports from the other region and from the RoW. The composite good is a combination of products from these three sources, and its price is therefore a weighted average of the price of goods produced locally and imported ones. Naturally, prices paid for products imported from the other region are equal to the prices received by the other region. And import prices are equal to their prices in foreign currency on world markets, converted to Canadian dollars according to the exchange rate, and after adding taxes in international imports levied by the federal government (import duties).

Chart 4c – Prices of Composite Goods
(excluding taxes and margins, except customs duties)



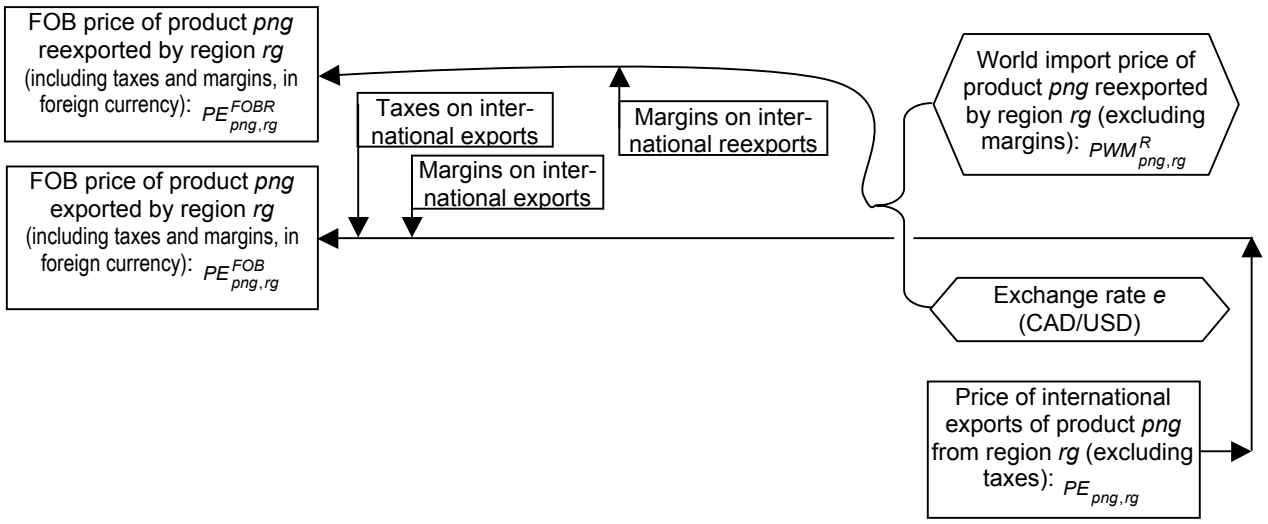
Buyer prices include taxes and transport and trade margins. In the model, these may vary depending on the category of buyer (consumer prices, investment goods prices, or production input prices). Production input prices apply to intermediate demand and, as we have mentioned earlier, jointly with the industry price of value added, they determine the unit costs of each industry. The price associated to each category of personal expenditures is a weighted average of the consumer prices of its components, to which are added permits.

Chart 4d – Domestic buyer prices
(inclusive of taxes and margins)



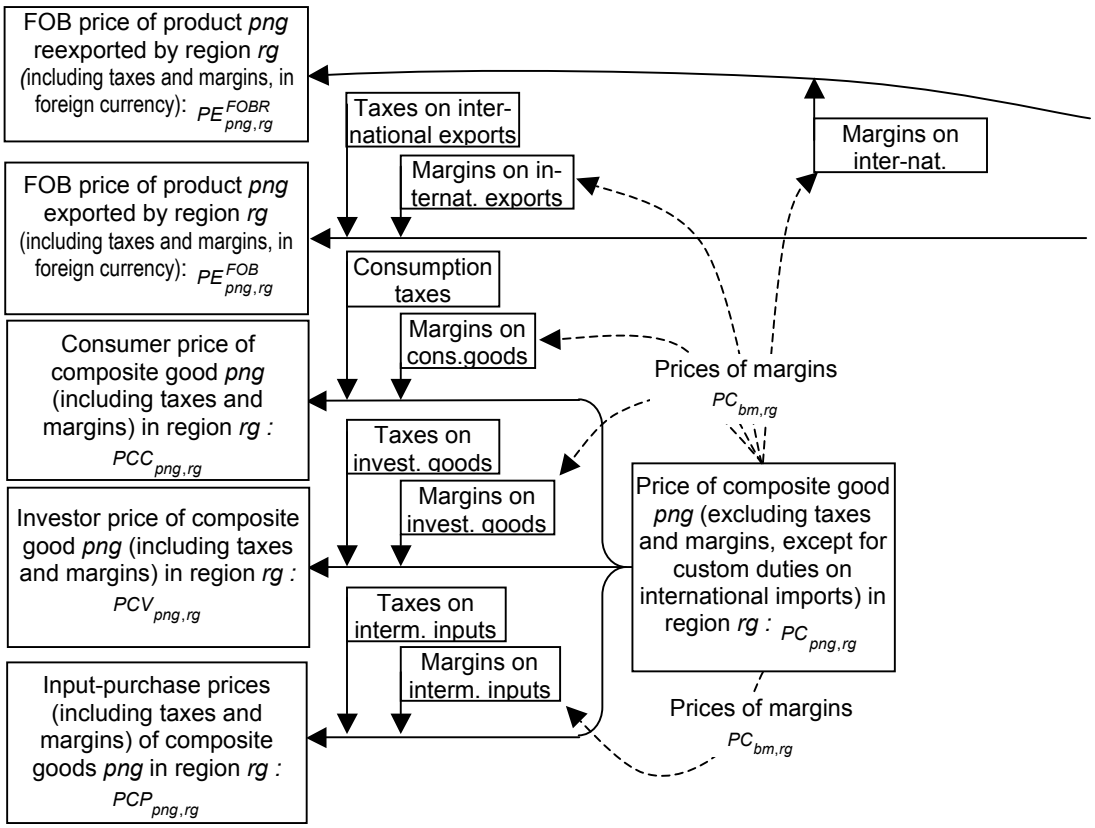
FOB export prices also include taxes and margins. As for reexports, they are not taxed, but nevertheless have associated margins ; these margins are added on to the world price of goods imported for reexport, converted to Canadian dollars according to the exchange rate.

Chart 4e – FOB (Free On Board) price of exports and reexports
(including taxes and margins)



Transport and trade margins consist of services that are actually produced. The prices of margins are therefore endogenous in the model. The *quantity* of margins associated with a flow is proportional to the corresponding *volume* (quantity), while the *amount* of margins is the product of their quantity, times their price.

Chart 4f – Prices of margins



Closure rules

General equilibrium models offer much flexibility in the range of phenomena that can be simulated. In particular, it is not necessary to define the closure rules once and for all. Those that were adopted for the base model can be changed to adapt them to the needs of different simulations. For example, for each factor (category of primary inputs), one may choose to fix exogenously, either its supply (« classical » closure, as in the base model), either its price (« keynesian » closure : equilibrium is then achieved by changing the quantity of the factor

used). Similarly, one may impose a constraint on the current account balance (and consequently on the amount of foreign savings ; that's also what is done in the base model) or else, fix the amount of investment, thus forcing savings to adjust [9].

Obviously, not all combinations are possible, but it is important to stress the possibility of changing closure rules, because otherwise, the model could seem overly rigid. The possibility of modifying closure rules is illustrated in the simulation results that will be presented later on.

General equilibrium

In this model, a general equilibrium is a price vector and a quantity vector that jointly verify the behavioral equations, as well as the following :

- Equilibrium on the domestic market of each good in each region.
- In trade between Québec and the RoC, and between each region and the RoW, equality between the demand for imports from each trading partner and the supply of exports from the other partner.
- Equilibrium on the market for each category of labor in each region.
- Equilibrium on the market of each type of capital for every industry in each region.
- Equality between total savings and the total value of investments.

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9 It is also possible to devise closure mechanisms whereby certain investments (large public investment projects, for instance) could be endogenous, while others would be exogenous. That represents a mechanism analogous to a crowding out of (private) investment.

Chart 1 – Production, supply and demand in a single region

(Québec or the Rest of Canada)

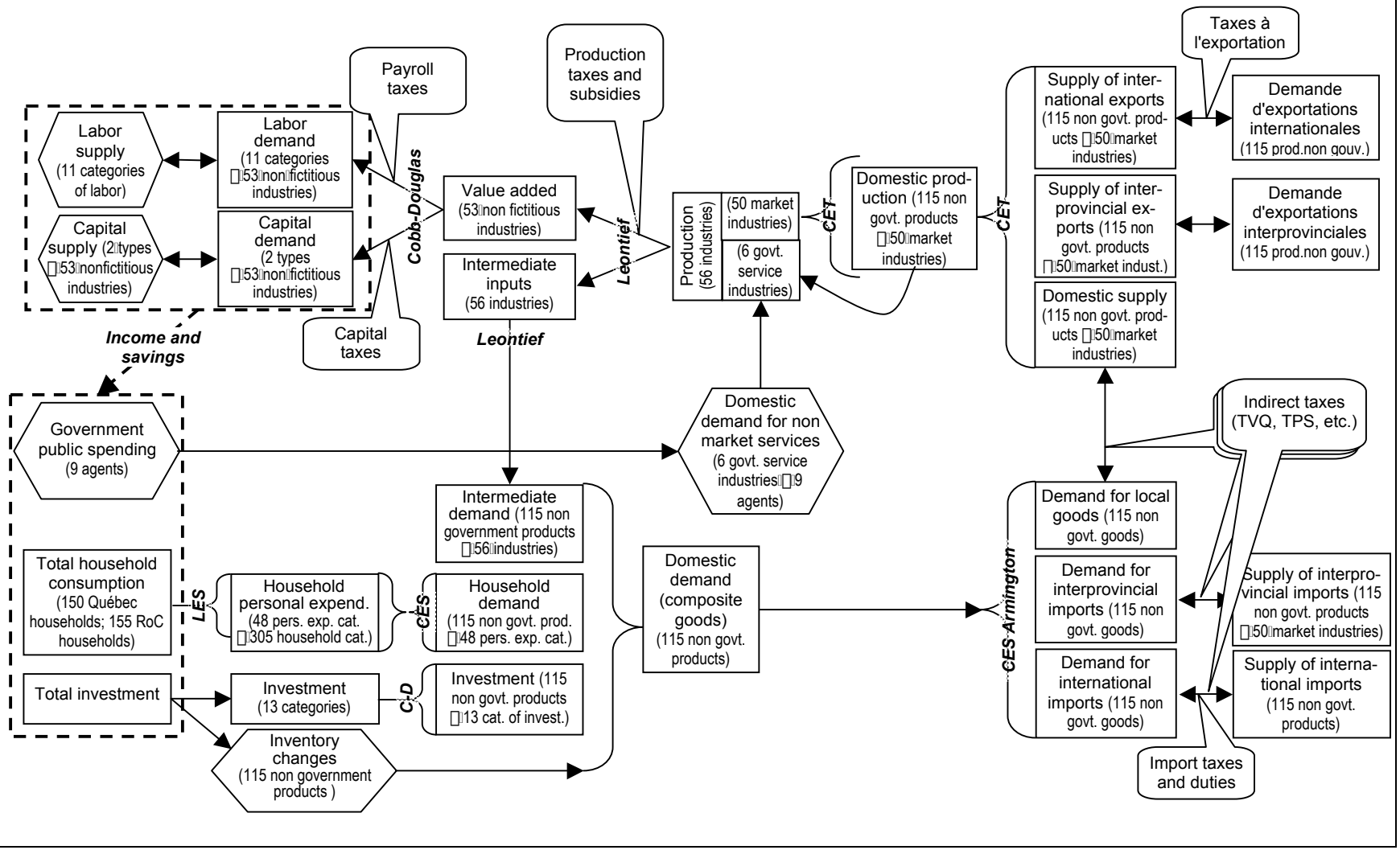

Chart 2 – Interprovincial and international trade

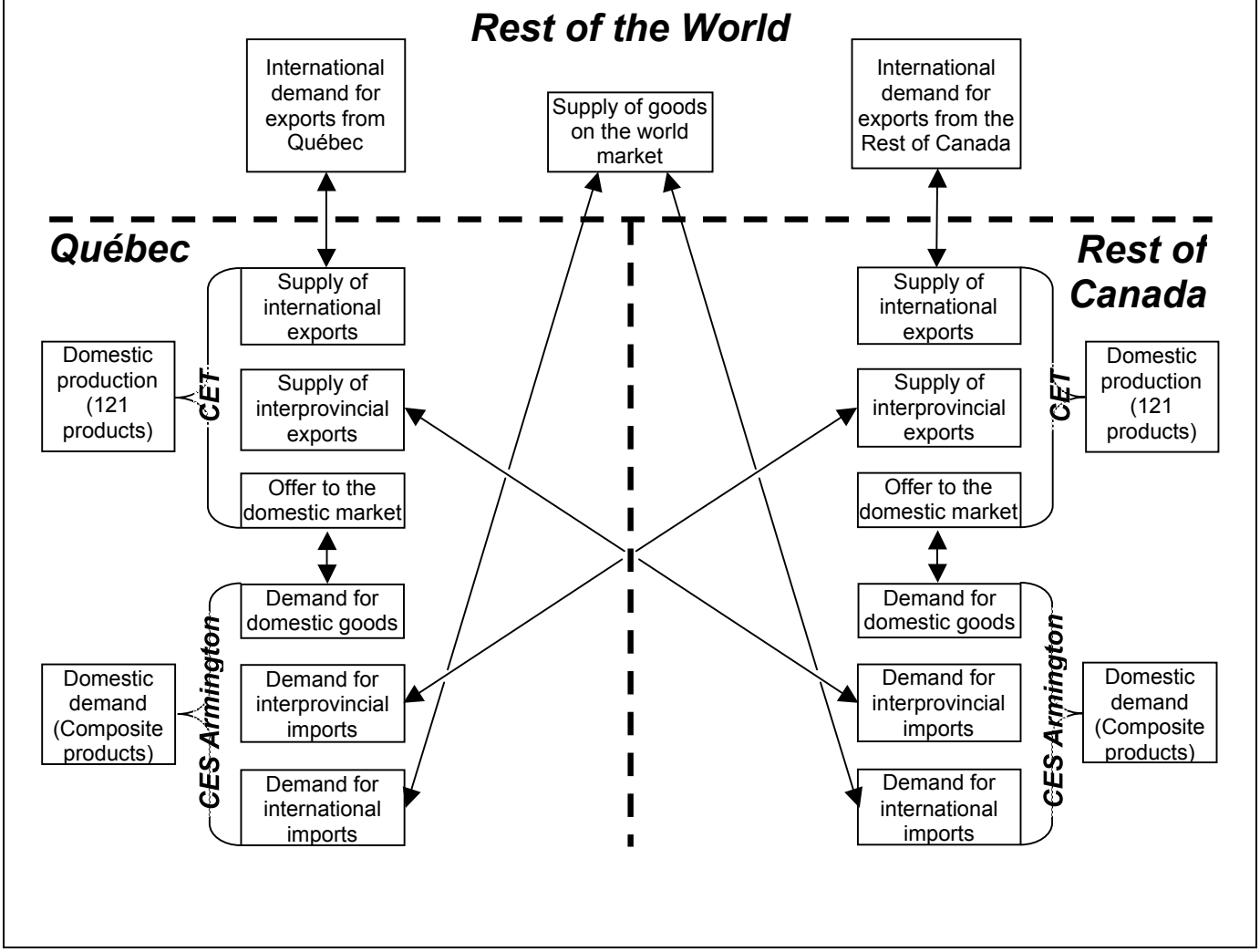

Chart 3 – Agents' incomes, savings and expenditures

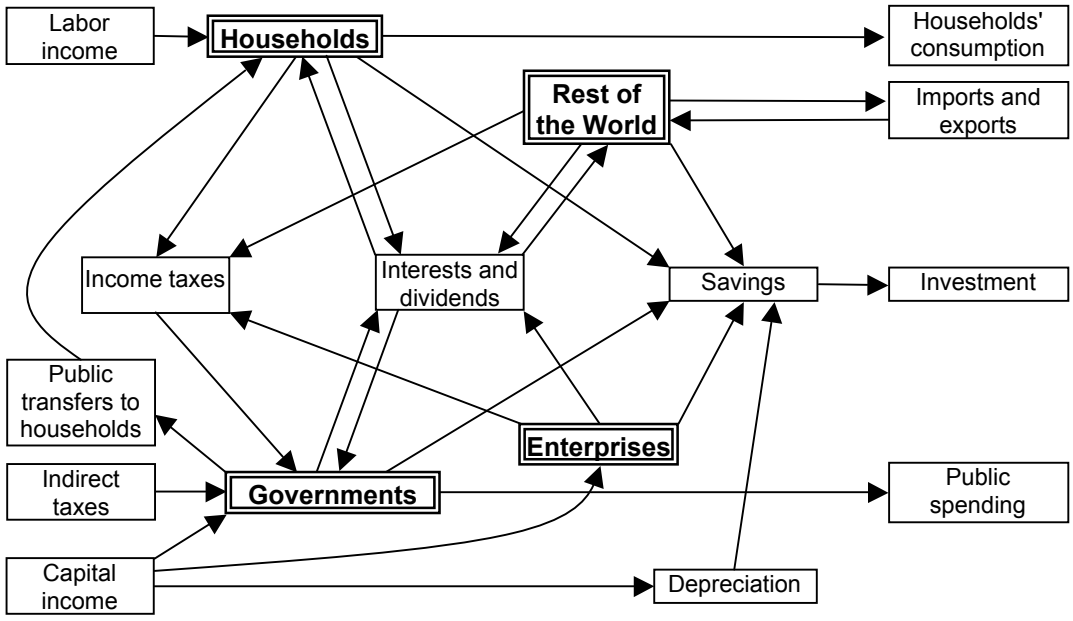

CHART 4 – PRICE DETERMINATION