Incorporating a detailed payment system in a CGE model: blueprint

by

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1. Introduction

This paper has been written in response to a request by the Network Economics Consulting Group (NECG) for a “blueprint” setting out plans to create COMPASS models. These will be **CO**mputable general equilibrium **M**odels to analyse **PA**yment **S**ystem**S**.

Computable general equilibrium (CGE) models are built around input-output tables (sometimes known as social accounting matrices). These matrices show the values of flows of goods and services from producing industries to using industries and to final consumers such as households, governments, capital creators and foreigners (exports). They also show the values of primary factors (labour, capital and land) absorbed in different industries. Detailed input-output tables contain information on margins and sales taxes associated with all flows of goods and services. Margins are services such as transport, wholesale trade and retail trade that connect producers to users. One interpretation of a CGE model is that it is a set of equations describing movements in the cells of an input-output table. These movements have both a price and a quantity component. For most input-output cells, a CGE model includes an equation for the price, reflecting costs, and an equation for the quantity, reflecting activity levels, relative prices and other determinants of demand (e.g. technological change).

Our approach to the task of providing the blueprint requested by NECG is to describe of the input-output tables that will be required for COMPASS models. We do this by starting in section 2 with a description of the input-output tables underlying existing CGE models. Then is section 3 we show how input-output tables must be expanded to allow detailed modelling of payments systems. As can be seen in section 3, our main idea is that payment services should be regarded as margins. The flow of commodity i from a producer to a purchaser is facilitated not only by transport, wholesale and retail margins, but also by credit-card services or other services that facilitate the transfer of money from the accounts of purchasers to the accounts of producers. Having developed this idea in section 3, in section 4 we outline the new equations that will be needed in CGE models to describe the prices and quantities of payment services. In section 5 we outline the data requirements for a CGE model extended to encompass the payments system. Section 6 contains concluding remarks and an assessment of our blueprint against the properties that NECG considers desirable for COMPASS models.

2. Structure of the input-output database for a typical CGE model

Figure 1 sets out the structure of the input-output database for a typical CGE model, e.g. the MONASH model of Australia (Dixon and Rimmer, 2002). The input-output data has three parts: an absorption matrix; a joint-production matrix; and a vector of import duties. The first row in the absorption matrix, BAS1, ..., BAS5, shows flows in year t of commodities to producers, investors, households, exports and other demand (e.g. government demand and inventory accumulation). Each of these matrices has C×S rows, one for each of C commodities from S sources. In standard applications of Australia's MONASH model, C is 115 and S is 2 (domestic and imported). BAS1 and BAS2 each have *I* columns where *I* is the number of industries (113 in standard MONASH). The typical component of BAS1 is the value of good i from source s [good (i,s)] used by industry j as an input to production, and the typical component of BAS2 is the value of (i,s) used to create capital for industry j. BAS3 to BAS5 each have one column. Most CGE models recognise one household, one foreign buyer, and one category of other demand. In the input-output database, no imported commodity is exported without being processed in a domestic industry. Consequently, BAS4(i,s) is zero wherever s= "imp".

All of the flows in BAS1, ..., BAS5 are valued at basic prices. The basic price of a domestically produced good (s= "dom") is the price received by the producer (that is the price paid by users excluding sales taxes, transport costs and other margin costs). The basic price of an imported good is the landed-duty-paid price, i.e., the price at the port of entry just after the commodity has cleared customs.

Costs separating producers or ports of entry from users appear in the input-output data in the margin and sales tax matrices. The margin matrices, MAR1, ..., MAR5, show the values of N margin commodities used in facilitating the flows identified in BAS1, ..., BAS5. In standard applications of MONASH, N=9. The nine commodities that can be used as margins are the domestic varieties of: wholesale trade; retail trade; road transport; rail and other transport; water transport; air transport; services to transport; insurance services; and restaurants and hotels. Imports are not used as margin services.

Each of the matrices MAR1, ..., MAR5 has C×S×N rows. These correspond to the use of N margin commodities in facilitating flows of C commodities from S sources (producers and ports of entry). MAR1 and MAR2 have *I* columns identifying *I* industrial producers and *I* industrial capital creators, and MAR3 to MAR5 each have one column. The typical components of MAR1 and MAR2 are the values of margin commodity n used in facilitating the flow of (i,s) to industry j for current production and for capital creation. Similarly, the typical components of MAR3 to MAR5 are the values of margin commodity n used in facilitating flows of (i,s) to households, ports of exit and other demands. As with the BAS matrices, all the flows in the MAR matrices are valued at basic prices. In the case of margin flows, we assume that there is no cost separation between producers and users, i.e., there are no margins on margins. Hence, there is no distinction between prices received by the suppliers of margins (basic prices) and prices paid by users of margins (purchasers' prices).

The row of tax matrices in Figure 1 record collections of sales taxes. The typical component of TAX1, for example, is the sales tax paid to the government as a result of the flow of good (i,s) to industry j for use as an intermediate input. While most of the entries in sales-tax matrices are non-negative, there may be a few negative entries, particularly in TAX4. These negative entries are subsidies. Unlike production taxes and import duties (both of which are included in the basic prices of commodities), sales taxes can be levied at different rates on different users.

Consequently, the ratio of TAX1(i,s,j) to BAS1(i,s,j), for example, may differ from the ratio of TAX3(i,s) to BAS3(i,s).

Payments by industries for M primary factors are recorded in Figure 1 in the PRIMFAC matrix. In standard applications, the core MONASH model contains eleven primary factors, i.e., M=11. These are capital, land, other costs (e.g. the costs of holding inventories) and eight types of labour. The vector TAX0 shows collections of taxes on production.

The final two data items in Figure 1 are TARIFF and MAKE. TARIFF is a C×1 vector showing tariff revenue by imported commodity. The joint-product matrix, MAKE, has dimensions C×*I*. Its typical component is the output (valued in basic prices) of commodity c by industry i.

Together, the absorption and joint-production matrices satisfy two balance conditions. First, the column sums of MAKE, which are values of industry outputs, are identical to the values of industry inputs. Hence, the j-th column sum of MAKE equals the j-th column sum of BAS1, MAR1, TAX1, PRIMFAC and TAX0.

Second, the row sums of MAKE, which are basic values of outputs of domestic commodities, are identical to basic values of demands for domestic commodities. If i is a non-margin commodity, then the i-th row sum of MAKE is equal to the sum across the (i,“dom”)-rows of BAS1 to BAS5. If i is a margin commodity, then the i-th row sum of MAKE is equal to the direct uses of domestic commodity i, i.e., the sum across the (i,“dom”)-rows of BAS1 to BAS5, plus the margins use of commodity i. The margins use of i is the sum of the components in the (c,s,i)-rows of MAR1 to MAR5 for all commodities c and both sources s.

3. Modifying the input-output database for COMPASS

Figure 2 sets out the input-output database for COMPASS. Relative to the input-output database for a typical CGE model (Figure 1), the COMPASS database for any country will contain extra detail on the payments system.

3.1. Payments commodities and activities

In creating COMPASS models we intend to identify Q payments commodities. These could include cash, cheques, debit cards, credit cards, direct entry, internet banking and other (e.g. retail store cards). These payments commodities will be produced by the payment-services or banking sector.

The payment-services sector will be divided into R activities with each activity having its own mix of inputs.

The first R-1 activities will produce payment services. The Rth activity, to be discussed later, will represent services supplied by buyers and sellers in organizing payments.

The first activity will be cash services. This activity undertakes all the expenditures associated with maintaining the money supply. It prints new money, distributes money to money-dispensing points (bank buildings and ATMs), maintains ATMs, collects cash from depositors, provides over-the-counter cash payments to withdrawers, stores cash in safes in bank buildings and destroys old money.

The next activity will be cheque services. This activity undertakes all the expenditures associated with maintaining the cheque system, including receiving cheques from depositors, transporting cheques to clearing houses, and dealing with stolen cheques and related fraud.

Depending on the availability of data, COMPASS models will have several activities covering plastic card services. We expect to identify credit-card services. This activity undertakes all of the expenditures associated with running the country's credit card system, including the costs of issuing credit cards (e.g. conducting checks of credit worthiness), dealing with card holders (e.g. replacing stolen cards) and the costs of fraud. Expenditures of the credit-card-service activity include the costs of machines issued to merchants to facilitate credit-card transactions and the costs of interactions with merchants. Finally they include the costs of the network required in recording transactions and transferring money between the accounts of buyers and sellers.

If it is possible from a data point of view, COMPASS models will distinguish debit card services separately from credit card services. The debit-card-services activity undertakes all of the expenditures associated with running the country's debit-card system. Relative to credit cards, the production of debit-card services may require less expenditure on card issuing (e.g. less rigorous checks of credit worthiness). On the other hand, a debit-card system may involve more rigorous checking of bank balances in the course of each transaction.

Another group of payment activities will be those concerned with arranging payment of regular bills from a customer's bank account (direct entry transactions), internet banking (e.g. the Bpay system in Australia) and transactions involving special cards (e.g. cards issued by major retail outlets for use in their own stores).

3.2. Representation of payments commodities and activities in the input-output database

As shown in Figure 2, COMPASS models will treat payments commodities as margins via the four sets of matrices: MAR1PE to MAR5PE; MAR1PI to MAR5PI; MAR0PE and MAR0PI .

The acronym MAR1PE stands for: **MAR**gin; purpose **1** (current production); **P**ayment commodity; **E**xternal. The typical element of MAR1PE is fees levied by the payment-services sector for provision of payments commodity q to facilitate of the flow of good i from source s to industry j for use in current production. If commodity q is credit-card services for example, then MAR1PE(i,s,j,q) is total fees levied by banks and credit-card companies on buyers and sellers in the flow of good i from source s to industry j for use in current production. These fees cover not only transfers of money between producers and users but also fees for transferring money to providers of margin services and fees for transferring money involved in the payment of sales taxes. The elements of the MARϕPE matrices, ϕ = 1, …, 5 represent *external* fees paid by participants in a transaction, that is fees for services provided by organizations (e.g. banks and credit card companies) that are not buyers, sellers, tax collectors or providers of transport, wholesale and retail margins in the transaction.

The acronym MAR1PI stands for: **MAR**gin; purpose **1** (current production); **P**ayment commodity; **I**nternal. The typical element of MAR1PI is *internal* expenses incurred by transaction participants in using payments commodity q to facilitate the flow of good i from source s to industry j for purpose 1. If commodity q is cash services for example, then MAR1PI(i,s,j,q) covers labour and equipment costs associated with buyers obtaining cash from ATMs and banks, with buyers guarding cash, with sellers receiving and guarding cash, and with sellers depositing cash.

In estimating MAR1PI, MAR2PI, MAR4PI and MAR5PI we must take into account paid clerical time required by buyers and sellers to achieve transactions using the various payments commodities q. For MAR3PI the equivalent of clerical time required by buyers is foregone household leisure involved in applying the various payments methods in dealing with bills.

The acronyms MARFPE and MARFPI stand for: **MAR**gin; primary **F**actor; **P**ayment commodity; **E**xternal or **I**nternal. The typical element of MARFPE is *external* expenses (e.g. fees paid to banks and credit-card companies) incurred by industry j in the use of payments commodity q in paying for primary factor f. The typical element of MARFPI is *internal* expenses incurred in using payments commodity q to facilitate payment by industry j for factor f. If factor f is labour and commodity q is cash services for example, then MARFPI(f,j,q) covers labour and equipment costs associated with employers obtaining cash from ATMs and banks, with employers guarding cash, with employees receiving and guarding cash, and with employees depositing cash.

The payment activities in COMPASS models will be treated as industries. This is indicated in Figure 2 by the R producer columns marked payment services. Potentially there could be a separate "industry" for each type of payments commodity. Alternatively, we may have comparatively few payments "industries" but with each industry able to produce several payments commodities. In this case, there will be payments service columns in the MAKE matrix with more than one nonzero entry.

As mentioned earlier, COMPASS models will have R-1 payments "industries" ($R-1 \leq Q$) that produce payments commodities. The Rth payments "industry" shown in Figure 2 will provide clerical services and other services typically required internally by buying and selling organizations including households to facilitate payments. The entries in MAR1PI to MAR5PI and MARFPI will represent purchases of the commodity produced by the Rth payments "industry".

3.3. Phantom sales taxes and allowance for two-sided markets

The demand and supply for a payments commodity such as credit-card services is an example of a two-sided market. The provider of a credit card service is selling a service to two agents (a buyer and a seller) who use the service cooperatively. A problem in two-sided markets is to decide how charges for the service should be split between the two agents. In the input-output data in Figure 2 we have not tackled this problem. We have recorded the costs of all payment services as a sum of costs incurred by buyers and sellers.

There is an extensive literature on two-sided markets. Recent contributions include Wright (2003a and b), Rochet (2003) and Rochet and Tirole (2002). This literature suggests that an inappropriate split of charges between the two sides of a market can lead to socially suboptimal use of the service. Consider, for example, a buyer and seller contemplating a transaction that can be facilitated by either the use of a credit card or cash. If the transaction is conducted by credit card, then servicing the buyer would cost the credit-card organization (including related entities such as banks) $2. Servicing the seller would cost $6. If the transaction is conducted by cash then handling the cash would cost the buyer $1 and the seller $10. For maximization of social welfare, the transaction should be conducted by credit card. The credit card allows the transaction to proceed at a cost of $8 (=2+6) whereas a cash transaction would cost $11 (=1+10). However there is a danger that an inappropriate split of charges may inhibit the use of the credit card. If each side is charged its servicing cost ($2 for the buyer and $6 for the seller), then the buyer will be unwilling to use a credit card (cash costs only $1) and the transaction must be made using cash. What is required to ensure the use of a credit card is a split of the $8 cost between buyer and seller such that the buyer pays no more than $1 and the seller pays no more than $10. Starting in a situation in which buyers and sellers pay their servicing costs, the credit card organization should be allowed to arrange a transfer (often termed an interchange fee) from sellers to buyers of between $1 and $4. A transfer anywhere in this range will allow the credit card transaction to take place.

Transfers between sellers and buyers designed to optimise credit-card use are sometimes inhibited by regulations. For example, a corporate regulator may interpret a charge of $7 to sellers for a service that costs $6 as evidence of exploitation of monopoly power by the credit-card organization. In fact it may be part of a legitimate attempt to optimise the use of credit cards via a $1 transfer from sellers to buyers. If transfers are inhibited by regulation or otherwise, then from the point of view of social welfare, credit cards may be under-used.

Two-sided markets and CGE modelling

CGE models such as COMPASS deal with the whole economy. They divide an economy into many industries, occupations and regions. They deal with government budgets, taxation, public expenditure, the current account, foreign debt and equity and other macroeconomic phenomena. Given the enormous scope of CGE models, they become unmanageable if anything but a relatively simple specification is given to any particular part of the economy. Richer specifications on parts of the economy of key interest in an investigation can be included in small special-purpose models. Insights from these special-purpose models can be introduced as shocks to variables in a CGE model so that economy-wide implications of policy and other changes can be ascertained. We clarify these ideas with an example. In an enquiry by the Industry Commission into the Australian motor vehicle industry (Industry Commission, 1997), a CGE model was used to work out the economy-wide effects of cuts in the motor vehicle tariff. The CGE model did not include the details of the financial positions of the four Australian motor vehicle assemblers (Holden, Ford, Toyota and Mitsubishi). Special-purpose modelling outside the CGE framework suggested that cuts in tariffs could cause the closure of Mitsubishi's Australian assembly plant. Because the Mitsubishi assembly plant is located entirely in the state of South Australia, the information from the special-purpose modelling was introduced into the CGE framework by a shock to the variables describing the regional location of assembly operations, in particular, a sharp negative shock to the South Australian share.

In the present context it would not be sensible to try to introduce directly into a COMPASS model all of the details of the market for credit-card services that would be relevant to calculating optimal transfers (interchange fees) between sellers and buyers. Such calculations are better carried out in special-purpose microeconomic models concentrating entirely on the specifics of credit-card transactions including the heterogeneity of buyers and of sellers. The focus of COMPASS models will be on the economy-wide effects of credit-card use and the use of alternative payment commodities.

For simulating the effects of regulatory or other inhibitions on the use of particular payments commodities we intend in COMPASS models to introduce phantom taxes. Assume that there is evidence (statistical, supplemented by special-purpose microeconomic modelling) that the use of credit cards is inhibited relative to the level that would be achieved by a planner who could impose the socially optimal mix of payments methods for facilitating flows of good i from source s to user k. Then we would assume that the economy is behaving as if there is a tax on credit-card services used for facilitating flows of good i from source s to user k. This tax will cause, in a COMPASS model, the mix of payment methods for facilitating the flow of (i,s) to k to be biased away from credit cards to other methods such as cash and cheques. To simulate the economy-wide effects of the removal of the inhibition on credit-card use we plan to reduce the rate of phantom tax.

In Figure 2 the "collections" of phantom taxes associated with payment commodities are recorded in the row TAX1PF to TAX5PF. The typical element in TAX1PF is the phantom tax associated with the use of payment commodity q in facilitating the flow of good i from source s to industry j for purpose 1. The acronym TAX1PF stands for: **TAX** collection; purpose **1** (current production); **P**ayment commodity; **F**antom (sic, we know that some people spell fantom with a ph).

4. Modelling issues: new equations

By working with a database in the form of Figure 2, we will be able to apply most of the equations from existing models such as MONASH. This is because Figure 2 can be considered merely a reinterpretation of Figure 1, involving a few new industries and a few new margin commodities. However, extensive additions to the equations of existing models will be required to introduce a detailed treatment of demands for payments margins. We also plan to investigate the feasibility of specifying a non-competitive market structure in the provision of payment services.

Demands for payments margins

In MONASH and other CGE models there is no price-induced substitution between different margin commodities: transport services are not a substitute for retail services and retail services are not a substitute for wholesale services. In COMPASS models we plan to allow substitution between different payment commodities. An examples of a group of payment-commodity demand equations incorporating substitution between cash, cheques, credit cards and other payment commodities is the following:

$$X1MARP\_TOT(i,s,j) = X1(i,s,j) * A1MARP\_TOT(i,s,j) \tag{4.1}$$

$$X1MARP(i,s,j,q) = X1MARP\_TOT(i,s,j) * f_{1isjq}(PP1(i,s,j,t), A1MARP(i,s,j,t), t = 1,...,Q) \quad (4.2)$$

$$X1MARPE(i,s,j,q) = X1MARP(i,s,j,q) * A1MARPE(i,s,j,q) \quad (4.3)$$

$$X1MARPI(i,s,j,q) = X1MARP(i,s,j,q) * A1MARPI(i,s,j,q) \quad (4.4)$$

$$PP1(i,s,j,q) = \frac{MAR1PE(i,s,j,q) + MAR1PI(i,s,j,q) + TAX1PF(i,s,j,q)}{X1MARP(i,s,j,q)} \quad (4.5)$$

$$MAR1PE(i,s,j,q) = X1MARPE(i,s,j,q) * P0(C+q) \quad (4.6)$$

$$MAR1PI(i,s,j,q) = X1MARPI(i,s,j,q) * P0(C+Q+1) \quad (4.7)$$

$$TAX1PF(i,s,j,q) = [MAR1PE(i,s,j,q) + MAR1PI(i,s,j,q)] * RATETAX1PF(i,s,j,q) \quad (4.8)$$

For understanding (4.1) to (4.8) it is simplest to define the notation while explaining each equation. Equation (4.1) makes the overall demand, X1MARP_TOT(i,s,j), for payment services to facilitate the flow of good i from source s to industry j for purpose 1 proportional to the quantity, X1(i,s,j), of this flow.[1] Changes in the factor of proportionality, i.e. changes in A1MARP_TOT(i,s,j), could be used to simulate the effects of changes in buying habits affecting the quantities of payment services required per unit of flow of (i,s,j) for purpose 1. For example, a reduction in A1MARP_TOT(i,s,j) could be used to simulate the effects of an increase in the quantity of (i,s,j) traded per transaction.

Equation (4.2) explains the demand, X1MAR(i,s,j,q), for payment commodity q to facility the flow of (i,s,j) for purpose 1. This demand is proportional to the total use of payment services in facilitating the flow of (i,s,j) for purpose 1. It also depends on the purchasers' prices, PP1(i,s,j,t), t = 1, …, Q, of payments commodities used in facilitating the flow of (i,s,j) for purpose 1. Finally, it depends on technological change variables, A1MARP(i,s,j,t), t = 1, …, Q, affecting the mix of payments commodities facilitating the flow of (i,s,j) for purpose 1. In deriving the form of the function f_{1isjq} we plan to assume that

[1] In using X1(i,s,j) on the right hand side of (4.1) we are assuming that margins and taxes associated with flow (i,s,j) for purpose 1 are proportional to the level of the flow.

X1MARP(i,s,j,q), q = 1, …, Q, are chosen to minimize

$$\sum_{q} PP1(i,s,j,q) * X1MARP(i,s,j,q)$$

subject to

$$X1MARP\_TOT(i,s,j) = CES_{1isj}(X1MARP(i,s,j,q)/A1MARP(i,s,j,q); q = 1,...,Q) .$$

That is we plan to assume that the mix of payments methods used to facilitate the flow of (i,s,j) for purpose 1 minimizes costs to buyers and sellers subject to a technological constraint that specifies the overall quantity of payment services as a CES function of the quantities of different types of payment services. The A1MARP(i,s,j,q) variables in this function allow for input-saving or -using technical changes. A 10 per cent reduction in A1MARP(i,s,j,q) introduces a technological improvement under which 10 per cent less payment service q could be used to achieve a given overall level of payment service while holding constant the use of all other payment services in facilitating the flow of (i,s,j) for purpose 1.

Equations (4.3) and (4.4) define the ingredients of payment commodity q used in facilitating the flow of (i,s,j) for purpose 1. These ingredients (recognized in matrices MAR1PE and MAR1PI) are services produced externally and services generated internally by the buyers and sellers. In (4.3), the demand for external services, X1MARPE(i,s,j,q), is modelled as being proportional to the overall demand for payments commodity q to facilitate the flow of (i,s,j) for purpose 1. Changes in the factor of proportionality, i.e. changes in A1MARPE(i,s,j,q), can be applied in simulations of the effects of changes in technology involving increased or decreased use of services from the payment-services sector per unit of payment commodity q to facilitate the flow of (i,s,j) for purpose 1. Together with similar demands by investors, households, exporters and the government, X1MARPE(i,s,j,q) is part of the total demand for commodity C+q, that is the qth commodity produced by the payment-services sector. The total demand for commodity C+q must be matched by the total supply generated in payment-services-sector activities.

In (4.4), the demand for internal services, X1MARPI(i,s,j,q), is also modelled as proportional to the overall demand for payments commodity q to facilitate the flow of (i,s,j) for purpose 1. Again, changes in the factor of proportionality, i.e. changes in A1MARPI(i,s,j,q), can be used in simulations of the effects of changes in technology.

Although X1MARPI(i,s,j,q) is a demand for internal services [e.g. clerical services provided by buyers and sellers when flow (i,s,j) for purpose 1 is facilitated by payments commodity q], it is convenient to model it as a demand for a service produced by a separate "industry". Together with similar demands by investors, households, exporters and the government, X1MARPI(i,s,j,q) is part of the total demand for commodity C+Q+1, the commodity produced by the Rth service-payments "industry". The total demand for commodity C+Q+1 must be matched by the total supply generated in the Rth service-payments "industry".

Equation (4.5) defines the purchasers' price, PP1(i,s,j,q), of payments commodity q used in facilitating flow (i,s,j) for purpose 1 as a ratio of costs to quantity. The numerator is the sum of the external and internal costs and phantom taxes associated with the use of q used in facilitating flow (i,s,j) for purpose 1. The denominator is the quantity of q used in this way.

Equations (4.6) and (4.7) define the external and internal costs of using payments commodity q in facilitating flow (i,s,j) for purpose 1 as products of quantities and prices. The prices, P0(C+q) and P0(C+Q+1), are basic prices of commodities produced by the payment-services sector. They reflect costs in this sector.

Equation (4.8) defines phantom tax collection associated with using payments commodity q in facilitating flow (i,s,j) for purpose 1. Collection is the product of costs (external and internal) and the tax rate, RATETAX1PF(i,s,j,q).

In forming COMPASS models, sets of equations similar to (4.1) to (4.8) will be included for commodity flows to investors, households, exporters and other demanders and for primary factor flows to industries.

Industrial organization in the provision of payment services

In most CGE models, industries are viewed as producing goods and services under constant returns to scale in a perfectly competitive environment. Exceptions to this treatment include Harris and Cox (1983), Harris (1984), Horridge (1987) and Abayasiri-Silva and Horridge (1998). These authors have shown how to include in a CGE framework monopolistic competition.

We plan to investigate the feasibility and appropriateness of adopting this approach in modelling the payment-services industries. Firms in these industries engage in extensive advertising, especially of credit cards, indicating that their products are differentiated. This means that these firms typically face downward-sloping demand curves for their products, implying that each firm has market power, that is the ability to set its own prices. It is also likely that there are considerable economies of scale in each firm. Market power and economies of scale for individual firms are two of the characteristics of monopolistic competition.

A third characteristic of monopolistic competition is free entry and exit. This means that there are zero pure profits. Research will be required to establish whether this is a reasonable assumption for firms in payment services industries.

5. Data requirements

The main data requirements for implementation of a COMPASS model, beyond those of existing CGE models, are estimates of the flows in Figure 2 referring to: (a) demands for payments services (that is, the matrices MAR1PE to MAR5PE, MAR1PI to MAR5PI, MARFPE and MARFPI); and (b) inputs to the payment services "industries" (that is, the entries in the R payments services columns of the producer input matrices, BAS1, MAR1, etc.).

To estimate the external payments matrices (MAR1PE to MAR5PE and MARFPE) we will need two types of information. The first is estimates of the shares of various payments instruments in the facilitation of different transactions. For example, to estimate the quantity aspects of MAR3PE we will need to know for a recent year the shares of household purchases of food, clothing, housing, utility services, education, taxes, holidays, cars, other consumer durables, etc that are paid for by cash, cheques, credit cards, debit cards, direct transfers and other payments methods. The second information requirement is estimates of the combined fees levied on buyers and sellers by banks and credit-card companies. These estimates are required for all of the payments instruments and need to be expressed as fees per dollar of payment facilitated. For example, to estimate the price aspects of MAR3PE we will need to know for a recent year the combined buyer/seller fees per dollar of household purchases of food, clothing, etc when these purchases are facilitated by cash, cheques, credit cards etc.

To estimate the internal payments matrices (MAR1PI to MAR5PI and MARFPI) we can use the share information already required for the external payments matrices to establish quantities. However, to estimate price aspects we will need information on the clerical, equipment and security costs to firms and households of using different types of payments instruments. For firms, this information might be gathered by a survey. Alternatively, we may rely on published information on the costs of payments clerks and of money-handling security services. For households, a survey might be used to establish time-saving arising from internet banking, direct payments and credit-card use relative to payments by cash and cheque.

The first R-1 input columns for the payment services sector would largely be a disaggregation of existing input-output data on the financial services sector. The work involved is outlined in the Appendix where we consider the Australian input-output tables. Information required for the Rth input column of the payment services sector is the same as that required for the price aspects of the internal payments matrices, that is for setting up the Rth column we need to estimate the typical profile of internal costs incurred by firms in facilitating payments for inputs and receiving payments for outputs.

In addition to the payments-related input-output flows identified in Figure 2, COMPASS models will require payments-related substitution elasticities. We will, for example, need to make judgements about the extent to which households and merchants together switch between cash, cheques, credit cards etc in response to changes in the purchaser's prices (including fees and internal costs) of these instruments. We doubt that there will be databases for rigorous estimation of these elasticities. Judgement supplemented by sensitivity analysis may be the only practical approach.

6. Does our blueprint meet NECG requirements?

Broad requirements

NECG requires that the payment system incorporated in COMPASS models be capable of :

(1) recognising relative price differences (including implicit costs) between payment instruments;

(2) demonstrating the net benefits of credit cards as a payment instrument to individual economies (reducing transactions costs and overcoming liquidity constraints);

(3) assessing the implications of credit card and other types of consumer debt; and

(4) assessing the impact of regulation of individual payment instruments.

Implementation of our blueprint would satisfy requirement (1). As set out in section 3, a COMPASS model built according to our plan would generate movements in the costs of using different payments instruments. We refer to these costs as purchasers prices. They include direct charges by external providers of payment services (e.g. banks and credit-card companies) and internal (implicit) costs borne by buyers and sellers. Our blueprint allows for substitution between payment instruments induced by changes in relative purchasers prices.

To meet requirement (2) we would conduct simulations involving the complete or partial elimination of credit cards. This could be achieved in a COMPASS model by the imposition of a suitable phantom tax on credit-card transactions. Buyers and sellers would be obliged to switch to other less efficient payment instruments such as cash and cheques. The contribution of credit cards to the economy could then be assessed by calculating the change in overall welfare (e.g. equivalent or compensating variation) caused by the imposition of the phantom credit-card tax.

In the earlier sections of this blueprint we have not addressed requirement (3). Our preliminary thoughts are as follows. Transaction facilitation (which we have addressed) is overwhelmingly the most important function of credit cards. A secondary function is the provision of highly flexible, highly convenient, high-interest-rate credit. This type of credit is highly flexible because it is granted without investigation by the creditor of either the purchase being contemplated by the debtor or of the debtor's current financial situation. It is highly convenient because it can deal with unforeseen, immediate credit needs arising from unanticipated expenditures or income shortfalls without new negotiations between debtor and creditor. However, for these reasons, credit made available through credit cards must attract a high interest rate. By providing highly flexible, highly convenient, high-interest-rate credit, credit cards generate a service that is not readily available from banks, credit unions and other major lending institutions. Thus credit cards make a contribution to society welfare by broadening the choice of available borrowing instruments. We plan to recognize this in COMPASS models by including different types of credit “products” in household utility functions, that is we will make household welfare a function of the use of different types of credit. In this way we will be able to simulate the welfare-enhancing effects of consumption smoothing made possible by the availability of flexible, convenient credit through credit cards.

As explained in section 3.3, we propose to meet requirement (4) by translating the effects of regulations into equivalent phantom tax rates. For example, evidence that regulations are inhibiting the use of credit cards will be recognized in COMPASS models by phantom taxes on credit-card transactions. The removal of regulations would then be simulated by introducing changes in the rates of phantom taxes.

Particular requirements

As well as the four broad requirements, NECG requires that our modelling be sufficiently flexible to throw light on specific payment-system problems in different countries.

For Australia, NECG would like a simulation of the economy-wide effects of recently introduced RBA regulations capping the size of credit-card interchange fees (transfers from sellers to buyers) and the removal of the no-surcharging rule. As explained in section 3.3 and in our discussion above of requirement (2), we plan to tackle this type of problem by simulating in COMPASS models the effects of phantom tax movements. The sizes of these movements will be suggested by special-purpose modelling of the details of the inhibiting effect on credit-card use of the particular regulations under considerations.

For South Korea and India, NECG draws attention to two problems. The first is under-use of credit cards caused by regulations limiting credit-card access to people on incomes above certain threshold levels. We envisage special-purpose modelling to assess the extent of regulation-induced under-use of credit cards followed by COMPASS simulations of the effects of reductions in the phantom tax rates applying to credit-card use. The second problem of particular interest to Korea and India concerns the black economy. The benefits of bringing more of the economy into the purview of the tax collector can be simulated by reductions in tax rates (made possible by a broadening of the tax base) and by increases in high-benefit public expenditure (currently inhibited by lack of funding sources). The extent to which increased credit-card use would reduce the black economy would need to be assessed outside the CGE framework.

For China and Japan, NECG sees a variety of factors influencing the extent to which credit cards are used. In China these factors include the Golden Card project designed to establish necessary card infrastructure within identified cities and to link these cities together. NECG would like simulations of the benefits of completing this project and of the costs of delaying parts of the project, e.g. the intercity links. NECG would also like simulations of benefits to China of increased card acceptance by Chinese merchants, especially at the time of the 2008 Olympics. For Japan, NECG is interested in inhibitions on credit-card use caused by lack of acceptance of foreign cards in Japanese ATMs. As with the problems discussed for other countries, in tackling the Chinese and Japanese problems, we envisage considerable use of special purpose analysis to assess the extent of inhibitions on credit-card use. The economy-wide benefits of relaxation of inhibitions can then be simulated in COMPASS models by changes in phantom tax rates. Via shifts in foreign-demand curves for tourism services, it will be possible in COMPASS models to simulate the benefits of increased spending by foreign tourists, encouraged by wider acceptance of their credit cards.

Concluding remarks

The COMPASS project as an important opportunity to undertake practical quantitative research on the contribution of credit cards to the economies of various countries. More generally, it is an opportunity to make a methodological advance in CGE modelling by specifying the role of money and other payment instruments. Previous CGE modelling projects have included a role for monetary policy (which is largely concerned with regulating interest rates and not much concerned with money) by providing links between interest rates, investment and consumption. However, the COMPASS project will be the first CGE modelling effort to recognize the role of money and other payment instruments as margin commodities required for facilitating flows of goods and services.

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Figure 1. Input-Output Data for typical CGE model

		Absorption matrix				
		1 Producers	2 Investors	3 House- Holds	4 Exports	5 Other
	Size	← I →	← I →	← 1 →	← 1 →	← 1 →
Basic flows	↑ $C{\times}S$ ↓	BAS1	BAS2	BAS3	BAS4	BAS5
Margins	↑ $C{\times}S{\times}N$ ↓	MAR1	MAR2	MAR3	MAR4	MAR5
Sales taxes	↑ $C{\times}S$ ↓	TAX1	TAX2	TAX3	TAX4	TAX5
Primary factors	↑ M ↓	PRIMFAC				
Production taxes	↑ 1 ↓	TAX0G				

	Joint Production Matrix
Size	← I →
↑ C ↓	MAKE

	Import Duty
Size	← 1 →
↑ C ↓	TARIFF

Figure 2. Input-Output Database for COMPASS

		Absorption matrix					
		1		2	3	4	5
		Producers					
		Industries	Payment services	Investors	House-holds	Exports	Other
	Size	← I →	← R →	← $I+R$ →	← 1 →	← 1 →	← 1 →
Basic flows	↑ $C \times S$ ↓	BAS1		BAS2	BAS3	BAS4	BAS5
Trans, retail & wholesale margins	↑ $C \times S \times N$ ↓	MAR1		MAR2	MAR3	MAR4	MAR5
Sales taxes	↑ $C \times S$ ↓	TAX1		TAX2	TAX3	TAX4	TAX5
Payment marg, external goods	↑ $C \times SxQ$ ↓	MAR1PE		MAR2PE	MAR3PE	MAR4PE	MAR5PE
Payment marg internal goods	↑ $C \times SxQ$ ↓	MAR1PI		MAR2PI	MAR3PI	MAR4PI	MAR5PI
Phantom payment taxes goods	↑ $C \times SxQ$ ↓	TAX1PF		TAX2PF	TAX3PF	TAX4PF	TAX5PF
Primary factors	↑ M ↓	PRIMFAC					
Payment marg, external Prim factors	↑ MxQ ↓	MARFPE					
Payment marg internal prim factors	↑ MxQ ↓	MARFPI					
Phantom payment taxes prim factors	↑ MxQ ↓	TAXFPF					
Production taxes	↑ 1 ↓	TAX0					

	Joint Production Matrix
Size	← $I+R$ →
↑ $C+Q$ ↓	MAKE

	Import Duty
Size	← 1 →
↑ C ↓	TARIFF

Appendix: Expanding the Financial Sector in the MONASH Model of Australia

MONASH is the leading CGE model of the Australian economy. The present version of MONASH is built around an input-output table of the type illustrated in Figure 1. MONASH does not currently recognize margins aspects of the payments system. This appendix outlines the disaggregation of the financial sector that we propose in the conversion of MONASH to the Australian version of COMPASS. In terms of Figure 2 we are concerned with the first R-1 input columns of the payment services sector and the corresponding R-1 columns of the MAKE matrix.

The activities of the financial sector *are* accounted for in the MONASH model. However, the accounting is aggregated in line with the classifications used in the Australian Bureau of Statistics input-output (IO) tables

In the current Australian IO accounts, the financial sector is represented by industries 7301 Banking and 7302 Non-bank finance. Industry 7301 consists of bank services – financial intermediation services and Bank services nec. Industry 7302 consists of the operations of building societies, credit unions, money-market corporations and any other non-bank institution offering financial services.

The costs of 7301 and 7302 represent the resources used by the financial sector. The revenues equal the excess of interest and fee revenue over interest costs and loyalty rebates. Together, 7301 and 7302 provide the following services:

- Wholesale banking – financing and facilitating transactions associated with money and capital markets (including foreign exchange markets), and with large corporations.
- Intermediation – lending of deposit funds accumulated by deposit-taking institutions to households and small business.
- Retail banking – the provision of payment instruments or services to facilitate low value retail, commercial and industrial transactions.

The main payments instruments provided by the retail banking industry are:

- Cash
- Cheques, payment orders and other paper instruments
- Direct entry

- Bpay
- Credit and charge cards
- Debit cards (EFTPos)
- Other payment, store and pre-paid cards.

These can be aggregated to five main products: Cash, Cheques, Credit cards, Debit cards, and Other.

This suggests a disaggregation of 7301 and 7302 into two single-product sectors (Wholesale banking and Intermediation) and one multi-product sector (Retail banking) that produces five payments services (Cash, Cheques, Credit cards, Debit cards, and Other).