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## Foreign Direct Investment in Applied General Equilibrium Models

Overview of the Literature

Global applied general equilibrium (AGE) models focus on the interactions between regional product markets. Many of these models are developed to represent trade flows and evaluate trade policies. Foreign direct investment (FDI) and foreign commercial presence are ignored in most of them, although sales by foreign affiliates sometimes exceed the value of trade flows. This paper gives an overview of the scarce literature on modelling FDI in AGE models. Modelling options, data availability and simulation results are reviewed. Some conclusions are drawn for future work.

# 1 Introduction[1]

Foreign Direct Investment (FDI) flows have mounted from 100 billion US$ in 1980 to about 600 billion US$ per year in the period 1998-2003. The increase of FDI flows outpaced that of trade flows: FDI flows have increased by about 25% per year in the eighties and nineties, while trade flows have increased annually by about 10%. Sales of foreign daughter companies[2] have increased by 10% to 15% each year while GDP increased at most by 5% per year.[3]

These numbers are stunning. Foreign commercial presence is becoming more and more important for serving foreign markets and to reduce the costs of production. The speed of these developments is one of the eye-catching characteristics of globalisation. Foreign commercial presence, whether it is established by new investment or by acquisitions, increases the ties between national markets. The financing and management of firm establishments, the sources of the inputs, and destination of production are becoming more and more international.

Several developments underpin the accelerating FDI flows. First, many industrial countries have abolished or at least reduced barriers to inward FDI since the eighties. Second, technological developments have improved transportation and communication possibilities; the most prominent example is ICT. Travelling and communication over larger distances has become easier and cheaper. As a consequence, it becomes easier to use available endowments in other countries. Third, trade liberalization made it possible to outsource parts of production processes to other countries. Because firms want to keep these processes under control, they often choose for foreign establishments instead of contracts with foreign suppliers.

Although FDI is becoming more and more important in the world economy, it is not widely examined.[4] Theories and empirics on trade are much further developed than on FDI. Researchers have developed large-scale models to analyse trade policies. These models are based on microeconomic theory, equilibrium mechanisms, and the forward and backward linkages between various inputs and output markets.[5]

However, in analysing trade liberalisation policies, the role of foreign direct investment becomes increasingly more important. Trade through foreign commercial presence is much more important than cross-border trade in services (Karsenty, 2000). Recently some economists have conducted research to the microeconomic underpinnings of FDI and have tried to

[1] This is a background paper for the project on the European Market for Services. In this project we assess the economic consequences of the proposed services directive by the European Commission. Therefore we have modelled FDI in our AGE model WorldScan, see Lejour et al. (2007 forthcoming). This paper discusses the relevant literature.

[2] The terms daughter company, foreign commercial presence, foreign affiliate, and foreign plants are used interchangeably.

[3] Sources: Markusen (2002), and UNCTAD (2004).

[4] Recently, many empirical papers have been published on FDI flows and the productivity of FDI. See Blonigen (2005) for a review of the empirical literature on the determinants of FDI and Rojas-Romagosa (2006) on the productivity effects and the references included there.

[5] Examples of these so called global AGE models are the GTAP model (Hertel, 1997), the Linkage model (Van der Mensbrugghe, 2001), the Mirage model (Bchir *et al.*, 2003), Michigan model (Brown and Stern, 2001), G-Cubed Model (McKibbin and Wilcoxen, 1999), WorldScan model (Lejour *et al.*, 2006), and the models of Rutherford (1999).

incorporate this in general equilibrium models. The work of Markusen (2002) is leading. He has developed theories of the behaviour of multinationals in their decisions to service foreign markets by exports of commercial presence. His microeconomic perspective fits into the origins of AGE models.

Because FDI has different effects on the various sectors in the economy, and affects input and output markets, applied general equilibrium models are an appropriate tool for analyzing FDI and FDI policies. It is of course also possible to analyse the macro effects of FDI on output and productivity in other types of models. However, these analyses do not take account of the effects on the structure of the economy. The relevance of FDI differs per sector. In some sectors foreign commercial presence is relatively more important to serve the foreign market than in other sectors. An example is business services, where the required proximity of consumers and producers asks for foreign presence instead of cross border trade. Moreover, policy proposals to facilitate FDI are quite often sector specific and not generic. Examples are the Services Directive by the European Commission, and the GATS proposals to liberalise services trade by the WTO members.

Foreign affiliates also compete with domestic firms at their home market. Not only at the output market, but also at the input markets, *e.g.* for labour and intermediate inputs. Moreover, foreign affiliates can transfer knowledge and intangible capital to hired employees or providers of intermediate deliveries. It is the question to what extent these so called FDI spillovers affect the productivity of domestic firms. AGE models are appropriate tools to analyze the economic effects of these types of relationships.

We review these models in section 2. We do not only review the modelling of FDI, but also discuss the underlying FDI data, the barriers to FDI, and the simulation results. Section 3 summarizes and draws some lessons.

# 2 FDI in AGE models

#### Capital mobility and real rates of return

In most applied models, FDI is not modelled explicitly. Some AGE models have modelled international capital mobility. This was however not the focus of these models, since modellers had to treat the differences between national savings and investment, as complement to the differences between exports and imports. In some versions of the GTAP model (Hertel, 1997) the excess of regional savings flows into a global pool. Regions which lack savings, receive a part of this pool. Sometimes the distribution of savings is simply based on transformation functions. Sometimes it is based on (perceived) differences in risk and or rates of return on investment, see Walmsley (2002). Our WorldScan model has a similar mechanism (Lejour *et al*. 2006). The difference between regional savings and investment flows to a global pool.

Countries lacking savings attract foreign capital by raising the return on capital. McKibbin and Wilcoxen (1999) assume perfect financial capital mobility between sectors and regions. Physical capital is fully immobile once it is installed, however.

Although some of these models have the possibility to increase international capital mobility and to reduce regional differences in the rate of return, they do not incorporate explicit bilateral FDI flows and barriers to FDI. Brown and Stern (2001) give an overview of these models and how they are used to model changes in the barriers to foreign investment.

#### Modelling FDI

Two strands can be identified in the literature on the modelling of FDI in AGE models. In the first strand the modelling is explicitly based on the modelling ideas of Petri (1997). Section 2.1 discusses these models. Other models are explicitly inspired by the ideas of Markusen (2002). These are identified in Section 2.2. Note that the differences between both strands are not very large. The classification is useful for presentation purposes but does not represent divergent views.

## 2.1 Petri's framework

In 1997 Petri presented a paper on modelling foreign direct investment in a general equilibrium framework. The paper has never been published, but it is the reference paper in this area. Petri's framework was later incorporated in other CGE models: the FTAP model by the Australian Productivity Commission (Hanslow *et al.* , 2000), the Michigan model (Brown and Stern, 2001), the model of Lee and Van der Mensbrugghe (2001), and the MIRAGE model (Bchir *et al*., 2002). However, most of these models apply some minor changes to the original framework of Petri.

First, Petri extended the widely used Armington assumption. In his paper, product varieties are differentiated by both the country of ownership of the firm and the location of production (i.e. a Japanese car produced in Japan will be different from a Japanese car produced in USA). This assumption has later been adopted by all CGE models that incorporated FDI. We will call it the Petri assumption. In the first stage of the consumer decision tree consumers decide on the nationality of the multinational. In the second stage they decide on the location: at home or abroad. In the third stage the choice between the origins of the imports is determined. In this modelling structure the affiliates of a multinational are close substitutes. The products of the affiliates of various multinationals at one location/region are less substitutable. This implication of Petri's demand structure is disputed in the models discussed below.

Petri also modelled foreign firms separately from local firms. Thus, both sets of firms have different demand and production characteristics. One of the main distinctions is that foreign

subsidiaries are linked to their parent multinational enterprise (MNE) through technology and intermediate input flows. Another innovation introduced by Petri was to model the allocation of capital first at the sectoral level and then by region. Thus capital is more mobile across the same sector in different regions, than between sectors in the same region. This idea is consistent with the capital-knowledge theory of MNEs developed by Markusen (2002). Petri does follow the convention of most CGE models, and uses an optimizing framework for the allocation of capital with less than perfect substitutability between regions and sectors.

One major drawback of his model, however, is that he still assumes perfect competition with constant returns to scale. Given the nature of the sectors where FDI is most likely to be present, this is a restrictive and unrealistic assumption if one wants to assess the full impact of increased FDI flows. Finally, he models barriers to FDI as a tax on profits, which does not absorb productive resources.

Petri's framework expands the dimensionality of global AGE models. Normally demand has a sector dimension, a country of origin and a country of destination dimension. Petri adds the ownership dimension to these three. This also applies for capital. Capital not only depends on the sectors and regions, but also on the ownership. This expansion increases considerably the size of the model and the solution time.

Data on FDI are hard to come by. For that reason Petri distinguishes only 6 regions and three sectors. This fairly limited number of regions and sectors reduces the size of the model. He implements this CGE setting to assess different liberalization scenarios in the APEC region. To calibrate FDI data and foreign affiliates production, he uses both bilateral sectoral FDI flow data and firm-level survey data for USA and Japan. He finds that the inclusion of FDI liberalization mechanisms strongly enhances the welfare gains of the liberalization process in the APEC region.

### The FTAP model[6]

FTAP (Hanslow**,** *et al.*, 2000) is a dynamic version of the GTAP model (Hertel, 1997) with FDI, which incorporates most of the insights of Petri (1997). However, they use the Petri assumption with a different ordering of the preference structure. In their model, consumers first decide on the location where the variety is produced and then, on the region of ownership of the firm. They forcefully argue that this modification is more convenient and realistic. In particular, it is more suitable for modelling horizontal, rather than vertical FDI. We call this the modified Petri assumption. Their treatment assumes that from a Korean perspective, for example, a US multinational located in Korea is a closer substitute for a Korean owned firm than it is for a US firm located in the United States. Petri's treatment assumes that US owned firms are closer substitutes for each other than for Korean firms, irrespective of location. One reason for the FTAP treatment is that, in many instances, it confirms better with reality. One of the

[6] This section is mainly based on Hanslow**,** *et al*. (2000), and the summary of the FTAP model in Dee *et al*. (2000).

distinguishing characteristics of services is that they are tailored each time to meet the needs of the individual consumer.

The supply of FDI is determined by the same imperfect transformation among types of wealth as in Petri (1997), although it is extended with bonds, land and natural resources. Investors in each economy first divide their wealth between 'bonds' (which can be thought of as any instrument of portfolio investment), real physical capital, and land and natural resources in their country of residence. This choice is governed by a CET semi-elasticity of 1, meaning that a one percentage point increase in the rate of return on real physical capital, for example, would increase the ratio of real physical capital to bond holdings by one per cent. A bond is a bond, irrespective of who issues it, implying perfect international arbitrage of rates of return on bonds. However, capital in different locations is seen as different assets. Investors choose the sector in which they invest (with a CET semi-elasticity of 1.2). Then they decide whether to invest at home or abroad in their chosen sector (with a CET semi-elasticity of 1.3). Finally, they select a particular foreign region in which to invest (with a CET semi-elasticity of 1.4). The less than perfect transformation among different forms of wealth reflects risk aversion and less than perfect information.

Petri's model assumed that total wealth in each region was fixed. In FTAP, while regional endowments of land and natural resources are fixed (and held solely by each region's residents), regional capital stocks can accumulate over time. With this treatment of capital accumulation, FTAP provides a long-run snapshot view of the impact of trade liberalisation. To the extent that liberalisation leads to changes in regional incomes and savings, this will be reflected in changes to the capital stocks that investors in each region will have been able to accumulate.

FTAP models barriers on establishment and on ongoing operations. The former are modelled as taxes on the movement on capital, the latter as taxes on output of the firms. Both taxes discriminate by ownership, which could imply an unfavourable treatment for foreign-owned firms. The barriers create rents and FTAP assumes that these rents accrue to the owners of the firms. They receive abnormal high returns because they were lucky to surpass the barriers while other potential entrants were not.

The Petri treatment of FDI requires the availability of data on bilateral FDI stocks, and on the activity levels and cost and sales structures of FDI firms. The methods used to estimate such data are similar to those of Petri. APEC (1995) and United Nations (1994) provided limited data on FDI stocks by source, destination and sector. These data are used to provide a full bilateral matrix of FDI stocks by source, destination and sector, using RAS methods. The data are collected and implemented in the model for 19, mainly Asian, regions and three sectors.

The FDI stock data are used in turn to generate estimates of the output levels of FDI firms. To do this, capital income flows are estimated by multiplying the FDI stocks by rates of return. These capital rentals are then grossed up to get an output estimate for FDI firms, using capital

rental to output ratios from the GTAP database. The detailed cost and sales structures of FDI firms are assumed to be the same as for locally owned firms.

Dee and Hanslow (2000) present the FTAP model results for global post-Uruguay round services trade liberalization. FTAP explicitly incorporates a bilateral treatment of FDI and the purpose of this paper was to assess the relative importance of services trade liberalization with respect to the liberalization of agriculture and manufactures in the (then forthcoming) Doha WTO round of negotiations. They find significant overall world-wide welfare gains, although these are mainly concentrated in non-OECD countries. Moreover, the gains in services liberalization are as big as those related to the combined liberalization of the remaining barriers to trade in agriculture and manufactured goods. The main results, however, are driven by increased FDI flows from OECD countries towards emerging markets, especially to China.

Regarding the EU, there is a significant outflow of FDI from the region. When only services are liberalized the EU experiences a welfare decrease of 6.2 million US$. In the case where services liberalization is combined with agriculture and manufactured goods liberalization, welfare experiences a slight increase of 225 million US$. In this last case, the increase in real GDP is only 0.1%. These results are a consequence of the EU losses from endowment changes. In the FTAP model, these changes include the reduction of capital in the economy due to FDI outflows, but also, factor efficiency effects and the effects due to an increased number of varieties.

#### The Michigan model[7]

Brown and Stern (2001) also use the modified Petri assumption to incorporate relationships and data for cross-border services trade and FDI in the Michigan Model. The advantage of this demand system is that multinationals set up foreign plants to serve a particular market. So there is proximity between producers and consumers which is relevant for the provision of services. However, the foreign plants also export to other markets. The multinational faces fixed costs in establishing the headquarter and the foreign plants. There is free entry and exit, and thus profits are zero. However, the profit condition is set at the level of the multinationals. It is possible that some plants generate losses while others generate profits.

Capital is mobile internationally, while labour is not. Capital can be perfectly mobile because the degree of capital mobility can be set exogenously. There is no explicit difference between financial and physical capital. Three barriers to foreign investment are modelled. The first is a barrier that increases the fixed costs of locating. The second is a tax on installed capital. The third is a tax on variable capital and labour. Brown and Stern (2001) only use the third barrier.

The Michigan model discriminates 19 regions and 3 sectors in order to keep the size of the model under control. The regions and sector structure is thus identical to the FTAP model. The

[7] This section is mainly based on Brown and Stern (2001).

FDI data have also been supplied by the Australian Productivity Commission. The FDI barriers are derived from data on price cost margins delivered by Hoekman (2000). For the country with the smallest price costs margin, the margin is attributed to the fixed costs of production. The excess in margins in the other countries is attributed to barriers on operation of foreign firms.

When a reduction in these taxes is simulated, they find both sizable but quite variable welfare effects (both positive and negative) between different countries. They conclude that these welfare effects are strongly associated with the capability of a country to attract FDI as a result of services liberalization.

In their last simulation, they exogenously increase the world capital stock by 3%, and then, the welfare effects are positive for all countries. However, this *ad hoc* increase in the total capital stock is not a result of their CGE model nor based on any empirical assessment. It just follows the intuition that a rising real return to capital is likely, over time, to increase the world's capital stock.

#### Lee and van der Mensbrugghe (2001)

This static CGE model is a combination of the demand nesting proposed in the FTAP model and the insights of Petri (1997). In particular they use the allocation of capital and the same protection rates on FDI as Petri[8], where the barriers to FDI are modelled as a capital income tax.

One major drawback of this model is that it assumes constant returns to scale and perfect competition in all sectors. As mentioned before, this is a restrictive assumption for analysing FDI.

The results show a very significant impact of FDI liberalization, which is about three times bigger than the effect of trade liberalization in the APEC region. These results vary between regions and they find that the real income effect of FDI liberalization depends on the net FDI inflows to each region. These inflows, in turn, are influenced by initial FDI barriers, the share of MNEs in total output and the ratio of inward FDI stocks with respect to the stock of outward FDI, among other factors. Finally, they also find significant variations in the impact of FDI liberalization between sectors.

#### The MIRAGE model (Bchir *et al.*, 2002)

This is a dynamic CGE model that also incorporates most of the FDI modelling features introduced by Petri (1997). It also includes monopolistic competition, where the entry of firms is progressive over time to implicitly account for the associated adjustment costs. They also differentiate between installed capital and new investments. Since installed capital is immobile, the allocation of capital can be sub-optimal and the adjustment process is also gradual.

[8] The authors acknowledge that these protection rates are probably too high, and thus, it reduces the credibility of their results.

The allocation of FDI is modelled in an optimizing framework, where final investment is a function of the initial savings pattern, the capital stock and the sectoral rate of return on capital. They use two different adjustment elasticities to obtain a short and long-run version of the model. In addition, their framework allows them to distinguish between the purchase of local firms by foreign investors (Brownfield FDI), and Greenfield investments that imply an increased number of local firms and varieties.

They apply this FDI modelling framework for an experiment aimed at assessing the impact of trade liberalization between the EU and its periphery. They conclude that the impact of FDI is directly associated with the change in capital stocks and the number of firms. In particular, the EU does not experience any significant changes, since its capital stock is not altered in the simulations.

For illustration purposes, they include an experiment where FDI creates technological spillovers. In this particular case, the welfare gains associated with increased FDI flows after liberalization are greatly expanded. However, they state that the empirical evidence on these type of productivity links is neither systematic nor robust enough to include them in their standard model.[9]

## 2.2 The knowledge-capital model of Markusen

The seminal work on modelling FDI decisions is from Markusen. His book *Multinational Firms and the Theory of International Trade* gives an overview of his work with several co-authors. Markusen models trade and investment decisions of multinationals in a general equilibrium framework. Because multinationals are responsible for more than 50% of all FDI flows, their decisions are essential in understanding the development of FDI flows.

The basic idea is that multinationals decide to serve the foreign market by exporting goods or services or by establishing a foreign daughter company. This decision depends on the size of the market, the distance, transportation costs and barriers to foreign direct investment. The multinational has also the option to outsource a part of the production based on cost advantages. In both cases, the multinational wants to keep control over production instead of making arrangements with a foreign firm. There are several reasons for doing this. The essential one is that the multinational possesses (firm) specific knowledge and/or capital. It may be difficult to transfer this knowledge or capital to foreign producers. Another reason is that the multinational does not want to share this specific knowledge or capital. This knowledge or capital can be the source of competitiveness and profits. The specificities of knowledge and capital are thus the underlying reason for the existence of multinationals.

Markusen works out his ideas in two-country models with several multinationals. The decision to invest abroad depends on several characteristics. In spite of all his simplifying

[9] For further references on FDI productivity spillovers, see Rojas-Romagosa (2006).

assumptions the models are complicated and can not be solved analytically. He often uses simulations to assess the importance of the characteristics for the foreign investment decisions.

This complexity is probably one of the main reasons why his ideas have not been incorporated extensively in large-scale AGE models. A second reason is a lack of data on bilateral FDI flows and stocks by sector, and on the transfers of specific knowledge and capital between the headquarter and daughter companies of the multinational. Moreover, an individual multinational decides to export or to establish a daughter company for serving a foreign market. In practice regional trade and investment flows are both present in a sector. So, the representative firm, as it is often formulated in models, trades with and invests in other countries. The regime switches between exporting and investing as in Markusen, are not relevant in the representative agent framework.[10]

**Applications of the knowledge-capital model**

Markusen has applied his knowledge-capital model in a one-country AGE model with Rutherford and Tarr (Markusen *et al.* , 2005). Firms need producer services to produce a good. These producer services are delivered by national and foreign providers. The foreign providers have established an affiliate. In producing this service they use specialized inputs from the headquarter in the foreign country which reflect management expertise or firm specific technology. These specialized inputs are the main difference between the services production of the national and foreign providers. There is imperfect competition.

It is hard to calibrate these specialized inputs, because there are no data available. In some of their applications on the WTO-entry of Russia, Rutherford, Tarr and their co-authors, assume in various papers[11] that the establishment of foreign service providers within Russia is forbidden. The price of these specialized services is infinitely high. This circumvents problems in calibrating specific knowledge-capital transfers from the headquarter to the daughter company. As part of the WTO deal Russia allows foreign establishments.

In their models Rutherford and Tarr use the basic concept of Markusen's knowledge-capital model. However, they do not calibrate the full model, nor do they have the data on specific inputs. To a large extent the foreign headquarter is not modelled. Moreover, they do not model FDI flows explicitly, which is not necessary in a one-country model as theirs, but will be necessary in global CGE models.

In the scenarios where they only reduce FDI barriers, they find that welfare increases by approximately 2.4% (equivalent variation). Although they directly link these relatively large

[10] One might question the usefulness of the representative agent framework. Recent empirical work stresses the heterogeneity of firms regarding trade and foreign investment. For example, **only** a small share of the firms is responsible for most of the exports in France. Multinationals conduct most of the FDI, and these firms are on average more productive than small firms, see Bernard *et al*. (2005) Helpman *et al*. (2004), and Keller and Yeaple (2003), among others.

[11] Jensen *et al.* (2004) and Rutherford *et al.* (2005).

welfare gains with economies of scale in the services sector, implicitly the result is driven by a large rise in FDI inflows.

Recently, Copenhagen Economics (2005) has applied the framework of Markusen *et al*. (2005) in a multi-region model to analyze the Services Directive for the EU member states. They distinguish all 25 Member States and a rest of the world region. Moreover, the economy is subdivided in 7 sectors. Per country of location they distinguish the production of the home firm and one multinational. The empirical distinction is based on OECD data on the activity of foreign affiliates of multinationals. The data of the value of specialized inputs between the headquarter of the multinational and the affiliate is calibrated at 25% of the value added of foreign capital. Data on foreign ownership are from OECD (FATS database). Foreign and home-owned firms have the same production structure apart from the specialized input. Foreign direct investment flows are not explicitly modelled. They have implemented cost-creating and rent-creating barriers. The former is modelled as a tax on labour inputs and the latter as a mark up on total costs.

When the overall effect of both the trade-related and FDI-related effects of services liberalization are accounted for, they find significant welfare gains of around 0.6% and a GDP increase of 33 billion euros.

# 3 Summary and lessons

Section 2 gives an extensive overview of all CGE models which have incorporated FDI. Here we summarize the main characteristics of the models and their data and draw some lessons. Nearly all models explicitly refer to Petri (1997). He distinguishes home and foreign owned capital in a sector. The basic idea is that multinationals invest abroad, and that the capital involved is different from the domestic capital in the host country. These differences are motivated by specificities attached to foreign capital such as knowledge. Markusen (2002) has stressed the relevance of these specificities extensively and some economists inspire their model developments explicitly on his ideas.

The common characteristics of these models are:

- Imperfect competition and increasing returns (except Petri, and Lee and Van der Mensbrugghe).
- An Armington demand structure where the varieties at one location of various multinationals are closer substitutes than the varieties of one multinational at different locations (modified Petri assumption).

- Multinationals have plants at various locations. Each country has one representative multinational per sector.
- Given this demand structure, the production variety of foreign plants can also be traded.
- Domestic firms and foreign plants have the same cost structure (due to lack of data, except for Petri).
- Limited availability of bilateral FDI data at the sector level.
- No data on specialized inputs (knowledge-capital) between headquarter and foreign plants.

The modelling of FDI barriers differs. The modellers do not explain extensively their motives for modelling the various barriers. The FTAP model distinguishes taxes on establishment (on capital) and ongoing operations (on output). The latter tax is comparable to a mark up on total costs as in the to Copenhagen Economics model. In both models the tax or mark-up creates a rent for the foreign producer. Both models are fuelled with own estimates on FDI barriers. In particular, Findlay and Warren (2000) are innovative and profound in this area.

All models refer to the knowledge-capital model of Markusen, but the specificities are not explicitly modelled, or calibrated. The Michigan, FTAP and Petri framework motivate limited sectoral capital mobility by the sector specific-capital in the spirit of Markusen. However, the empirical material underpinning of the limited capital mobility between sectors and domestic versus foreign is scarce. Hence, the values of the substitution elasticities are imposed in an ad hoc manner. In general the substitution within a sector between investing at home and abroad is higher than between sectors.[12]

Petri, and Rutherford and Tarr's, model a specific input between the headquarter and the foreign plants abroad, but this mechanism is not fuelled with data. Only Copenhagen Economics make some "guestimate". There are no hard data on the firm-specific inputs between the headquarter and the daughter companies. There are balance of payment data on dividend flows, royalties, intra-firm trade, and service fees, which are to some extent related to FDI. However, these data are unilateral, not discriminating sectors or countries of origin or destination.

Due to data limitations it is in practice difficult to model the Markusen framework. Data on sales, labour and capital inputs of foreign affiliates is scarce (an exception is the incomplete OECD database on foreign affiliates). Often data on foreign FDI stocks are used, to indicate the relevance of foreign affiliates assuming identical cost structures for the home and foreign owned affiliates within a region. The OECD, UNCTAD and APEC deliver data on bilateral FDI flows and stocks. However the data of the countries which report the outgoing and ingoing FDI

[12] The FTAP model assumes elasticities of 6.5 and 6 respectively, and Lee and van der Mensbrugghe assume values of 3 and 2.

flows have to be reconciled.[13] There are also data on out and in-going flows and stocks per sector but these data do not distinguish the country of origin or destination. Using RAS methods we could construct bilateral FDI data by sector, see also the methods used for the FTAP model. For our modelling of FDI in WorldScan (Lejour *et al*,, 2007), van Leeuwen and Lejour (2006) use a similar method to obtain bilateral FDI stocks for 23 regions (most of them EU countries) and 10 economic sectors.

A common feature of the previous models, is that the welfare gains derived by increased FDI related to services liberalization, are strongly associated with the *net* inflow of FDI. Countries that experience a net positive inflow are likely to increase GDP and social welfare. This fact can explain why the GDP gain for EU countries with relatively small net inflows is not significant. Without an increase in the total stock of capital, which can in turn produce a significant net positive FDI inflow for most EU countries, it appears that the GDP effects of increased FDI flows due to services liberalization are small.

In addition, the inclusion of imperfect competition is also a common feature of the CGE models that explicitly account for FDI flows. However, the welfare effects do not seem to be directly related to the economies of scale, nor to the positive effects of an increased number of varieties in consumption and production.

A mechanism that could introduce significant welfare effects (as these are expected by FDI liberalisation) is to model domestic and multinational firms with different cost structures and productivity levels. This approach will follow the theoretical work of Markusen (2002) and, to the best of our knowledge, has not yet been empirically applied to CGE models with explicit FDI flows (except for the Mirage model). Replacing domestic capital with foreign capital can raise production output through two channels. First, assuming the existence of separate domestic and foreign firms, productivity differences between these two types of firms may exist. In general, foreign firms are expected to be more productive than domestic firms and a shift to more foreign capital will therefore raise total output. Second, it is expected that the higher level of FDI related knowledge will not only remain within the firm, but will spill over to other firms as well. For instance, competition will force domestic firms to raise their standards and quality as well.

In an accompanying CPB memorandum, Rojas-Romagosa (2006) provides an overview of the literature on the productivity advantages of MNEs and the empirical estimates of the spillover effects. In particular, he refers to some numerical estimates that can be applied as initial “guestimates” of FDI spillovers within a CGE application. In addition, from the FATS

[13] This problem is well known for bilateral trade data. Methods are developed to identify the most reliable reporter of outgoing and ingoing trade flows to reconcile these data to be useful in AGE models, see Lejour and van Leeuwen (2006).

data base and micro-econometric work, we can derive productivity differences between foreign plants and domestic firms in a host country. The quality of these data varies, they are not exhaustive, and not always conclusive on the supposed higher productivity of foreign plants, see Kox *et al*. (2004) among others.

To sum up, there is a growing body of theoretical and CGE applications that can be taken as a useful starting point for the implementation of FDI flows in WorldScan. However, there is scope for further improvements in the data used and the modelling techniques applied. Two such topics include the differentiation between foreign and local firms, and the inclusion of productivity spillovers related to the presence of MNE's. The increased importance of FDI ensures that this will be a relevant research topic in the future, with important policy implications.

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