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Abstract

Depending on the definition of the tax base, the statutory corporate tax rate implies rather different measures of effective average and marginal tax rates. This paper develops a model of a monopolistically competitive industry with extensive and intensive business investment and shows how these margins respond to changes in average and marginal corporate tax rates. Intensive investment refers to the size of a firm's capital stock. Extensive investment refers to the firm's production location and reflects the trade-off between exports and foreign direct investment as alternative modes of foreign market access. The paper derives comparative static effects of the corporate tax and shows how the cost of public funds depends on the elasticities of the extensive and intensive investment responses.

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Keywords

Exports, foreign direct investment, corporate taxation, extensive and intensive investment, costs of public funds.

JEL Classification

D21, F23, H25, L11, L22

1 Introduction

With increasing globalization and mobility of firms, international competitiveness has become a dominating concern in recent tax reform. Policy makers give priority to creating a favorable tax environment for internationally mobile firms. These firms tend to be the most productive and profitable ones. It is believed that a company's average tax rate is the decisive measure when a country wants to become more attractive as a location of international direct investment. A low *effective average tax rate* (EATR), compared to other countries, helps to keep mobile firms at home and thus reduces outbound foreign direct investment (FDI). It also helps to convince multinational enterprises (MNEs) to establish subsidiaries (inbound FDI) and generate employment and income at home rather than producing abroad and exporting to the domestic market. The EATR refers to the discrete location decision of firms. The *effective marginal tax rate* (EMTR), in contrast, refers to the intensive margin of capital formation, making existing firms grow larger or repeat investment of the same type. The EMTR is thus believed to be relevant for the growth of domestic businesses which refrain from FDI and, if at all, serve foreign markets via exports. The voluminous study of the European Commission (2001) on company taxation in Europe has provided detailed compilations of various measures of EMTRs and EATRs in an intra-European and world wide comparison. The measurement of effective tax rates was recently summarized by Devereux and Griffith (2003) and Sorensen (2004).

Recent examples of tax reform proposals that aim to create an internationally more competitive tax environment include, among others, the Technical Committee on Business Taxation (1997) for Canada, the GCEA et al. (2006) and Scientific Advisory Board of the German Ministry of Finance (2004) for Germany or the proposal of a growth oriented dual income tax in Keuschnigg (2004) and Keuschnigg and Dietz (2006) for Switzerland, among others. Even the U.S. with its large internal market has become more concerned with the international impact of tax reform as the recent proposal by the President's Advisory Panel on Federal Tax Reform (2006) testifies. The proposal by the GCEA (2006) for Germany, for example, compiles and internationally compares EATRs. To press its case, it demonstrates how the reform proposal significantly improves Germany's ranking in an international comparison of EATRs at the company level. It is argued that this better ranking reflects a major improvement in Germany's stance in the international tax competition game. Germany's international position with respect to the EATR would improve from 12th to 5th rank within the set of countries listed. Interestingly, the report does not explicitely list EMTRs and only states the implied changes to the cost of capital.

Table 1 summarizes calculations for effective tax rates from the European Commission's (2001) report on company taxation in Europe and also includes EMTRs. For Germany, the effects of the 2001 tax reform are included. Both in terms of marginal and average effective rates, no European country except France puts a higher tax burden on business investment than Germany. Also, the EATRs are considerably higher and much dominated by the statutory company tax rate. This paper will also investigate whether the EATR is the appropriate concept for measuring tax distortion at the extensive margin.

Country	Corporate Tax Rate	Cost of Capital	EMTR	EATR
Austria	34.00	6.3	20.9	29.8
Belgium	40.17	6.4	22.4	34.5
Denmark	32.00	6.4	21.9	28.8
Finland	28.00	6.2	19.9	25.5
France	40.00	7.5	33.2	37.5
Germany	39.30	6.8	26,0	34.8
Greece	40.00	6.1	18.2	29.6
Ireland	10.00	5.7	11.7	10.5
Italy	41.25	4.8	-4.1	29.8
Luxembourg	37.45	6.3	20.7	32.2
Netherlands	35.00	6.5	22.6	31.0
Portugal	37.40	6.5	22.5	32.6
Spain	35.00	6.5	22.8	31.0
Sweden	28.00	5.8	14.3	22.9
UK	30.00	6.6	24.7	28.2

Source: European Commission (2001), Tables 7 and 8. Only corporate taxes. Germany after 2001, Box 7, Annex Table 1a.

Table 1: International Comparison of Effective Tax Rates

Much of the academic literature on the taxation of multinational investment (see the reviews of Gordon and Hines, 2002, Gresik, 2001, Weichenrieder, 1995, and Janeba, 1997, or the papers by Haufler and Schjelderup, 2000, and Davies, 2004, to mention a few recent contributions) does not connect very well with these descriptive measures of effective average and marginal tax rates. The dominant framework postulates that multinational investment flows occur until the marginal product of capital is equalized across countries. Taxes may drive a wedge between gross returns to capital across countries and thereby lead to an inefficient international allocation of capital. It is not possible to rationalize the role of EATRs in a framework that allows only for marginal investments but excludes the discrete nature of FDI. Inspired by empirical work of Hines (1996) and Devereux and Griffith (1998) and others, and lately discussed by Devereux, Griffith and Klemm (2002), the recent theoretical literature has studied models of FDI in imperfectly competitive markets to investigate the impact of taxes on discrete location choice (see Devereux and Hubbard, 2003, Fuest, 2005, or Bond, 2000, for an early discussion). These papers, however, tend to ignore the intensive margin of business investment which remains very important for immobile national firms.

This rather new literature in public finance, however, misses a systematic treatment that allows to identify the separate roles of EMTRs and EATRs for intensive and extensive investment in a unified framework. The present paper fills this gap. It is not known precisely how the corporate tax, by determining the average and marginal effective tax rates, impacts on the extensive and intensive margins of business investment. It is even less known how the behavioral responses on these two margins determine the cost of public funds as created by the corporate income tax. Ideally, one should be able to draw a parallel to the literature on wage taxation in the presence of intensive and extensive labor supply (see Saez, 2002, Immervoll, Kleven, Kreiner and Saez, 2006, and Kleven and Kreiner, 2006). In fact, the paper shows that the cost of public funds from corporate taxation can be parameterized in much the same way by appropriately defining the behavioral elasticities of discrete and marginal business investment. This requires, of course, a consistent welfare analysis of corporate taxation in imperfectly competitive markets, a task which was deemed too complicated so far (see the published comments on Devereux, Griffith and Klemm, 2002).

Compared to standard public finance analysis, this paper takes an entirely different route to model discrete and marginal investment. It builds on new trade theory which emphasizes the heterogeneity of firms and explains how firms choose between exports and FDI as alternative means to serve foreign markets (see Melitz, 2003, Helpman, 2006, Grossman and Helpman, 2005, and Helpman, Melitz and Yeaple, 2004, among others). We develop a much simplified, probabilistic version of the "Melitz model" with monopolistically competitive firms. To keep the model simple, we consider only outbound FDI by domestic firms, ignore inbound FDI, and also eliminate productivity differences across firms. Instead of productivity differences, our probabilistic approach introduces a foreign market entry risk that differs across firms. The symmetry of firms with respect to all other characteristics keeps the model very tractable. Given extra fixed costs associated with FDI, only the firms with the highest probability of successfully entering foreign markets will prefer (outbound) FDI over exports. Firms that find it difficult to penetrate foreign markets (low success probability of market entry) will not be able to break even with the FDI alternative since FDI must also pay back the fixed cost of establishing foreign subsidiaries. The choice between FDI and exports reflects a proximity concentration trade-off: FDI saves transport costs but duplicates production and fixed costs.

The fraction of firms choosing FDI and foreign production over exports and domestic production defines the extensive margin of investment. It will be shown how the corporate tax, depending on the implied EMTR, affects intensive investment and firm size by inflating the user cost of capital. It will also be shown how the domestic corporate tax, depending on the implied EATR, diminishes firm values from domestic export production relative to firm values from foreign subsidiary production. The corporate tax thus affects extensive investment by reducing firm value from domestic export production and inducing more firms to locate abroad. As a final innovation, the paper will derive a welfare based measure of the cost of public funds due to the corporate tax that will depend on the extensive and intensive investment elasticities. Section 2 now proceeds in setting up the basic framework. Section 3 states comparative static results and characterizes the costs of public funds. Section 4 concludes.

2 The Model

The argument is based on a simple two period model of a small economy with monopolistic competition and variable outbound FDI. In the first period, a fixed labor endowment is employed to produce a traditional good (numeraire) which can be consumed or invested. The traditional sector employs a Ricardian technology with a unit labor coefficient and pays a wage rate of one. A fixed number of n industrial firms each invests capital (standard good) in period one to supply differentiated goods in period two. Each firm is endowed with a worldwide patent for a specific brand which is a close substitute for other varieties. The firm faces demand worldwide and produces under conditions of monopolistic competition. It is assumed, however, that foreign market entry is more difficult than supplying the domestic market and is therefore subject to risk. In consequence, firms will always serve the domestic market but may or may not be successful in penetrating the foreign market. In case of failure, the brand is not offered abroad. Firms also confront the discrete decision whether they should serve the foreign market via exports from home subject to transport costs. Alternatively, they could save on transport costs by relocating production abroad and serving the market locally. However, establishing a foreign subsidiary company requires extra administrative and other fixed costs. To keep the model as simple as possible, we suppress production of differentiated goods by foreign firms. Foreign consumption of varieties exclusively relies on imports (exports of home economy) or subsidiary production of multinationals.

Decision making by firms follows a logical sequence. To begin with, firms inherit a product design from past innovation and a probability that the product will actually be valued by consumers. To keep things simple, we assume that a new product designed by domestic firms always appeals to consumers in the home market. In contrast, the firm may or may not be able to penetrate the foreign market. The success probability of foreign market introduction varies for different brands. Second, firms decide whether they serve foreign markets with exports or FDI. Third, they choose capital investment which fixes plant size and sales volume. Fourth, firms distribute profits and consumers allocate income to innovative and traditional goods. The presentation of the model follows the solution principle of backward induction and starts with consumer choice.

2.1 Demand

Domestic households are endowed with fixed labor L which is paid a wage $w = 1$ per unit. In the first period, households earn fixed labor income, consume a quantity C_1 of the standard good (numeraire) and save the rest. In the second period, savings S yield total wealth RS including interest where $R = 1 + r$ is one plus the interest rate. In addition, agents receive profits π^e on ownership of monopolistic firms and get lump-sum transfers z from the government. They spend C_2 on consumption of the traditional good and E on their purchases of n differentiated goods. Each brand is available at a producer price p_j and is consumed in quantity c_j. Spending is constrained by first and second period budgets

$$C_1 = L - S, \quad C_2 + E = RS + \pi^e + z, \quad E = \int_0^n (1 - \nu) p_j c_j dj = n (1 - \nu) pc. \tag{2.1}$$

The last equality reflects the symmetric nature of preferences and costs. We also include a demand subsidy for differentiated goods at rate v. The subsidy is merely a technical device that serves to eliminate the markup pricing distortion if needed (see e.g. Keuschnigg, 1998). Given producer prices p_j, the consumer price is reduced to $(1 - \nu) p_j$.

Eliminating savings yields the intertemporal budget constraint. It will be convenient to express it in second period units,

$$RC_1 + C_2 + E = LR + \pi^e + z. \tag{2.2}$$

Assuming linearly separable preferences, present and future consumption are perfect substitutes. The interest rate r must thus be equal to the subjective discount rate. Consumers do not care *when* to consume but care only about total consumption. Lifetime utility in second period units is $U = RC_1 + C_2 + \int_0^n u(c_j) dj$. Substituting (2.2)

$$U = LR + \pi^e + z + \int_0^n [u(c_j) - (1 - \nu) p_j c_j] dj. \tag{2.3}$$

The square bracket gives consumer surplus from consumption of innovative goods. Demand follows from utility maximization which results in $(1-\nu)\, p_j = u'(c_j)$ or

$$u(c_j) = A^{1-\alpha} \cdot (c_j)^{\alpha} / \alpha \quad \Rightarrow \quad c_j = A/ \left((1-\nu)\, p_j\right)^{\varepsilon}, \quad \varepsilon = 1/(1-\alpha) > 1. \tag{2.4}$$

The parameter ε is the price elasticity of demand where $0 < \alpha < 1$.

Foreign variables are marked by an upper index f. The foreign economy is endowed with fixed labor L^f. It uses an investment technology that converts one unit of the standard good today into R units tomorrow. It is specialized in the production of the standard *numeraire* good and is not engaged in innovate goods production. Varieties are consumed in the second period only and stem from imports or subsidiary production of multinationals. Since foreign market entry is risky, not all varieties on offer in the home country are also supplied abroad. Hence, $n_X + n_I < n$. Lower indices denote varieties supplied via exports or FDI. In the symmetric case, budget constraints are

$$C_1^f = L^f - S^f, \quad C_2^f + E^f = RS^f, \quad E^f = n_X p_X c_X + n_I p_I c_I. \tag{2.5}$$

Measured in second period units, life-time welfare is $U^f = RC_1^f + C_2^f + \int_0^{n^f} u(c_j^f) dj$. After substituting (2.5), $U^f = RL^f + n_X \left[u(c_X) - p_X c_X\right] + n_I \left[u(c_I) - p_I c_I\right]$. Demand for foreign varieties follows from $p_j^f = u'(c_j^f)$. Using the same specification as in (2.4) and noting the preference parameter A^f, demand for brand j is

$$c_j^f = A^f / \left(p_j^f\right)^{\varepsilon}. \tag{2.6}$$

2.2 Home Market Production

The focus is on the home country's production and trade of differentiated goods. To save on notation, we suppress the variety index j. Firms invest k units of the standard good in the first period. Since capital does not depreciate, this investment yields k units of the standard good in the second period. At the same time, capital is used in period two to produce k units of a given brand of the differentiated good. The monopolistic firm supplies the entire domestic market for its brand, $c = k$, and earns revenues pk equal to consumer spending as in (2.1).[1] The government levies a proportional profit tax (corporate tax) at rate t but allows a deduction of ek from the tax base. When $e = 1$, firms can fully deduct investment, making the corporate tax an investment neutral cash-flow tax. If $e < 1$, the tax discriminates against investment. The discounted present value of the firm's production for the home market is

$$\frac{\pi}{R} = \frac{(1-t)\,pk + (1-et)\,k}{R} - (1-et)\,k, \quad \pi = (1-t)\,pk - (1-et)\,rk, \tag{2.7}$$

where π stands for second period profits. In period two, the government collects tax revenue $\pi^T = t\,(pk + ek) - tekR = t\,(p - er)\,k$.

In solving for optimal investment, the firm takes account of its monopoly position $c = k$ in the market for her brand. Using (2.4), the revenue function is seen to be concave in capital,[2] $p\,(k)\,k = k^{\alpha} \cdot A^{1-\alpha}/\,(1-\nu)$. Alternatively, using $k = A/\,[(1-\nu)\,p]^{\varepsilon}$, the firm's revenue from domestic sales amounts to

$$p \cdot k = A \cdot (1-\nu)^{-\varepsilon} \cdot p^{1-\varepsilon}. \tag{2.8}$$

With this information, and slightly rewriting (2.7), the monopolistically competitive firm's investment follows from

$$\pi = \max_k\,(1-t)\,(pk - uk)\,, \quad u \equiv \frac{1-et}{1-t} \cdot r, \tag{2.9}$$

where u stands for the user cost of capital. Taking account of the fact that any increased output from additional investment reduces the producer price p, the optimality condition becomes $p - u + k \cdot dp/dk = 0$. Using the price elasticity given in (2.4) yields

$$\alpha \cdot p\,(k) = u, \quad k = A \cdot (\alpha/\,[(1-\nu)\,u])^{\varepsilon}\,. \tag{2.10}$$

[1] In the absence of taxes, the present value of a firm with investment k is $(pk + k)\,/R - k$ which amounts to $\pi = pk - rk$ if expressed in second period values. Mark-up pricing over marginal cost, $p > r$, yields strictly positive profits indicating an excess return on capital over its user cost r. The foreign technology converts k^f units of the standard goods into Rk^f units tomorrow, yielding second period profits of $\pi^f = rk^f - rk^f = 0$. Profits are zero since capital yields no more than a normal return r.

[2] For this reason, we can keep technology linear. A concave net output function $f\,(k)$ would only complicate the analysis without additional insights.

Price is a fixed markup $1/\alpha$ over the user cost of capital. The demand curve in (2.4) determines the level of sales at this price which, in turn, yields output and capital invested. Obviously, a higher demand subsidy stimulates output and sales. The marginal revenue function $\alpha p(k)$ is like a downward sloping marginal product of capital curve in standard investment models, yielding optimal capital where the marginal product is equal to the user cost of capital. Figure 1 illustrates the investment problem of the monopolistically competitive firm.

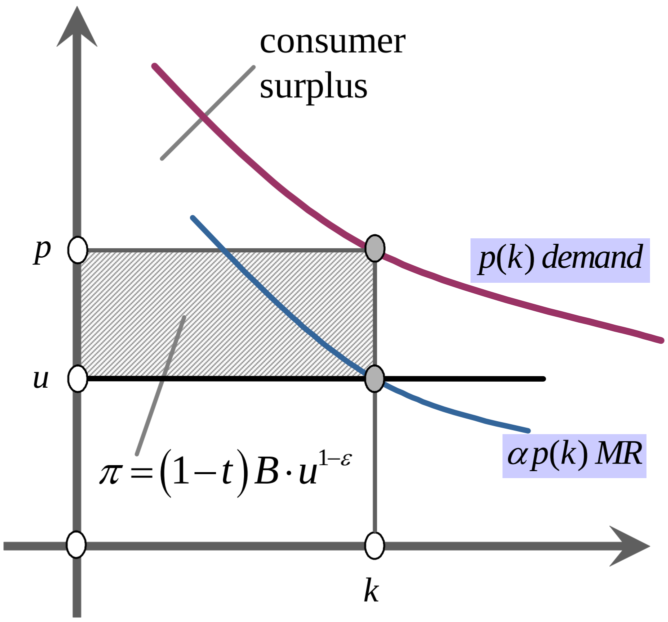

Fig. 1: Optimal Investment and Profit

A closed form solution for profits is found when using $\alpha p = u$ to substitute out u in (2.9) which yields $\pi = (1-t)(1-\alpha) pk$. Replace pk by (2.8) and again use the markup $p = u/\alpha$ to arrive at

$$\pi = (1-t) B/u^{\varepsilon-1}, \quad B \equiv (1-\alpha) A\alpha^{\varepsilon-1}/(1-\nu)^{\varepsilon}. \tag{2.11}$$

2.3 Foreign Market Entry

A domestic firm with a given product design can sell its brand worldwide. Suppose now that foreign market entry was successful and the firm has decided to produce at home and serve the foreign market with exports. Exports involve real trade costs $\theta - 1$ of shipping goods across border. To cover transport cost, the foreign demand price p_X must exceed the domestic producer price by a factor θ. For the same reason, an export firm must produce a quantity $k_X > c_X$ larger than what arrives at foreign consumers. The difference is lost on cross border transport. Foreign demand prices and domestic producer prices for exports are thus related by

$$p_X = \theta p, \quad k_X = \theta c_X, \quad p_X \cdot c_X = p \cdot k_X, \quad \theta \geq 1. \tag{2.12}$$

When the firm with a monopoly on brand j successfully picks up export business, it must invest an extra k_X of the standard good and will obtain value π_X *in addition to* the value π of serving the home market,

$$\pi_X = (1-t)\, pk_X - (1-et)\, rk_X = (1-t)\,(p-u)\, k_X. \tag{2.13}$$

The firm pays tax in the second period equal to $\pi_X^T = t\,(p - er)\, k_X$.

Since $p_X = \theta p$, export demand in (2.6) is $c_X = A^f / (\theta p)^{\varepsilon}$ and yields revenues

$$pk_X = p_X c_X = A^f / (\theta p)^{\varepsilon - 1}. \tag{2.14}$$

By the same steps as before, exporters choose a markup of producer price over the user cost of capital as in (2.10), $\alpha p = u$. Consequently, profits from export business amount to $\pi_X = (1-t)\,(1-\alpha)\, pk_X$ or

$$\pi_X = (1-t)\, B^f / u^{\varepsilon - 1}, \quad B^f \equiv (1-\alpha)\, A^f\, (\alpha/\theta)^{\varepsilon - 1}. \tag{2.15}$$

Instead of exporting to the foreign market, the firm could have chosen FDI by establishing a foreign subsidiary. When producing locally, the firm faces foreign factor prices. Since the analysis in this paper keeps foreign taxes constant and is exclusively concerned with the intensive and extensive investment response to the domestic corporate tax, it is useful to entirely suppress foreign taxes. Therefore, the user cost of capital invested abroad is equal to the foreign interest rate, $u^f = r$, which is, by assumption, equal to domestic interest. Having opted for FDI to serve the foreign market, the firm saves on transport costs. For this reason, the firm can charge a lower price p_I to foreign customers. The value of the foreign subsidiary to the domestic parent company is

$$\pi_I = (p_I - r)\, k_I. \tag{2.16}$$

By similar steps as before, foreign subsidiaries set a markup of producer price over foreign user cost of capital as in (2.10), $\alpha p_I = r$. The profit definition thus yields $\pi_I = (1-\alpha)\, p_I k_I = (1-\alpha)\, A^f\, (\alpha/r)^{\varepsilon-1}$. The export versus FDI decision explained below will be well behaved only if $\pi_I > \pi_X$. Comparing the closed form profit terms, the inequality is equivalent to $1/r^{\varepsilon-1} > (1-t) \,/\, (\theta u)^{\varepsilon-1}$. It is surely satisfied in the absence of taxation where $u = r$. If real trade costs are positive, $\theta > 1$, the condition reduces to $1 > 1/\theta^{\varepsilon-1}$ and is necessarily fulfilled since $\varepsilon > 1$ as well. If taxes are not too large, the inequality also holds with positive taxes.

2.4 Exports Versus FDI

The key element of the model refers to the choice of domestic firms to serve foreign markets via two rivaling modes: exports or FDI.[3] The decision defines the extensive margin of domestic investment by relocating production and investing abroad if exporting becomes less attractive than foreign subsidiary production. The simplest approach is to assume that foreign market entry is risky and firms succeed only with probability q. All firms attempt foreign market entry but some will not be successful so that there is a margin of purely local firms that earn π only. Total profit of successful firms from global sales

[3] To endogenize this margin, we choose a much simplified "Melitz model" of monopolistic competition (see Melitz, 2003). Instead of considering firm heterogeneity in labor productivity, giving rise to a distribution of unit costs, prices, demand and firm size, we assume identical productivity across firms and keep the production and demand side symmetric. The only heterogeneity is the risk of foreign market entry. Our assumptions much increase analytical tractability which has plagued the applications of the Melitz model. One disadvantage is that we cannot capture how trade and fiscal policy change aggregate productivity by affecting firm composition. However, this aspect is not the focus of the paper.

amount to $\pi + \pi_X$ for exporters and $\pi + \pi_I$ for a multinational company with foreign subsidiaries. Ex ante, before success of foreign market entry is known, the expected value of global sales is

$$\bar{\pi}_X = \pi + q \cdot \pi_X, \quad \bar{\pi}_I = \pi + q \cdot \pi_I. \tag{2.17}$$

Preparing foreign market entry requires some fixed costs such as building a distribution network, fulfilling foreign regulations etc. They are normalized to zero for exports, $f_X = 0$, making exports the default mode.[4] Opting for FDI by establishing a foreign subsidiary is more expensive. Suppose there are *differential* fixed costs f_I relating to FDI. Ex ante, before the success of market entry is known, the expected present value of a foreign subsidiary, net of these fixed costs, would be $q \cdot \pi_I / R - f_I$. In terms of second period values it amounts to $q \cdot \pi_I - F$ where $F \equiv R f_I$.

As a result of past innovation, new product designs are endowed with variable probabilities q of successful foreign market introduction. The success probability is drawn from a distribution $G(q)$. Given q, the firm decides whether to choose exports (default mode) or FDI. The extra fixed cost F necessary for FDI is lost without any gain if market entry fails. FDI is therefore worthwhile only if $\bar{\pi}_I - F > \bar{\pi}_X$. This condition holds only for those products which come with the highest probability of successful foreign market entry. The critical, indifferent firm is defined by[5]

$$q \cdot (\pi_I - \pi_X) = F, \quad F \equiv f_I R. \tag{2.18}$$

Figure 2 illustrates the choice between exports and FDI. Since exports give rise to extra transport cost, variable profits are larger when producing locally, $\pi_I > \pi_X$. FDI, however, gives rise to extra fixed costs. If a firm will be successful in introducing her brand in the foreign market with a low probability q only, then the differential profit

[4] If f_X were positive, some firms would not attempt foreign market entry at all and choose to stay local from the beginning.

[5] Instead of (2.17), one could assume that new products appeal to all customers in the same way so that the risk of market introduction is symmetric across regions. In this case, expected profits are $\bar{\pi}_X = q \cdot (\pi + \pi_X)$ and $\bar{\pi}_I = q \cdot (\pi + \pi_I)$, giving rise to the same critical probability as in (2.18).

$\pi_I - \pi_X$ from FDI will materialize only rarely while the fixed cost of establishing the subsidiary will be necessary in any case. Choosing FDI instead of exports will thus not be profitable for firms with low success probability and pays only for firms that can expect to be successful with high probability. Given the distribution of success probabilities across firms, the identity of the critical firm then pins down the mass of exporters and the mass of firms that go multinational by establishing a foreign subsidiary.

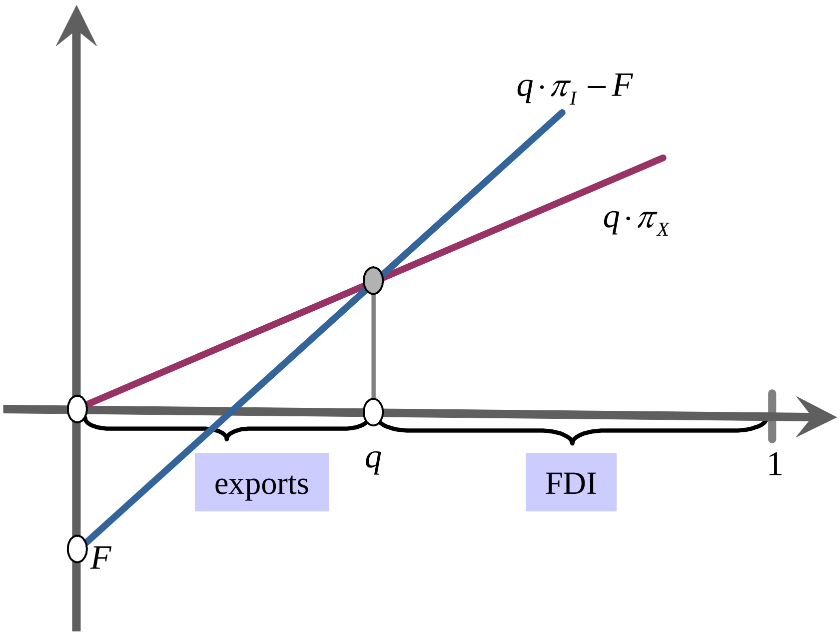

Fig. 2: Exports Versus FDI

According to Figure 2 and equation (2.18), all firms with success probabilities smaller than the critical one, $q' < q$, choose exports, the rest opts for FDI. In the aggregate, of all n domestic firms, a fraction s_X are successful exporters, a fraction s_I are multinational companies with foreign subsidiaries, and a share $1 - s_X - s_I$ were not successful in penetrating foreign markets, stay national and serve only the local markets. These fractions are given by

$$s_X = \int_0^q q' dG(q'), \quad s_I = \int_q^1 q' dG(q'), \quad s_F = \int_q^1 dG(q'). \tag{2.19}$$

From all n firms, $n_F = s_F \cdot n$ spend fixed costs F because they *attempt* FDI. The remaining share $1 - s_F$ does not spend any resources on preparing FDI but rather remains with exports or domestic sales if the export strategy fails.

Since foreign market entry is risky and fails with (variable) probability q, the number of successful market entrants is much smaller than the number of domestic firms, i.e. $s_I < s_F$, $s_X < 1 - s_F$ and, thereby, $s_I + s_X < 1$. Of all n firms, a share $1 - s_I - s_X$ is not present in foreign markets but exclusively operates at home. Therefore, the range of goods available abroad is smaller than the varieties at home. For completeness, one may also compute the average success probabilities $Q_I = s_I/s_F$ among all those which attempt FDI. The fixed costs of FDI preparation are thus wasted $(1 - Q_I)\, s_F n = (s_F - s_I)\, n$ times. The average success probability among all firms which choose the export strategy is $Q_X = s_X/(1 - s_F)$.

From now on, we will normalize the mass of firms to unity, $n = 1$. Therefore, s_X is the number as well as the share of exporters among all firms, etc. In the aggregate, domestic households appropriate in the second period monopolistic profits with total value of

$$\pi^e = \pi + s_X \cdot \pi_X + V_I, \quad V_I = \int_q^1 (q \cdot \pi_I - F)\, dG(q') = s_I \cdot \pi_I - s_F \cdot F. \tag{2.20}$$

The aggregate value of repatriated profits from foreign subsidiaries, net of fixed costs spent abroad, is V_I. Repatriated profits are part of the economy's net foreign factor income.

2.5 General Equilibrium

The government is assumed to refund tax revenue in the second period net of the demand subsidy as lump-sum transfers to households. Since corporate tax revenue stems only from firms producing at home, the public sector budget is

$$z = t \cdot (p - er)\, K - \nu pc, \quad K \equiv k + s_X k_X. \tag{2.21}$$

Aggregate savings must be equal to aggregate private capital investment, $S = K$. Investment gives rise to demand for standard goods in the first period and reflects the investments for domestic and export sales. Goods demand $s_I k_I$ caused by outbound FDI of domestic MNEs represents demand for standard goods abroad. The appendix derives aggregate output market equilibrium as a consequence of Walras' Law.

3 Impact and Cost of Corporate Taxation

3.1 Effective Average and Marginal Tax Rates

How exactly is an increase in the corporate tax rate changing the effective marginal (EMTR) and average tax rates (EATR)? Apart from reducing aggregate investment, what is the relative impact on the intensive and extensive margins? To answer these questions, one first needs to clarify how the statutory rate changes the effective rates that actually work on the two margins. The EMTR refers to the tax burden on a firm's last unit of investment. The tax drives a wedge between the pre-tax return or marginal revenue αp and the after tax return r. In pushing up the pre-tax return equal to the cost of capital, it makes the last units of investment unprofitable and thereby impairs business growth. Figure 1 illustrates. Expressing the wedge as a fraction of the gross return defines the EMTR, denoted by t_m. Using (2.9),

$$t_m \equiv \frac{u-r}{u} = \frac{(1-e)\,t}{1-et}, \quad 1-t_m = \frac{1-t}{1-et}. \tag{3.1}$$

The EMTR relates gross and net returns by $r = (1-t_m)\,u$ and summarizes all relevant parameters of the tax code in a single measure of the distortion on the intensive margin. It is well known that immediate investment expensing ($e = 1$) transforms the corporate tax into a cash-flow tax and consequently results in a zero EMTR. The tax is neutral on the intensive margin because it reduces costs and returns of marginal investment by the same proportion. When there is no expensing at all, $e = 0$, the EMTR coincides with the statutory tax rate, $t_m = t$.

The effective average tax rate (EATR) is total taxes paid as a share of gross income. In an intertemporal model, the relevant concept is the ratio of the present value of tax liability over the gross, social present value of the firm. Using (2.7), the relevant values in second period units are $\pi^* \equiv \pi + \pi^T = (p-r)\,k$ and $\pi^T = t\,(p-er)\,k$. The EATR is thus defined as

$$t_a \equiv \frac{\pi^T}{\pi^*} = \frac{p-er}{p-r}\cdot t, \quad 1-t_a = \frac{\pi}{\pi^*} = (1-t)\,\frac{p-u}{p-r}. \tag{3.2}$$

The EATR is larger than the statutory rate, $t_a > t$, if $e < 1$. In this case, the costs of capital are only partly deducted from gross returns, implying that the tax base is broader than economic profit. With immediate expensing, $e = 1$, EATR equals the statutory rate, $t_a = t$, while the EMTR is zero. With π^* being the gross value of the firm, net profits and tax payments are $\pi = (1 - t_a)\,\pi^*$ and $\pi^T = t_a \pi^*$ where $\pi^* = \pi + \pi^T$.

To characterize the comparative static response to tax reform, we compute changes of variables relative to their values in the initial equilibrium. The hat notation indicates relative changes such as $\hat{u} \equiv du/u$. The exceptions are changes in tax rates which are expressed relative to net of tax prices, e.g. $\hat{t}_m \equiv dt_m/\,(1 - t_m)$. Since $(1 - t_m)\,u = r$ and given a constant markup, user cost and producer price change in proportion to the EMTR,

$$\hat{p} = \hat{u} = \hat{t}_m. \tag{3.3}$$

How are the effective rates changed by an increase in the statutory rate? The EATR is an endogenous tax measure that must be determined jointly with the impact of taxes on equilibrium. Its relative change is found by log-linearizing the equation for $1 - t_a$ in (3.2), yielding $-\hat{t}_a = -\hat{t} + \frac{dp-du}{p-u} - \frac{dp}{p-r}$. Appropriately expanding and noting (3.3) gives

$$\hat{t}_a = \hat{t} + \frac{r}{p-r} \cdot \hat{t}_m, \quad \hat{t}_m = \frac{1-e}{1-et} \cdot \hat{t}. \tag{3.4}$$

A first insight is that the statutory rate changes the EATR both directly as well as indirectly via its impact on the EMTR. Quite intuitively, a cash-flow tax with immediate expensing is neutral on the intensive margin. In this case, the AETR is identical to the statutory rate, $\hat{t}_m = 0$ and $\hat{t}_a = \hat{t}$, and will be seen to distort extensive investment.

3.2 Investment and Profits

The EMTR pushes up the user cost of capital and leads firms to charge higher prices. To sustain higher prices, the monopolist must cut back sales and invests less. By the demand curve in (2.4),

$$\hat{k} = -\varepsilon \cdot \hat{u} = -\varepsilon \cdot \hat{t}_m. \tag{3.5}$$

The firm's net of tax profit depends both on the average and marginal tax rates. To see this, note that gross profit is $\pi^* = (p - r)\, k$, leaving a net of tax profit $\pi = (1 - t_a)\, \pi^*$. Gross profit in log-linearized form is $\hat{\pi}^* = \frac{p}{p-r} \cdot \hat{p} + \hat{k}$. Substitute the preceding results,

$$\hat{\pi} = \hat{\pi}^* - \hat{t}_a = -\left(\varepsilon - \frac{p}{p-r}\right) \cdot \hat{t}_m - \hat{t}_a = -\frac{p - er}{p - u} \cdot \hat{t}, \quad \hat{\pi}_X = \hat{\pi}. \tag{3.6}$$

The third equality states the net effect which is induced by the statutory rate. It is directly obtained by applying the envelope theorem to (2.7), $d\pi/dt = -(p - er)\, k$, and dividing this by $\pi = (1 - t)(p - u)\, k$.[6] A cash-flow tax, $e = 1$, is not distorting intensive investment and yields $t_m = 0$ and $t_a = t$. An increase in the statutory rate would thus leave gross profit unaffected, $\hat{\pi}^* = 0$, and reduce net of tax profit by $\hat{\pi} = -\hat{t}_a = -\hat{t}$.

Other things being constant, an increase in the statutory tax rate reduces exporting profits in exactly the same way. Although the level of demand is different, the relative change in net profits is the same because the demand elasticity is identical in home and foreign markets. Assuming that the home country applies the exemption method to avoid double taxation, profits of foreign subsidiaries net of foreign corporate tax are exempted at home. Hence, profits π_I from FDI are unaffected by domestic taxation as is evident from (2.16). Investment of foreign subsidiaries depends only on foreign user cost that is possibly inflated by foreign taxes.

The FDI export trade-off is illustrated in Figure 2 and formally resolved by fixing the cut-off value q in (2.18). Log-differentiating yields $\hat{q} = \hat{\pi}_X \cdot \pi_X / (\pi_I - \pi_X)$ since profits π_I of foreign subsidiaries are exogenous from the home economy's perspective. Inserting the change in export profits from above yields

$$\hat{q} = \frac{\pi_X}{\pi_I - \pi_X} \cdot \hat{\pi}_X, \quad \hat{\pi}_X = -\frac{p - er}{p - u} \cdot \hat{t}. \tag{3.7}$$

Domestic corporate taxation raises outbound FDI for two reasons. First, it raises the EATR and thereby reduces the net of tax profit from exporting, making it more

[6] The two expressions are equivalent. Use $\varepsilon = 1/(1 - \alpha)$ and eliminate α by the condition (2.10) to get $\varepsilon = p/(p - u)$. Insert this and $\hat{t}_a$ from (3.4) into the round bracket and get $\hat{\pi} = -\frac{u}{p-u}\hat{t}_m - \hat{t}$. Substitute now for $\hat{t}_m$ and use u from (2.9) to obtain, after some rearrangements, $\hat{\pi} = -\frac{p-er}{p-u} \cdot \hat{t}$.

attractive to serve foreign markets via FDI. Second, it also raises the EMTR, thereby impairing investment and company growth and reducing profits from domestic export production. The net effect is given in (3.6) and makes exports less profitable relative to the FDI alternative. In reducing the cut-off value that identifies the critical firm, the tax shrinks the number of domestically producing exporters. As more firms decide to serve foreign demand locally by relocating production abroad, the decomposition of firms into exporters and multinationals changes in favor of MNEs. Log-differentiating (2.19) gives the formal impact on firm shares,

$$\hat{s}_X = \mu_X \cdot \hat{q}, \quad \hat{s}_I = -\mu_I \cdot \hat{q}, \quad \hat{s}_F = -\mu_F \cdot \hat{q}, \tag{3.8}$$

where the coefficients $\mu_X \equiv q^2 g(q)/s_X$, $\mu_I \equiv q^2 g(q)/s_I$ and $\mu_F \equiv qg(q)/s_F$ are defined as positive values.

Aggregate investment reflects intensive (via k and k_X) and extensive investment (via s_X). Noting $\hat{k} = \hat{k}_X$, linearization of national investment in (2.21) yields

$$\hat{K} = \hat{k} + \frac{s_X k_X}{K} \cdot \hat{s}_X = \hat{k} + \eta \cdot \hat{\pi}_X, \quad \eta \equiv \frac{s_X k_X}{K} \frac{\mu_X \pi_X}{\pi_I - \pi_X}. \tag{3.9}$$

A higher EMTR reduces investment on the intensive margin, i.e. by $\hat{k}$, while a higher EATR impairs investment on the extensive margin via reduced export profits $\hat{\pi}_X$. When exports become less profitable relative to FDI, more firms decide to relocate production and investment by establishing a subsidiary company close to foreign customers.

Profits of exporters and multinationals at home are different since only exporters are subject to transport costs and must therefore charge higher prices. Consequently, sales and profits are smaller. The corporate tax might thus affect aggregate profits π^e not only by diminishing the value of exporting profits but also by affecting the composition of firms. By (3.8), the effect of the cut-off probability on firm composition satisfies $ds_X = qg(q) \cdot dq = -ds_I$. Hence, expected profits in (2.20) change by $\pi^e \hat{\pi}^e = \pi\hat{\pi} + s_X \pi_X \hat{\pi}_X - [q \cdot (\pi_I - \pi_X) - F]\, g(q)\, dq$. The last bracket is zero due to the endogenous export FDI choice. Substituting out the change in profits as in (3.6) yields

$$\pi^e \hat{\pi}^e = -(\pi + s_X \pi_X) \cdot \frac{p - er}{p - u} \cdot \hat{t}. \tag{3.10}$$

3.3 Cost of Public Funds

The deadweight loss of the corporate tax reflects the fact that the welfare loss imposed on the private sector exceeds the extra tax revenue that is raised by government. To quantify the difference, it is convenient to define the tax base B and rewrite tax revenue, net of the demand subsidy, as

$$z = t \cdot B - \nu \cdot p \cdot c, \quad B \equiv (p - er) K. \tag{3.11}$$

Corporate tax revenue is $T = t \cdot B$ and changes by $dT = (1-t) B \left[\hat{t} + \frac{t}{1-t}\hat{B}\right]$. The tax base responds to both firm size and location choice. If investment shrinks on the extensive margin, it leaves the margin $p - er$ constant but erodes the tax base by lowering investment K. Smaller firm size, however, not only reduces K but also comes with a counterveiling effect on the tax base since reduced output boosts prices and thereby inflates the margin $p - er$. Making use of $\hat{p} = -\hat{k}/\varepsilon$ and (3.9), the tax base adjusts by

$$\hat{B} = \mu \cdot \hat{k} + \eta \cdot \hat{\pi}_X, \quad \mu \equiv 1 - \frac{p}{p - er}\frac{1}{\varepsilon} \geq 0. \tag{3.12}$$

The elasticity μ of the tax base with respect to intensive investment is non-negative. With full expensing, $e = 1$, the user cost is equal to the interest. Markup pricing yields $p/(p - er) = 1/(1-\alpha) = \varepsilon$, giving $\mu = 0$. If no investment deductions are allowed, $e = 0$, the elasticity emerges as $\mu = \alpha$ and is strictly positive.

By earlier definitions, one can express the tax liability and net profits of an export firm in terms of the average tax rate: $t(p - er) k_X = t_a \pi_X^*$ and $(1-t)(p-u) k_X = \pi_X = (1 - t_a) \pi_X^*$. Dividing these relations implies $\frac{t}{1-t}\frac{p-er}{p-u} = \frac{t_a}{1-t_a}$. Consequently, one can rewrite the impact on profits in (3.7) as $\hat{\pi}_X = -\frac{t_a}{1-t_a}\frac{1-t}{t} \cdot \hat{t}$. Substitute this together with $\hat{k} = -\varepsilon \hat{t}_m = -\varepsilon (t_m/t) \hat{t}$, where the last equality uses (3.4) and (3.1), to get

$$\frac{t}{1-t} \cdot \hat{B} = -\left[\frac{t_m}{1-t} \cdot \mu\varepsilon + \frac{t_a}{1-t_a} \cdot \eta\right] \cdot \hat{t}. \tag{3.13}$$

The change in corporate tax revenue noted after (3.11) thus becomes

$$dT = (1-t) B \left[1 - \frac{t_m}{1-t} \cdot \mu\varepsilon - \frac{t_a}{1-t_a} \cdot \eta\right] \cdot \hat{t}. \tag{3.14}$$

The first term in the square bracket is simply the direct revenue effect from raising the tax rate. The second term relating to ε captures the distorting effect of the tax rate on intensive investment (or firm size) and on the producer price which both affect the tax base. The third term relating to η is the value reducing effect of the increased statutory tax rate which implies an extensive adjustment via η.

To characterize the deadweight loss, one starts by calculating the welfare change in (2.3), $dU = \pi^e \hat{\pi}^e + dz - (1-\nu)\, cdp$. The last term reflects the loss of consumer surplus when the price marginally increases, see Figure 1. To evaluate this formula, we first use (2.9) and (2.13) to show that net profits and the tax base B are related by

$$\pi + s_X \pi_X = (1-t)(p-u) K = (1-t) B \frac{p-u}{p-er}. \tag{3.15}$$

In consequence, the impact on total profits in (3.10) is $\pi^e \hat{\pi}^e = -(1-t) B\hat{t}$. Further, (3.11) implies a change in transfers to housholds equal to $dz = dT - \nu \cdot d(pc)$. Substituting these results and using $c = k$, and $\hat{p} = -(1-\alpha)\hat{k}$ from (2.4) together with $\hat{k} = -\varepsilon \hat{t}_m$, the welfare differential becomes

$$dU = -(1-t) B\hat{t} + dT - (1-v-\alpha) \cdot pk \cdot \varepsilon \hat{t}_m. \tag{3.16}$$

Substituting (3.14) and (3.4), the impact on welfare is

$$\frac{dU}{(1-t) B} = -\left[\frac{t_m}{1-t}\mu\varepsilon + \frac{t_a}{1-t_a}\eta + \Omega\varepsilon\right]\hat{t}, \quad \Omega \equiv \frac{1-v-\alpha}{(1-t) B} \cdot \frac{(1-e) pk}{1-et}. \tag{3.17}$$

The last term Ω in the bracket reflects the effect of markup pricing on consumer surplus. In reducing intensive investment, the tax reduces sales and thereby leads to higher prices which cuts into consumer surplus. This could be offset with an appropriate demand subsidy, which would ensure $(1-\nu) p = u$ and thereby equate consumer price to marginal cost. Since markup pricing results in $\alpha p = u$, the required subsidy would be $1 - \nu = \alpha$. If the demand subsidy were optimally chosen in the initial equilibrium, the pricing distortion is eliminated ($\Omega = 0$). When the tax marginally increases the user cost and the producer price, the welfare impact of the price increase is zero to the first order. Of course, the welfare loss also disappears with $1 = e$ since in this case the tax does not distort intensive investment, leaving user cost and producer price unaffected. The first two terms in the square bracket relate to the twofold investment distortion. The distortion on the intensive margin depends on the EMTR and the intensive investment elasticity ε. The distortion on the extensive margin depends on the EATR and the extensive elasticity η.

We can now measure the tax distortion in terms of the marginal deadweight loss per additional Euro of corporate tax revenue. Using (3.14) and (3.17),

$$MDWL \equiv \frac{-dU}{dT} = \frac{\frac{t_m}{1-t} \cdot \mu\varepsilon + \frac{t_a}{1-t_a} \cdot \eta + \Omega \cdot \varepsilon}{1 - \frac{t_m}{1-t} \cdot \mu\varepsilon - \frac{t_a}{1-t_a} \cdot \eta}. \tag{3.18}$$

The marginal cost of public funds is one plus the marginal deadweight loss,

$$MCPF = \frac{1 + \Omega \cdot \varepsilon}{1 - \frac{t_m}{1-t} \cdot \mu\varepsilon - \frac{t_a}{1-t_a} \cdot \eta}. \tag{3.19}$$

Except for the extra term Ω referring to the markup pricing distortion, this formula is entirely parallel to the analysis of intensive and extensive labor supply distortions. It compares, for example, with MCPF formula in equation (III.34) in Keuschnigg (2005) which is based on Immervoll, Kleven, Kreiner and Saez (2006) and Kleven and Kreiner (2006) and earlier work of Saez (2002).

To evaluate the formula more fully, it is useful to discuss two special cases. Consider first the case where fixed costs of FDI are prohibitive which prevents any multinational investment at all. Therefore, the share of successful exporters s_X is fixed (and $s_I = s_F = 0$ in 2.19) which eliminates the extensive margin of investment, $\eta = 0$. One is exclusively left with the standard distortion on the intensive margin where corporate taxation reduces the level of investment by domestic firms,

$$MCPF = \frac{1 + \Omega\varepsilon}{1 - \frac{t_m}{1-t}\mu\varepsilon}. \tag{3.20}$$

The cash-flow tax ($e = 1$) would be entirely neutral in this case, reducing t_m and Ω to zero. The tax is neutral not only with respect to intensive investment but thereby also avoids the loss in consumer surplus from the pricing distortion.[7] The marginal cost of public funds would be one as with a lump-sum tax.

[7] The pricing distortion Ω could be eliminated in any case with a demand subsidy $v = 1 - \alpha$.

A second useful case to consider is an increase in the cash-flow tax with immediate expensing ($e = 1$). The EMTR is kept to zero since the tax entirely avoids the intensive distortion. The MCPF then reflects the distortion on the extensive margin only,

$$MCPF = \frac{1}{1 - \frac{t_a}{1-t_a}\eta}. \tag{3.21}$$

The cash-flow tax is thus not neutral in an economy with multinational investment. The magnitude of the distortion and the cost of public funds associated with the corporate tax depend on the EATR and the extensive elasticity η. This elasticity is defined in (3.9) and measures by how much aggregate investment K declines as more firms relocate investment and production from home to the foreign country in response to an increasing profit differential $\pi_I - \pi_X$ between export and FDI sales.

4 Conclusions

To the best of my knowledge, the public finance literature has not provided so far a consistent characterization of the intensive and extensive investment distortions associated with the corporate tax, or other taxes at the personal level which affect firm values and capital accumulation within firms. This gap is all the more serious since the policy oriented discussion has recently assigned a very prominent role to the importance of EATRs (see, for example, GCEA et al., 2006, or European Commission, 2001). The policy report by the GCEA does not even present any detailed calculations of the proposed reform on EMTRs but emphasizes much the reduction of EATRs. A first insight from the theoretical analysis is that, strictly speaking, the EATR is not an independent concept but rather depends on the statutory rate as well as the EMTR. The effective marginal rate affects firm growth and changes the firm's gross of tax value and the present value of tax payments. It thereby enters the EATR which is the ratio of these two values.

Traditional thinking is probably still much dominated by the excess burden associated with intensive investment. If one appropriately considers the extensive response, the marginal cost of public funds must probably be revised up quite substantially since the tax shrinks aggregate investment on two margins: First, all domestically active firms invest less. Second, some firms no longer build new plants at home for export production but rather build them abroad to be closer to foreign customers. The welfare cost of the corporate tax is therefore importantly related to the size of the EATR and the extensive elasticity. This elasticity determines how many plants are built abroad rather than at home in response to a tax induced increase in differential net of tax profits.

Appendix: Market Clearing

Substituting the savings investment identity $S = K$ into the budget $C_1 = L - S$ in (2.1) gives domestic output market equilibrium in the first period,

$$C_1 + K = L. \tag{A.1}$$

GDP $Y_1 = L$ consists of traditional sector output only and is spent on consumption and investment K. The model does not explain trade in the first period.

To obtain the GNP identity in the second period, insert π^e from (2.20) and $S = K$ into the second period budget constraint (2.1). Using also the profit definitions of π, π_X and π_I and the public sector budget (2.21) yields

$$C_2 + pc = Y_2 \equiv pK + K + V_I. \tag{A.2}$$

The first two terms on the right side amount to domestic GDP consisting of the output value of innovative and traditional goods. The last term is profit repatriation from foreign subsidiaries. Adding this to GDP gives domestic GNP Y_2 which is equal to domestic absorption. There are no imports of differentiated goods.

Note that a monopolist supplies the entire market, $c = k$. Using $K = k + s_X k_X$, the GNP equation is rearranged to give

$$(C_2 - K) - s_X p k_X = V_I. \tag{A.3}$$

The bracket on the left side is imports of standard goods. The second term is exports of differentiated goods. The trade balance deficit (excess imports) must be equal to foreign factor income which stems from profit repatriations of foreign subsidiaries.

The foreign economy is, by assumption, not producing any innovative goods. By the Ricardian technology, output in the first period is equal to labor L^f. Without trade, first period output market equilibrium is $L^f - C_1^f = S^f = K^f + s_I k_I + s_F f_I$, where aggregate foreign savings must pay for local investment K^f plus inbound FDI investment demand $s_I k_I + s_F f_I$. Savings earn a return r and yield second period income RS^f derived from output of the standard good. Income is spent on standard goods and on imported or FDI produced varieties. Foreign GNP amounts to $Y_2^f = RS^f$ and is spent on consumption of standard and differentiated goods,

$$Y_2^f = C_2^f + s_X c_X p_X + s_I c_I p_I. \tag{A.4}$$

GNP abroad is lower than GDP because of profit repatriations leaving the country. To see this, substitute savings S^f as noted above, expand by $+V_I - V_I$, and use $\pi_I = (p_I - r)\, k_I$ from (2.16) and V_I from (2.20),

$$Y_2^f = RS^f = RK^f + s_I k_I + s_I p_I k_I - V_I. \tag{A.5}$$

Combining (A.4-5) and using the monopoly position $c_I = k_I$ of foreign subsidiaries yields the foreign trade balance condition,

$$RK^f + s_I k_I - C_2^f = s_X c_X p_X + V_I. \tag{A.6}$$

The left side is net exports of standard goods which must pay for imports of innovative goods and profit repatriations.

Adding up (A.3) and (A.6) and noting $c_X p_X = p k_X$ yields world market clearing for standard goods in the second period,

$$C_2 + C_2^f = \left(RK^f + s_I k_I\right) + K. \tag{A.7}$$

The first bracket stands for traditional sector output abroad and the second bracket for traditional sector output at home.

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