MODELING TAX REFORM IN AN INTERNATIONAL SETTING*

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INTRODUCTION

The integration of international product and factor markets implies that the treatment of the international sector is becoming increasingly important in building economic models, including the computable general equilibrium (CGE) models that are often used to evaluate potential fundamental tax reforms. In this paper, we examine several ways that these issues have been addressed, with an emphasis on evaluating different methods of modeling the foreign sector and assessing the ways in which the estimated effects of fundamental tax reform might be altered when different foreign sector specifications are utilized. We also describe how the Diamond-Zodrow (2006) closed economy CGE model might best be extended to include international trade and capital mobility, in order to accurately measure the effects of tax reforms on the U.S. economy. The paper is organized as follows. The next section highlights several well-known results for small open economy models. The third section discusses existing modeling frameworks in a large open economy environment. The final section discusses a model framework, based on blending the features of the various models described previously, that can be grafted onto an expanded version of the model used by Diamond and Zodrow (2006).

THE SMALL OPEN ECONOMY CASE

Intertemporal models that analyze the economic effects of fundamental tax reform in small open economies assume that the supply of capital is perfectly elastic; that is, international capital mobility implies that the economy faces a fixed after-tax rate of return. Tradable goods are either assumed to be identical to domestically produced goods or are not explicitly modeled (Auerbach, 1996; Engen and Gale, 1997; Keuschnigg, 1991).[1] The results of simulating consumption tax reforms generally indicate higher levels of domestic savings and capital formation in comparison to closed economy models. For example, Engen and Gale (1997) simulate replacing the current hybrid income-consumption tax system with a VAT-type consumption tax. They estimate that the capital stock increases by 1.4 percent in the short run and 9.8 percent in the long run in a closed economy, whereas it increases by 1.8 percent in the short run and 15.1 percent in the long run in a small open economy setting; similarly, in a closed economy, output increases by 0.8 percent in the year of reform and by 2.4 percent in the long run, while output in a small open economy increases by 0.9 percent in the short run and by 3.5 percent in the long run. Auerbach (1996) finds that implementing a Hall-Rabushka Flat Tax with transition relief increases output by 1.7 percent in the short run and 5.6 percent in the long run in a closed economy. By comparison, output increases by 5.5 percent in the short run and 9.3 percent in the long run in a small open economy environment. In a model with infinitely lived individuals, Mendoza and Tesar (1998) show that in a closed economy, replacing the U.S. capital income tax with a consumption tax decreases output by 0.4 percent initially and increases output by 13.5 percent in the long run; by comparison, in a small open economy, output decreases by 2.7 percent in the short run but increases by 19.3 percent in the long run. The immediate reduction of short-run labor supply results mainly from the substitution effect, which increases the relative price of labor relative to leisure.[2]

Small open economy models also typically generate larger welfare gains from consumption tax reform than closed economy models. In the Mendoza-Tesar study, the net welfare gains of a tax reform that replaces the U.S. income tax with a consumption tax are nearly 34 percent larger when the authors assume that the United States is a small open economy instead of a closed economy. Auerbach also finds welfare gains that are approximately 23 percent larger when the United States is modeled as a small open economy.[3]

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Although these results are quite interesting, several factors suggest that extending these analyses would be useful. For example, the assumption that the United States is a small open economy that has no influence on the worldwide rate of return to capital is implausible, given that the United States accounts for roughly a third of the world capital stock. Similarly, the assumption of zero adjustment costs implies instantaneous reallocation of capital, which is especially implausible in an international context. In addition, the modeling of the tradable goods sector (if any) could be richer. For example, none of these studies considers possible quality differences between foreign and domestically produced goods, the coexistence of tradable and non-tradable goods, or the possibility that a country might produce more than one type of good. Although the extent of international capital mobility and the degree of substitutability between domestic and foreign tradable goods are still contentious issues, the recent literature suggests that neither is perfect (Ballard, 2002). To the extent that the world capital market is imperfect and capital reallocation takes time, the magnitudes of international capital flows induced by fundamental tax reform are likely to be overestimated in a model with no adjustment costs. In addition, Gravelle and Smetters (2006) find that imperfect substitutability of foreign and domestic tradable goods limits the magnitude of cross-country capital flows and therefore reduces the incidence of the corporate income tax on domestic labor. They indicate if foreign and domestic tradable goods are perfect substitutes, the effects of capital flows can be replicated through trade even when direct capital flows are prohibited; similarly, imperfect substitutability of foreign and domestic tradable goods effectively makes capital less mobile even when direct capital flows are allowed.

THE LARGE OPEN ECONOMY CASE

A small but growing number of studies, which vary in their assumptions regarding international capital mobility and the substitutability of foreign and domestic tradable goods, provide numerous insights into modeling tax reform in a large open economy. The most relevant studies are Ballard, Fullerton, Shoven, and Whalley (1985, hereafter BFSW), Mutti and Grubert (1985), a series of papers by Bovenberg and co-authors,[4] Harberger (1995, 2006), Gravelle and Smetters (2006), and Randolph (2006). The BFSW models were the first CGE models to include an international sector. Three specifications of the foreign sector (BFSW-II, -III, -IV) are provided in addition to a base case (BFSW-I), in which trade is balanced, tradable goods are perfect substitutes, and there are no cross-border capital flows. These models are used to investigate the effects of corporate-personal income tax integration, the introduction of a VAT, and the adoption of an 80 percent savings deduction (a partial individual cash flow tax approach to consumption taxation).[5] In BFSW-III, the model most relevant to the current discussion, trade is balanced in every period and imperfect mobility of capital is allowed between the United States and the rest of the world (ROW). Capital imports (or exports) in a specific period are determined by a constant elasticity expression, which specifies the extent of international capital mobility in the model.[6] This relationship, combined with the assumption of perfectly substitutable imports, are the only foreign sector elements of the model, as the rest of the international sector is not considered.

The BFSW-III model reaches two important conclusions. First, welfare effects are driven by the impact of reform on the after-tax rate of return to capital in the United States, as perceived by foreign investors. For example, if the after-tax rate of return to capital in the United States decreases (as occurs with the savings deduction reform), capital flows out of the United States to the ROW, and U.S. welfare is adversely affected. Second, the magnitudes of welfare changes are fairly sensitive to the capital supply elasticity—the larger the elasticity, the larger the welfare losses. The increased after-tax rate of return for domestic savers encourages domestic saving and increased capital formation over time leads to a decreased price of capital services. A large capital supply elasticity results in substantial amounts of accumulated capital flows out of the United States and thus larger welfare losses.[7] On the other hand, if the elasticity that governs capital flows is close to zero, the welfare results could reverse since most of the new capital is used domestically and U.S. consumers experience welfare gains. However, as discussed above, the extent of international capital mobility, and thus the appropriate value of the capital supply elasticity, is unclear. In BFSW-III, Hartman (1983) notes that a 10 percent decrease in the U.S. interest rate with a capital supply elasticity of -1 would cause one-half of the U.S. capital stock

to reallocate overseas. Even when the value of the capital supply elasticity is reduced to one-tenth of the benchmark value, 5 percent of U.S. capital flows out of the country. However, Hartman's calculation is based on the assumption that the ROW owns a very large quantity of worldwide capital, 5 times larger than the U.S. endowment. With the more reasonable assumption that the United States owns 30 percent of the world capital stock, the magnitude of capital outflows is roughly halved: a 10 percent decrease in the U.S. interest rate causes a still significant 23 percent of the U.S. capital stock to reallocate overseas, and a reduction of the capital supply elasticity to one-tenth of the benchmark value results in a 2.3 percent outflow of U.S. capital.[8]

The dynamic structure of BFSW-III, which effectively assumes an infinite repetition of a two-period problem, does not allow for an analysis of intergenerational issues. In addition, this feature, together with the explicitly specified elasticity of savings with respect to interest rate, prevents their infinite-period model from generating any human wealth effects.[9] In contrast, the models of Goulder and Summers (1989) and Fullerton and Rogers (1993) expand the BFSW framework to include isoelastic instantaneous utility functions with consumers that maximize lifetime utility subject to a lifetime income constraint.[10] However, a criticism of this approach is that it generally implies large behavioral responses, especially large savings elasticities (Ballard, 1997; Gravelle, 2002).

Mutti and Grubert (1985) examine how international capital mobility alters the incidence of capital income taxes and the effects of capital income taxes on the allocation and level of investment. Their model extends the BFSW framework by introducing foreign production explicitly and allowing international capital flows. This implies that the marginal product of capital in the foreign sector is dependent on international capital flows. In addition, Mutti and Grubert account for the differences in the tax treatment of capital income payments to foreigners by allowing foreign and domestic savers to hold different portfolios in response to the different effective tax rates they face. These factors allow for more accurate modeling of the changes in the relative attractiveness of foreign and domestic investments in response to various tax policy changes. Their model includes three production factors (skilled labor, unskilled labor, and capital in each country), three sectors (net exported good, net imported good, and non-tradable good) in each country and allows imperfect substitution between domestic and foreign tradable goods; hence households allocate income among the four tradable goods and the domestic non-tradable good. Their formulation of consumer optimization also improves on the BFSW specification by incorporating imperfect product substitution directly into the nested CES utility function.

The main conclusion reached by Mutti and Grubert is that for most combinations of the elasticity of savings and the elasticity of substitution between domestic and foreign assets, capital does not bear the full burden of capital income taxes.[11] This result is not primarily driven by a large savings elasticity, as a limited degree of international capital mobility is sufficient to significantly alter the traditional closed economy result that the incidence of capital income taxes is borne by capital owners. For example, if saving is completely inelastic and capital markets are not especially well integrated (the elasticity of substitution between foreign and domestic capital assets is equal to one), capital receives less than one-half the benefit from a reduction in the corporate tax rate. By comparison, if saving is responsive and capital is perfectly mobile, domestic capital only receives 5.5 percent of the benefit of a corporate tax rate cut.

Goulder and Eichengreen (1988) and Bovenberg and Goulder (1991) construct CGE models with infinitely lived individuals and improve on the BFSW-III and the Mutti and Grubert models by incorporating perfect foresight and optimizing firm investment behavior. Including perfect foresight reduces the adjustment speed of the economy to the new steady state by moderating the response of investment to tax changes since investors anticipate the future decline in the return to capital induced by capital deepening; in contrast, under myopic expectations, households expect reform-induced increases in the after-tax rate of return to last forever, therefore inducing larger initial savings responses.

These papers also propose an alternative way of modeling international capital flows, which integrates portfolio choices in the general utility maximization problem of the household.[12] However, the simulation results indicate that, for similar policy experiments, the two model specifications of international capital flows proposed by Bovenberg and BFSW generate almost identical results (Goulder and Eichengreen, 1988, p. 42), suggest-

ing that the specification of BFSW is a reasonable starting point.

Harberger (1995) expands his famous closed economy general equilibrium model (Harberger, 1962) to a large open economy setting (United States and ROW) with four production sectors -- a corporate tradable goods sector (manufactured goods), a corporate non-tradable goods sector (transportation and public utilities), a noncorporate tradable goods sector (agriculture), and a noncorporate non-tradable goods sector (housing and services). Each sector employs labor and capital as factors of production, and the noncorporate tradable goods sector also uses land as an input. Harberger concludes that when capital income is taxed in the corporate sector in the United States (that is, the corporate tax is modeled as a partial factor tax), both the worldwide after-tax rate of return and the U.S. wage rate decrease. Capital owners throughout the world and domestic labor bear a significant portion of the tax in the long run, with over shifting to labor, which is likely to bear 200-250 percent of the full burden of the U.S. corporate income tax (CIT). Harberger (1995) calculates the source-side of the burden on domestic labor through the reduction of nominal wages, but does not explicitly quantify the effects on the prices of goods. Since domestic labor may also benefit as consumers if output prices fall, a more comprehensive measure needs to consider both effects. Harberger (2006) incorporates both effects and concludes that adding the uses-side effect reduces the burden on labor by roughly half.

The most comprehensive treatment of the international sector is provided by Gravelle and Smetters (2006), who formalize the Harberger four-sector analytical model and then simulate it to analyze the incidence of the corporate income tax. Gravelle and Smetters use a constant elasticity expression similar to BFSW-III to model imperfect international capital mobility, and allow for imperfect substitution between domestic and foreign corporate tradable goods in consumption (in contrast to the BFSW-II study that considers imperfect substitution in inputs). They note that domestic market power is large when the elasticity of substitution between domestic and foreign tradable goods is low. In this case, controlling for the capital supply elasticity, the home country can influence the world prices of internationally traded goods, regardless of the size of the domestic economy.[13] Gravelle and Smetters show that for their preferred parameter values that specify low to medium levels of capital supply elasticity and substitutability of tradable goods, most of the long-run burden of the corporate income tax falls on domestic capital and the balance is exported, rather than being borne by domestic labor. When both the capital supply elasticity and the substitutability of tradable goods are high, essentially implying a small open economy scenario, domestic labor and capital bear 71 and 36 percent of the burden, respectively.

Harberger (2006) emphasizes that only the combination of a high-capital supply elasticity and a high substitutability of tradable goods is plausible, suggesting that labor bears most of the burden of the corporate income tax. He stresses that the existence of covered interest arbitrage, together with a closely connected world capital market, makes capital flows highly responsive to small changes in interest rates. Harberger also argues that the lower values for the substitutability of tradable goods used by Gravelle and Smetters imply huge domestic market power, which he believes is also highly implausible. Thus, although Harberger likes the modeling structure used by Gravelle and Smetters, he believes it is realistic only for the cases in which the capital supply elasticity and the substitution elasticity for tradable goods are high.

Randolph (2006) extends the Gravelle-Smetters and Harberger approach by incorporating a fifth production sector in both the domestic and foreign economies, as he divides the corporate tradable goods sector into two subsectors. One subsector produces corporate tradable goods that are perfect substitutes for the goods produced by the corresponding foreign sector, while the other subsector produces corporate tradable goods that are imperfect substitutes for the goods produced by their foreign counterpart. Randolph indicates that there are two channels by which the incidence of corporate income taxes is affected in this framework. First, the price of the good produced in the domestic corporate subsector with perfect substitutes cannot change, so that the domestic wage has to decrease to offset the increased corporate cost of capital. Second, the corporate subsector with imperfect substitutes influences incidence through the "trade effect"—if capital intensities of production are unequal across the domestic and foreign corporate subsectors with imperfect substitutes, output substitutability between the two sectors will affect incidence, depending on whether the corporate subsector with perfect substitutes is more or

less capital-intensive than the corporate subsector with imperfect substitutes.[14] With perfect capital mobility, Randolph's results are similar to those of Harberger and Gravelle and Smetters when both capital supply elasticity and substitutability of tradable goods are large, as domestic labor and capital bear 74 and 33 percent of the burden, respectively. In addition, foreign capital bears 72 percent of the burden, which is offset by a 71 percent increase in wages enjoyed by foreign labor.[15]

Imperfect capital mobility is included in the analysis by allowing the size of the domestic economy to vary (e.g., from 30 to 70 percent of the world economy). This reduces the set of attractive investment opportunities available for capital to be reallocated abroad and thus reduces capital mobility. Since any capital exported drives down the marginal return to investment at a higher rate per unit of reallocated capital, less capital is reallocated abroad. Randolph finds that the reduction of capital mobility substantially reduces the burden on domestic labor while the burden on domestic capital is much larger.

Both the Gravelle and Smetters and Randolph models formally analyze the incidence of CIT in large open economy settings, but they do not consider the possibility of capital accumulation. As Ballard (2002) stresses, such models are better suited to predict short- to medium-run outcomes rather than long-run outcomes, as the long run capital stock reductions resulting from a higher CIT due to reductions in domestic saving may imply that labor will bear a larger share of the tax burden.

FOREIGN SECTOR MODELING IN A CGE MODEL

The previous sections provided a brief review of several alternative approaches to modeling international capital and trade flows and discussed the importance of different model structures on the estimates of the effects of various tax policy changes. This section discusses the framework utilized in our model, specifies how our approach extends and complements the existing literature, and briefly reviews some preliminary results.

In contrast to Harberger (1962), Gravelle-Smetters (2006), and Randolph (2006), but similar to Mutti and Grubert (1985), Bovenberg and Goulder (1991, 1993), and Goulder and Eichengreen (1988), the model allows for endogenous capital accumulation in the United States and in the ROW. Numerous studies, dating back to Feldstein (1974a, b) and Judd (1985), find that endogenous capital accumulation is capable of significantly altering the incidence of capital income taxes. As in Altig, Auerbach, Kotlikoff, Smetters, and Walliser (2001), hereafter AAKSW, and the papers by Bovenberg and coauthors, the model includes adjustment costs that slow the reallocation of capital and the rate of new investment during a transition period (although, unlike the model developed by Bovenberg, we do not distinguish between financial and physical capital, with only the latter subject to adjustment costs). Adjustment costs are an important factor in determining the distributional impacts of various tax reform proposals (Zodrow, 2002). For example, under a consumption tax reform, new and existing investments will earn above-normal returns during the transition period, since adjustment costs imply that the capital stock will not instantaneously adjust to its post-reform levels, including international reallocations. Accurately accounting for these flows is critical, since Mutti and Grubert (1985) show that even small movements in international capital flows can have large impacts on efficiency and distributional results.[16]

We follow Harberger (1962), Gravelle-Smetters (2006), Randolph (2006), Mutti and Grubert (1985), Bovenberg and Goulder (1991, 1993), and Goulder and Eichengreen (1988) in considering a multi-sector model that incorporates corporate tradable and non-tradable sectors, a noncorporate tradable and non-tradable sector, and a separate housing sector. This approach extends the analyses of the transition effects of fundamental tax reform in models with a single production sector (Auerbach, 1996; AAKSW, 2001; Mendoza and Tesar, 1998; and Keuschnigg, 1991), as it captures the effects of imperfect substitution of internationally tradable goods and the interactions between the corporate, noncorporate, and housing sectors. Although the effects of eliminating the distortion between saving and consumption under a consumption tax reform can be analyzed in a single-sector model, such a model cannot capture the efficiency gains derived from the uniform treatment of all forms of business investment and saving (that is, the elimination of the inter-asset and inter-industry distortions). In particular, the efficiency gains, asset price effects, and distributional effects of eliminating distortions between rental and owner-occupied housing, between housing and other forms of investment, and between corporate and

noncorporate investment can be analyzed in our model, as well as the implications of accounting for international capital and trade flows in analyzing these issues.

More generally, by merging a dynamic overlapping generations CGE model with the models in the recent international tax modeling literature, our model captures the effects of adding large open economy complications to analyses of the effects of tax reforms on a wide variety of critical economic variables. In particular, unlike infinite horizon models (Goulder and Eichengreen, 1988; Mendoza and Tesar, 1998), the model can analyze intergenerational welfare effects, including the effects of any one time windfall tax-induced levies and all the other asset price effects attributable to a consumption tax reform.[17] These calculations include the interactions between adjustment costs in capital accumulation, the tax treatment of the United States versus foreign capital owners, and international capital flows; as stressed by Mutti and Grubert (1985), differences in the treatment of residents and foreign capital owners are a significant factor in determining changes in international capital flows and the incidence of changes in capital income taxes and thus changes in domestic welfare.

We are currently incorporating these features into the existing Diamond-Zodrow (2006) model to examine the effects of international trade and capital flows on estimates of the efficiency and distributional effects of various tax reform proposals, including those that would replace the income tax with various forms of consumption-based taxation. Preliminary results suggest that in the steady state, the domestic capital stock increases by approximately 15 percent, which is higher than the increase in the closed-economy case by about 13 percent. In addition, the results confirm the case for transition relief in the rental housing sector is relatively compelling, and show that partly due to the lost of relatively favorable treatment on noncorporate assets, the two noncorporate sectors experience windfall losses along the whole transition path. Although higher adjustment costs moderate windfall losses in these two sectors, the magnitudes of such losses may be large enough to justify transition relief. The less generous treatment of capital in the foreign economy triggers large capital outflows from the ROW into the United States and increases the value of imported capital, with the gap widening along the whole transition path. Overall, the welfare gains from replacing the existing U.S. tax system with a flat tax in a large open economy are about 10-15 percent larger than in a closed economy model with similar structural settings and parameter values.

Notes

[1] For example, Keuschnigg (1991) constructs a small open economy model by assuming the foreign population is 100 times larger than the domestic population, so that the domestic rate of return to capital is essentially unchanged after reform. In contrast, Auerbach (1996) and Engen and Gale (1997) do not consider foreign production and consumption explicitly and instead simply assume that the after-tax rate of return remains unchanged after reform.

[2] Because of their infinite horizon framework, some behavioral responses are quite large. During the first year of reform, consumption declines by 8.3 percent in a closed economy and by 3.8 percent in an open economy. Ballard (2002) notes that the closed economy result translates to about a $400 billion dollar decline in consumption and argues that such a change is implausible.

[3] Kotlikoff and Jokisch (2005) examine the welfare effects of a national retail sales tax and conclude welfare gains are slightly smaller in a small open economy environment.

[4] These papers include Goulder and Eichengreen (1988), and Bovenberg and Goulder (1991, 1993), which are extensions of earlier models by Bovenberg (1986, 1988). Bovenberg (1986, 1988) construct models that are log-linearized around the initial steady state for simplicity, which implies that their results hold exactly only for infinitesimally small changes.

[5] Specifically, in BFSW-II, a new aggregate input commodity is introduced and enters domestic production as an imperfectly substitutable input; trade is balanced and there are no capital flows. BFSW-IV allows capital purchases so that foreign investors can make direct investments in the United States instead of renting capital; trade is still balanced in this model. This paper considers imperfect substitution in outputs as in Gravelle and Smetters (2006), but allows no direct purchase of capital.

[6] The key concept can be summarized with the following equation

$$\frac{K^W - K_s^F}{K^W} = \left(\frac{r_s^{US}}{r^W}\right)^{\varepsilon\kappa},$$

where K^W is the fixed ROW capital stock, K_s^F is foreign exports of capital to the United States, r^W is the after-tax rate of return to capital in the ROW, r_s^{US} is the after-tax rate of return to capital in the United States, and $\varepsilon\kappa$

is a constant elasticity that determines the extent of international capital flows.

[7] In BFSW-III, the domestic capital stock increases by a substantial 25 percent.

[8] Also note that although the BFSW-III model includes an exchange rate variable, it is superfluous since all prices in their model are endogenous. It is a real trade model without financial exchange rate variables; BFSW simply use the exchange rate to convert foreign demand and supply functions to U.S. prices.

[9] In their base case, they use Boskin's (1978) estimate of an uncompensated saving elasticity of 0.4.

[10] Note that, these models generally adopt the BFSW-II model setting, which considers only imperfect substitution of tradable goods but disallows international capital flows.

[11] Capital goods are not modeled explicitly in this model. Instead, they are modeled as a composite of five consumption goods available in each country with demands for capital goods derived from savings. Savers in each country can invest both in domestic and foreign capital, and these investments are not perfect substitutes.

[12] Such integration is achieved by a portfolio preference function in the following form

$$U_t = \int_t^{\infty} e^{-\delta(s-t)} \frac{\sigma}{\sigma-1} (C_s^{\beta} A_s^{1-\beta})^{\frac{\sigma-1}{\sigma}} ds,$$

where *A* represents a CES function of the shares of the household's portfolio devoted to domestic and foreign assets. Households' portfolio decisions include choosing the shares of domestic and foreign assets in financial wealth. An increase in the relative rate of return offered by a given asset induces households to hold a larger fraction of their wealth in that asset.

[13] Gravelle and Smetters (2006) assume the noncorporate tradable goods is the numeraire, instead of corporate tradable goods as in Harberger (1995, 2006).

[14] For example, if the second subsector is more capital-intensive than the first subsector, labor bears a smaller burden since the domestic wage rates fall by less in relation to the base case where capital-labor ratios are equal across the two sectors. Because the first subsector is more labor-intensive than the base case, the wage does not have to fall by as much to fully offset the increased cost of capital in the first sector.

[15] Gravelle and Smetters also consider the five-sector structure but decide to aggregate all of the corporate tradable sectors and apply an overall elasticity of substitution. They indicate equilibrium is impossible if there are two goods in the "first subsector" with different capital intensities. After the tax increase, the more capital-intensive sector will contract or disappear, while the less capital-intensive sector expands.

[16] In addition, Grubert and Newlon (1995) emphasize the importance of distinguishing between debt- and equity-financed investments in evaluating the effects of consumption tax reforms, since global debt markets are more integrated. They indicate investments in U.S. equity would increase due to the increase in after tax equity returns, but lower interest rates would result in outflows of debt-financed investments. A consumption tax reform, therefore, has an uncertain effect on the total U.S. capital stock.

[17] The model follows Summers (1981), Hayashi (1982), Goulder and Summers (1989) and Keuschnigg (1991) in modeling investment decisions as the outcome of firm value maximization in the presence of adjustment costs. Asset prices are calculated explicitly as part of the optimization process.

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