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17-9 Trade and Fiscal Deficits, Tax Reform, and the Dollar: General Equilibrium Impact Estimates

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Abstract

Advocates of using a border tax adjustment (BTA) to shift the corporate profits tax to a "destination" basis argue that such an arrangement would not be protectionist, because the import tax and export subsidy would be fully offset by an induced appreciation of the dollar. To examine this claim, this study applies an updated and extended general equilibrium model from the author's 2005 book, *The United States as a Debtor Nation.* Cline finds that across various scenarios, the dollar appreciation typically would be less than half the amount needed to offset fully the BTA. Advocates of the BTA implicitly assume a strong, prompt expectational boost to the dollar upon announcement of the shift. Instead, market practitioners and mainstream macroeconomic models see the interest rate as the main driver of the exchange rate. Although an incipient rise in the trade balance would indeed put upward pressure on the interest rate and thus the exchange rate, it would also result in reduced investment. With the trade deficit equal to investment minus saving (I–S = M–X), reduced investment would tend to set the new equilibrium at a lower trade deficit before the interest rate would rise sufficiently to boost the dollar to a level that would completely offset the BTA.

JEL Categories: D58, F13, F31, F47, H25
Keywords: Border Tax Adjustment, Tax Reform, General Equilibrium Model

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INTRODUCTION

The relatively rare present control of the US executive branch and both houses of Congress by a single party raises the possibility of major changes in economic policy. In considering the impact of such changes, it is important to incorporate not only direct effects but also the feedback from induced side effects. To examine the overall effect of direct and indirect impacts of policy changes, the proper analytical framework is a general equilibrium model of the economy. This study seeks to provide such a model. To provide the greatest possible transparency, the model is kept simple by using a linear structure in all equations. This approach should provide reasonable first approximations, especially if the policy changes are moderate rather than extreme. Moreover, in most cases there would be little clear basis for specifying the particular parameters in nonlinear formulations.

This fiscal, exchange rate, and trade general equilibrium model, or FERTGEM, is based on an earlier general equilibrium model of the US external accounts developed in Cline (2005). This study updates the parameters of the model and in some instances makes changes to the structure of the equation in question. The purpose of the model is to examine the interaction of the fiscal deficit, the trade balance, the exchange rate, and the major components of GDP in response to alternative tax structures, government spending policies, and trade-related policies. The implementation in this study focuses on two recent proposals: the House Republican proposal of a destination-based cash-flow tax for corporate tax reform, put forth by House Speaker Paul Ryan and House Ways and Means Committee Chair Kevin Brady; and a significant cut in taxes (see Cline 2017a, b).

THE MODEL

The national income and product accounts (NIPA) identity is the first equation that must be met in general equilibrium determination of the external and fiscal balances. This identity leads to the familiar relationship that the trade deficit must equal the excess of investment over saving. Thus:

$$Y = C + I + G + X - M \quad (1)$$

where Y is GDP, C is consumption, I is investment, G is government spending, X is exports of goods and services, and M is imports of goods and services. This is the "product demand" side of the economy. On the factor payments side, output must equal income paid to workers and owners of capital, and this income must be used for consumption, saving, or tax payments. Thus:

$$Y = C + S_P + R \quad (1a)$$

where S_p is private saving and R is government tax revenue. Subtracting equation 1a from equation 1 and rearranging yields:

$$I - S_P + G - R = M - X; \quad I - S_P - S_G = M - X \quad (1b)$$

where S_G is "government saving," or R–G. Equation 1b confirms that the trade deficit (right-hand side) equals the excess of investment over saving, defined to include private saving (S_P) and government saving (S_G).

The second building block of a general equilibrium framework is the partial equilibrium relationship between trade and the exchange rate and levels of activity. Abstracting from time lags, these traditional relationships show imports as a function of the real exchange rate, domestic GDP, and import protection; and exports as a function of the real exchange rate, foreign GDP, and the export subsidy. In order to construct a simple model that can be solved by standard matrix methods, the relationships are specified here as being linear. Thus:

$$M = \alpha_M + \beta E/(1+t) + \mu Y \tag{2}$$

$$X = \alpha_X - \gamma E/(1+s) + \varepsilon Y_F \tag{3}$$

where E is the real exchange rate, defined as the amount of foreign currency per US dollar after deflating both sides by domestic prices (so that a rise in E means a stronger dollar), Y_F is foreign GDP, t is the import tariff rate, and s is the export subsidy rate. In the base case both t and s are zero. However, as discussed below and in appendix B, in analyzing the effect of the border tax adjustment (BTA) in the House Republican tax reform plan, both t and s are set at the proposed 20 percent corporate tax rate.

The addition of equations 2 and 3 already establishes a system in which the two traditional approaches to external balance must be met simultaneously: the "absorption approach," concentrating on aggregate resource use compared to resource availability (the I–S_P–S_G = M–X identity); and the "elasticities approach," which determines changes in exports and imports by consideration of changes in the price and income variables as applied to the respective price and income elasticities.[1]

Simple specifications of the other components of a general equilibrium system relating the trade accounts to the fiscal accounts include the following. Consumption depends on disposable income, which in turn depends on the level of taxes. Consumption is also responsive to the interest rate, because of the influence of consumer finance on such durables as automobiles. Thus:

$$C = \alpha_C + \delta Y^D - \eta r; \tag{4}$$

$$Y^D = Y - R = Y(1-\tau) \tag{5}$$

where r is the interest rate, Y^D is disposable income, and τ is the tax rate (assumed for simplicity to be both the average and marginal tax rate).[2]

1. The classic statement of the absorption approach is by Alexander (1952). The elasticities approach dates back much further, notably including to 19th century economist Alfred Marshall and 20th century economist Abba Lerner.

2. That is: $R = \tau Y$.

For its part, investment is specified as a negative function of the interest rate, which determines the cost of capital. An important part of this relationship is the influence of the interest rate on residential investment. Investment is also a positive function of the level of GDP, considering that rising GDP generates demand for increased productive capacity (the accelerator effect). Thus:

$$I = \alpha_I - \theta r + \psi Y \quad (6)$$

The real exchange rate is also a function of the interest rate. Higher interest rates induce stronger capital inflows, bidding up the dollar. In a simple linear formulation, the exchange rate is determined as:

$$E = \alpha_E + \rho r \quad (7)$$

Although it is the domestic interest rate relative to the foreign interest rate that matters in determining the exchange rate, with the foreign interest rate held constant, its effect in equation 7 is incorporated in the constant term.

Some would argue that the exchange rate equation should be specified in terms adjusted for the level of protection, such that the left-hand side of equation 7 would become $E/(1+t)$. An argument related to this viewpoint is that for a permanent change such as the border tax adjustment, one should expect that the new exchange rate completely adjusts such that the combined effect of the exchange rate and the BTA is identical to that of the previous exchange rate without the BTA. Such an argument would tend to dismiss any general equilibrium effects of a new BTA on grounds that "first principles" would require no change in the external balance if the BTA is permanent.

There are several problems with such arguments. On the first argument, it is not the case that capital markets bid up or push down exchange rates in response to changes in protection. Investors are not being repaid in goods incorporating the force of changed tariffs but rather in nominal currency amounts enhanced by the interest accrued in the security in question. As for the "permanent change" proposition, a proximate problem with the argument as applied to the Ryan-Brady proposal for US tax reform (the proposal examined in this study) is that financial markets would probably not consider the reform to be permanent because of its protectionist structure and therefore its likely eventual change in the face of foreign retaliation. Because the BTA, as proposed, taxes the entirety of imports and exempts the entirety of exports, rather than taxing or exempting only the corporate profit component of total value, the measure fails the test of "like treatment" for domestic and foreign goods. It is thus incorrect to view the Ryan-Brady BTA as an internationally legitimate shift of taxation from an origin-based to a destination-based framework analogous to the widely accepted precedent of the BTA applicable to value-added taxes (VAT).[3]

More fundamentally, the proposition that introducing a permanent BTA would necessarily leave external balances unchanged and would promptly force completely neutralizing exchange rate appreciation does not

3. See Cline (2017a), Hufbauer and Lu (2017), and Bown (2017).

take account of path dependency and implies an implausible assumption that the external balance must be unchanging. There is nothing sacrosanct about the size of the US external deficit. On the contrary, the US trade deficit has long been larger than what would typically be considered the normative target for an advanced economy, so some reduction in the deficit from the import tariff and export subsidy could be seen as moving the external balance toward rather than away from a long-term norm.[4]

Nor does the experience with border adjustment in the case of the value-added consumption tax provide convincing evidence that the BTA for the corporate profit tax would cause a fully offsetting appreciation of the exchange rate. Empirical tests do tend to support the proposition that border tax adjustment for the VAT leaves real trade prices unchanged (Freund and Gagnon 2017). However, the primary operational mechanism whereby the real exchange rate appreciates in the case of the VAT is that the consumption tax directly boosts prices. No comparable mechanism would directly boost domestic prices and therefore the real exchange rate in the case of the BTA for the corporate profit tax. Instead, the assumption of fully offsetting appreciation must rest on financial market expectations, in what might be seen as a "north star" premise that financial markets always expect the effective exchange rate, incorporating tariff and subsidy effects, to return to a permanent, unchanging level.[5] Yet in practice, participants in the foreign exchange market are reported to be highly skeptical of a fully offsetting appreciation, in other words highly dubious about a north-star value, in considerable part because magnitudes of daily trading in foreign exchange associated with changing financial, macroeconomic, and political expectations dwarf the amounts associated with trade.[6]

In short, it would be precarious to base policy on the proposition that the exchange rate appreciation caused by the BTA for the destination-based corporate profit tax would completely offset the influence of the BTA, which is a new import tariff and export subsidy. A key objective of the approach of this study is to provide a realistic analysis of what changes in the exchange rate and the trade balance might be expected to occur over the medium to longer term as a consequence of introducing the BTA. Correspondingly, the analysis examines what changes in investment and saving might occur such that the I – S = M – X accounting identity would be maintained despite changes in M – X. The principal vehicle through which the BTA affects the exchange rate in the approach here is its upward pressure on the interest rate.

For its part, the interest rate responds to upward pressure on output, as the BTA constrains imports and induces more exports. Monetary authorities influence the interest rate, seeking to increase it when inflation increases. They are correspondingly likely to vary interest rates in response to the level of output relative to

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4. High income countries with abundant capital relative to labor would traditionally be seen as net suppliers of capital to developing countries with abundant labor and scarce capital, but net capital outflows would require a trade surplus rather than a trade deficit. The International Monetary Fund (IMF 2016, p. 17) judges that an appropriate norm for the US current account balance would be –0.6 to –1.1 percent of GDP, far smaller than the actual average of –3.3 percent over the past decade (IMF 2017).

5. In this framework, the left-hand side of equation 7) would be $E/(1+t)$, and the right-hand side would include a north-star constant, call it E^*.

6. Andrea Wong, "Currency Traders Spot Fatal Flaw in Republicans' Border Tax Plan," *Bloomberg*, April 18, 2017.

potential output. This means that the interest rate is likely to rise with GDP. In addition, the interest rate is influenced by the size of the fiscal deficit, as government "crowding out" exerts pressure on the capital market. Thus:

$$r = \alpha_r + \phi D^F + \pi P + \lambda Y \quad (8)$$

where D^F is the fiscal deficit and P is the level of the domestic price index.[7]

The level of prices depends on whether the economy is overheated or below potential output. It also depends on the exchange rate and the level of protection, because of the influence of the exchange rate on the price of tradeables, especially imports. Thus:

$$P = \alpha_P + \omega Y - \Gamma E/(1+t) \quad (9)$$

The fiscal deficit is the excess of total government spending over revenue. Total spending includes spending on real activity, *G*, which enters into the national accounts, as well as the interest paid on public debt, which is a transfer rather than a production concept and is thus not included in the national accounts activity concept of *G*. Because the model is "comparative static" in that it describes a single solution at a point in time once all of the variables settle to their equilibrium levels, rather than "dynamic" in the sense of tracing out a path over time, the level of public debt is a given constant, which may be designated Δ. Interest payments on the debt will then be $r\Delta$. There is another discrepancy between the national accounts concept of *G* and federal budgetary spending. The national accounts concept excludes other transfers as well, but it includes government activity at the state and local levels. These two differences largely offset each other, but there is a remaining difference between them, designated here as α_{DF} .The fiscal deficit is then:

$$D^F = \alpha_{DF} + G + (0.01)r\Delta - R = \alpha_{DF} + G + (0.01)r\Delta - \tau Y \quad (10)$$

Equations 1 through 10 constitute a system of 10 simultaneous equations for 10 endogenous variables ($Y, C, I, X, M, E, Y^D, r, P, D^F$) and five exogenous variables (G, τ, Y_F, t, and s). Fiscal policy, as represented by spending (G) and taxes (τ), is thus explicitly exogenous. In addition, monetary policy can be made exogenous by imposing a shift in the constant term α_r in equation 8. Similarly, if it is believed that policymakers can affect the exchange rate by jawboning, coordinated intervention, special foreign withholding taxes, capital controls, or other direct measures (beyond monetary and fiscal policy), then there can also be an exogenous "exchange rate policy," expressed through a shift in the constant term α_E.

There are three other equations in which G, τ, and Y_F are set equal to exogenous fixed values. The full set of equations can be expressed in matrix form, as follows:

$$\underset{13x13}{A}\ \underset{13x1}{Z} = \underset{13x1}{K} \quad (11)$$

7. A specification using ($Y - Y^*$) where Y^* is potential GDP, rather than just Y, would simply shift the constant term downward by λY^*.

where A is a matrix of coefficients, Z is a vector of the 13 variables, and K is a vector of constants. The two other exogenous variables, t and s, do not have separate equations but instead are assigned differing specified values in equations 2 and 3, depending on the scenario. Table 1 presents this matrix equation in the form of a table in which each entry is multiplied by the variable shown in the column to obtain the equation in the row. Thus, the first equation corresponds to equation 1 rearranged as $Y - C - I - X + M - G = 0$.

The set of equations can then be solved for the values of the variables in vector Z by applying Cramer's rule to each successive variable.[8]

CALIBRATION

Base year 2016 values, in billions of dollars, are used for the national accounts identity (equation 1). GDP is set at Y = 18,569; consumption at C = 10,758; gross private investment at I = 3,036; exports of goods and services at X = 2,232; imports of goods and services at M = 2,734; and government consumption and investment at G = 3,277 (BEA 2017a).

The calculation of parameters in the various equations applies the following approach. In each linear equation, there is a constant term and a series of coefficients applied to explanatory variables. For each of these relationships, there will typically be a "stylized" (or "Bayesian") value for the "elasticity," which indicates the percentage change in the dependent variable for a 1 percent change in the independent variable. The equations seek instead the "marginal" relationship. There is a fundamental identity whereby the elasticity equals the ratio of the marginal to the average relationship of the dependent variable to the independent variable. That is: $e = [\partial y/\partial x]/[y/x]$.[9] Given a stylized estimate of e, it is possible to estimate the marginal coefficient $\partial y/\partial x$ as $e \times [y/x]$. The base values of x and y are known, so the equation parameter in question can be estimated. Then when each of the estimated marginal coefficients is applied to each of the independent variables, and the sum is subtracted from the base level of the dependent variable, the residual is the constant for the equation in question.

For the import and export equations, the 2005 version of this model adopted the traditional Houthakker-Magee asymmetry structure, whereby the income elasticity of US imports is considerably higher than that of US exports, setting the elasticity at 1.8 for imports and 1.2 for exports (Cline 2005). However, in the period after the Great Recession, trade growth has been slower than that of GDP.[10] Cyclical factors, including falling commodity prices, seem likely to have contributed to the slowdown.[11] The updated estimates here substantially reduce the income elasticities, to 1.2 for imports and 1.0 for exports.

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8. Cramer's rule states that the solution to the vector of unknowns **Z** in a matrix equation **AZ = K** can be obtained as a ratio of two determinants: $z_i = |\mathbf{B_i}| / |\mathbf{A}|$, where z_i is the equilibrium value of unknown variable i, and $\mathbf{B_i}$ is a matrix constructed by replacing column i in matrix **A** with the vector of constants, **K**.

9. This relationship follows from the definition of the elasticity as the ratio of the proportionate change in the dependent variable to the proportionate change in the independent variable, or $[\partial y/y]/[\partial x/x]$.

10. Thus, from 2011 to 2016 nonoil imports fell from 14.4 percent of GDP to 13.8 percent, and exports of goods and services fell from 13.7 percent of GDP to 11.9 percent. Calculated from BEA (2017a, c).

11. See Freund (2016).

For the import equation, the coefficient for marginal change in imports with respect to GDP equals the income elasticity multiplied by the average ratio of imports to GDP: $\mu = \partial M/\partial Y = 1.2 \times [M/Y]$. Applying base values of M = 2,734 and Y = 18,569, the result is $\mu = 1.2 \times 0.147 = 0.177$. For the import coefficient on the exchange rate, $\beta = \partial M/\partial E$, the underlying price elasticity is set at unity. However, the formulation here treats the import price passthrough and elasticity jointly. With passthrough at 0.5 (Cline 2005) and the underlying elasticity at 1, the effective elasticity is 0.5. As a consequence, $\beta/[M/E] = 0.5$. The base value of E is index level 100. Applying the 2016 base values, β =0.5 [2,734/100] = 13.67, or a $13.67 billion change in import volume per percentage point change in the real exchange rate. For the constant term, given the estimates of μ and β, from equation 2 the estimate becomes: α_M = 2,734 – (0.177 × 18,569) – (13.67 × 100) = −1,920.[12]

The base case, t = 0, is a close approximation for the US economy after decades of trade liberalization. Several of the policy shocks examined below introduce a tariff of 20 percent. That is, with the corporate tax rate at 20 percent and with a BTA eliminating deductibility of imports (as in the Ryan-Brady proposal), the effect is equivalent to imposing a tariff of 20 percent. This shock effectively shrinks the coefficient on the exchange rate from 13.67 to 13.67/1.2 = 11.39.

For exports, the price elasticity is also set at unity. For simplicity, full passthrough is assumed.[13] The exchange rate coefficient is thus: $\gamma = 1 \times [X/E]$ = [2,232/100] = 22.32, or a $22.32 billion reduction in exports per percentage point increase in the real exchange rate index. Foreign GDP in 2016 at market exchange rates is estimated as the world total GDP minus US GDP, placing foreign income at $56,709 billion (IMF 2017). With an export income elasticity of 1.0, the coefficient for the marginal impact of foreign income on exports becomes ε = 1.0 × [2,232/56,709] = 0.0394. Applying the price and income coefficients and subtracting from the base export level, from equation 3 the constant term becomes: α_X = 2,232 + 22.32 × 100 – 0.0394 × 56,709 = 2,232.

As in the case of imports, in a policy scenario with an export subsidy s, the coefficient on the exchange rate is adjusted to a new level to take account of the shock. As on the import side, with s set at 20 percent, the effective coefficient on the exchange rate changes from 22.32 to 22.32/1.2 =18.6.

For consumption, for 1990 through 2016 the median ratio of personal consumption to disposable income was 0.91, and the median ratio of the change in personal consumption to change in disposable income was 0.89 (calculated from BEA 2017a). The parameter δ in equation 4 is thus set at 0.90. Disposable income in 2016 was $14,046 billion, or 75.6 percent of GDP. The effective average tax rate for purposes of this model is thus τ = 24.4 percent, representing revenue of about 18 percent of GDP for federal taxes and about 6 percent for state and local taxes. Following the estimate in Cline (2005) and adjusting to current GDP scale, consumption

12. As the national accounts are in real terms, change in volume equals change in value. However, a subsequent adjustment must be made in price to examine the corresponding change in import value. Given an estimate of the new level of real imports after a policy shock, the new nominal level of imports will be the new real level multiplied by the new price, which will involve both the change in the exchange rate and the extent of passthrough. With M^* as real imports, M_n as nominal imports, and passthrough at 0.05, nominal imports in a particular scenario will be: $M_n = M^* \times [1+ 0.5\times\{100/E–1\}]$.

13. As discussed in Cline (2005), most studies find that for the United States, passthrough from exchange rates to trade prices is considerably higher for exports than for imports.

also responds to the interest rate, with consumption of automobiles and other interest-sensitive sectors declining by \$12.7 billion from a 1 percentage point increase in the interest rate, or η = \$12.7 billion. Consumption in 2016 was \$12,758 billion. A representative base long-term interest rate is set at 3 percent. The constant term for consumption in equation 4 is thus: $\alpha_C = 12{,}758 - [0.90 \times 0.756 \times 18{,}569] + 12.7 \times 3 = 162$ billion dollars.

The coefficient relating investment to the interest rate can be calibrated by considering the response of the desired level of capital to the interest rate and translating this impact to a plausible path for investment. Appendix A applies an aggregate production function analysis to obtain the expected change in investment from a change in the interest rate. For capital broadly defined (including consumer durables and business and residential structures), using the relationship that the capital stock is 3 times GDP, and assuming an elasticity of substitution of 0.5 between capital and labor, the appendix estimates that an increase in the interest rate by 100 basis points reduces investment by \$343 billion, or $\theta = 343$.

The relationship of investment to GDP is also set to incorporate some "accelerator" influence, with an elasticity of 1.1 (i.e., a 1 percent rise in GDP induces a 1.1 percent rise in investment). In recent years gross private investment has averaged approximately 16 percent of GDP. On this basis, the coefficient ψ in equation 6 is: $\psi = 1.1 \times 0.16 = 0.176$. The base value for the interest rate is set at 3 percent, meant to represent the 10-year bond at a more normal rate than the actual level in 2016 (2.1 percent).[14] Applying the interest rate and GDP coefficients to equation 6, the constant term then becomes: $\alpha_I = 797$.[15]

The base value for the real exchange rate index (*E*) is 100. Cline (2017b) finds that in 2004–16, the dollar rose or fell against the euro and yen by 11.1 percent for each 100 basis point increase (decrease) in the US 10-year rate relative to German and Japanese long-term rates. The large macroeconomic model of the Federal Reserve (FRB/US) applies a parameter of a 6 percent increase in the real dollar for a 100 basis point increase in the real 10-year rate relative to real foreign long-term rates.[16] On this basis, a reasonable estimate for the impact of the interest rate on the exchange rate is: ρ = 8 percent increase for 1 percentage point increase in the interest rate. Again using 3 percent as the base long-term interest rate, the constant term then becomes $\alpha_E = 76$.

For the relationship of the real interest rate to the fiscal deficit, Gale and Orszag (2004) estimated that an additional 1 percent of GDP in the fiscal deficit increases the long-term interest rate by 25 to 35 basis points. On this basis, and applying the 2016 GDP base of \$18.6 trillion, an additional deficit of \$186 billion translates into a 0.3 percentage point increase in the interest rate. In equation 8 the corresponding coefficient is $\varphi = 0.3/186 = 0.00161$ percentage point per billion dollars of additional fiscal deficit.

With respect to the impact of GDP expansion on the interest rate, the "Taylor Rule" describing monetary policy provides a basis for determining the needed parameter (Taylor 1993). This rule states that the change

14. Bloomberg.

15. That is, with \$18,569 billion as 2016 base GDP, and gross investment at \$3,036 billion in 2016, equation 6 becomes: \$3,036 billion = $\alpha_I - [343 \times 3] + [0.176 \times 18{,}569]$; $\alpha_I = 797$.

16. For a description of the model, see Brayton, Laubach, and Reifschneider (2014). For the exchange rate equation, see Federal Reserve (2017a).

in the real policy interest rate (federal funds rate) is determined half on the basis of the deviation of inflation from the target inflation rate and half on the basis of the deviation of actual from potential output.[17] Backcasts applying this rule for 1987–2003 and using a target inflation rate of 2 percent obtain a very close fit with actual federal funds interest rates (Carlstrom and Fuerst, 2003).

The IMF (2017) places the US output gap in 2016 at only –0.43 percent. Accordingly, potential output in 2016 was $18,649 billion. Each increment of 1 percent of this base, or $186.5 billion, generates a Taylor-rule tightening of monetary policy by 0.5 percentage point. So in equation 8, the corresponding coefficient λ = 0.5/186.5 = 0.00268 percentage point change in the interest rate for each additional $1 billion in GDP.

The other half of the Taylor rule concerns inflation. For this component the coefficient is simply π = 0.5. That is, if inflation rises by 1 percent, the Federal Reserve raises interest rates by 0.5 percent. As discussed below, the model applies the change in the price *level* as this change in the inflation rate. Given the parameters φ, λ, and π, and using 3 percent as the base level of the nominal interest rate and $587 billion as the base 2016 fiscal deficit (CBO 2017), the constant in the interest rate equation can be estimated as: $\alpha_r = 3 - 0.00161 \times 587 - 0.00268 \times 18{,}569 - 0.5 \times 100 = -97.70$ percent.

For prices (equation 9), the specification requires translation of annual rates of inflation into a price level. As a model of comparative static equilibrium, the model is best suited to identifying an equilibrium *level* of prices (price index level), not an equilibrium rate of change for prices (rate of inflation). In equation 9, use of the price level fits naturally with inclusion of the level of the exchange rate as an explanatory variable (E). The coefficient on the exchange rate, Γ, is obtained as follows. The import passthrough ratio is 0.5, so a 1 percent rise in the real exchange rate E reduces the price of imports by one-half percent. (Export passthrough is complete, so dollar export prices do not change when the exchange rate changes.) Imports of goods and services amount to approximately 15 percent of GDP (14.7 percent in 2016; BEA 2017a). Allowing for spillover into tradeables more generally, we can place "importables" at say 20 percent of GDP. So if a 1 percent decline in the exchange rate boosts import prices by one-half percent, then applying a weight of one-fifth for importables in the overall price index will result in an increase of one-tenth of 1 percent for prices overall. With the price index at 100, this means that a 1 percent depreciation in the real exchange rate causes a 0.1 percent rise in the price index, giving a parameter value of: $\Gamma = 0.1$.

The parameter relating prices to GDP is more difficult to assess. Blanchard (2016) provides new estimates of the Phillips curve, finding that there is only a modest relationship between unemployment and the inflation rate. He places the coefficient at –0.2; a decline in the unemployment rate by 1 percentage point increases inflation by 0.2 percentage point.[18] Traditionally a decline of unemployment by 1 percentage point would have

17. Taylor assumed target inflation of 2 percent and a long-term average real federal funds rate of 2 percent, giving a nominal interest rate of 4 percent under target conditions warranting "neutral" monetary policy. For other conditions, the rule implies: $r^* \equiv r - \pi = 2 + 0.5(\pi - 2) + 0.5\,(100 \times [Y/Y_p - 1])$, where r^* is the real interest rate, π is the inflation rate, and Y_p is potential output.

18. In comparison, two decades earlier Gordon (1996) placed the coefficient at –0.5.

been associated with a rise in output by 2 percent (Okun's law).[19] However, after the Great Recession there has been less increase in output than would have been predicted by this rule of thumb. The unemployment rate fell from 9.61 percent in 2010 to 4.85 percent in 2016; real output rose by 12.4 percent over the same period (IMF 2017). The average decline in unemployment was 0.79 percentage point per year, so growth might have been expected to be about 1.6 percentage point faster than "normal." The working-age population was growing at 0.55 percent per year in this period (FRED 2017a). If normal productivity growth had been even 1 percent per year, a normal growth rate would have been expected to be about 1.5 percent, and the decline in unemployment would have boosted the expected rate to about 3 percent. Going forward, an updated Okun's law might at best place the relationship at a boost of 1 percent in output for 1 percentage point decline in unemployment.

On this basis, a shock to demand by 1 percent of GDP (or by $186 billion) would reduce the unemployment rate by 1 percentage point. Using the Blanchard estimate of the Phillips curve coefficient, this decline would boost inflation by 0.2 percentage points. By implication, the coefficient of the price level on GDP in equation 9 would be calibrated at $\omega = 0.2 / 186 = 0.00108$ percentage point increase per billion dollars in additional demand. Given the estimates of Γ and ω, and considering that both the base period price index and real exchange rate index are set at 100, the resulting value for the constant in equation 9 is: $\alpha_P = 89.95$. In the simulations involving a border tax adjustment with $t = 20$ percent, the effective coefficient of the price level on the exchange rate changes from –0.1 to –0.1/1.2 = –0.083.

Deriving this coefficient further requires mapping percent price change (inflation rate) to price levels. The (revised) Phillips curve and (revised) Okun's law are stated as annual percentage rates. The treatment here assumes that the impacts in question are sustained only one year, so changes in the inflation rate also equal the change in the price level. It could alternately be assumed, for example, that the cumulative comparative static impact should be based on, say, three years or more of annual inflation. However, the central role of the price variable in the model is as an influence on the interest rate, and the specification in the interest rate equation applies the change in the price level for one year only. For consistency, the price equation cumulates inflation for only one year as well.

Finally, in the fiscal deficit (equation 10), the contribution of interest on the debt is simply the interest rate as applied to debt at the end of the previous year. Federal debt held by the public at the end of fiscal 2016 was $14.2 trillion (77 percent of GDP), and interest on the debt in fiscal 2017 is projected at $270 billion, implying an average interest rate of 1.9 percent (CBO 2017, 10). The somewhat higher rate of 3 percent used here reflects a trend toward normalization after an exceedingly low interest rate environment.[20] After taking account of

19. The idea is that firms tend to hold on to workers during recessions but are slow to hire additional workers during the expansion, so that employment varies less than proportionately with swings in output over the business cycle.

20. Note that this is the 10-year rate. Although the Taylor Rule cited above applies to the short-term federal funds rate, the incremental coefficient λ discussed above will apply to both the 10-year rate and the short-term policy rate if the yield curve remains unchanged. For a long-term comparative static analysis, an unchanged yield curve is arguably the correct assumption.

interest, government spending G, and tax revenue, the residual is $1,412 billion, or $\alpha_{DF} = 1,412$. This constant term includes the effect of the difference between the national accounts concept of government activity (federal, state, and local spending, excluding transfers) and the corresponding budgetary concept for the federal deficit, the use of the economy-wide tax rate rather than the federal tax rate in the model (for obtaining disposable income), and the excess of the base interest rate at 3 percent over the actual interest rate in 2016.[21]

In the case of the BTA, exports are no longer subject to the corporate profits tax, and imports can no longer be deducted from the corporate tax base. With imports at $2.7 trillion and exports at $2.2 trillion in the base year, and with a hypothesized corporate tax rate of 20 percent, the effect is to increase net revenue by 20 percent of the difference, or by $100 billion. All of the BTA simulations thus subtract 100 from the fiscal deficit constant, α_{DF}.[22]

The full set of parameter estimates is reported in table 2.

POLICY SIMULATIONS

As the point of departure, it is first important to determine whether the model replicates the actual 2016 outcomes. In table 3, the first column shows actual GDP and other economic variable magnitudes for 2016. The second column shows the solution to the vector Z in equation 11. Aside from very small rounding differences, the model precisely replicates the base year values, reflecting the possibility of obtaining an exact solution in a linear system in which the number of unknown variables equals the number of equations.

Border Tax Adjustment. The first policy simulation with the FERTGEM model is to calculate the impact of a border tax adjustment (BTA), in which the corporate profit tax is 20 percent, no imports are deductible from the tax base, and all exports are deductible from the tax base. As discussed above and in appendix B, the effect of the BTA is to impose a tariff of 20 percent on imports and provide a subsidy of 20 percent to exports ($t = s = 0.2$). This BTA is a key feature of the corporate tax reform proposed by Speaker of the House Paul Ryan and House Ways and Means Committee Chairman Kevin Brady.[23] The third column in table 3, simulation A, reports the

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21. Thus, the federal fiscal deficit is estimated at $587 billion (CBO 2017). National accounts government spending in 2016 was $3,277 billion. End-2016 debt held by the public was $14,298 billion. The hypothesized 3 percent base interest rate would imply interest of $429 billion. Revenue for all levels of government at the rate of 24.4 percent of GDP would have been $4,531 billion. The residual constant α_{DF} is thus 1,412.

22. Paradoxically, going forward it no longer remains the case that the fiscal impact of the BTA is 20 percent of the nominal trade deficit, and in several of the simulations appreciation of the dollar combined with the BTA tariff reduces nominal imports by enough to reduce the nominal trade deficit substantially, or even cause a nominal trade surplus in one extreme case. Nevertheless, the $100 billion favorable fiscal shift is against the base and is used in all the simulations of the BTA. In principle if there were a large increase in nominal imports in the future, additional revenue could be added, but this outcome does not occur across the simulations. As for the possibility of revenue loss to export "subsidies," such an effect would only arise if there were a large increase in exports that represent a shift away from domestic sales (rather than increased production). In the main BTA simulation (A) in table 3, exports rise by $233 billion, so if they came entirely at the expense of domestic sales the fiscal gain from the BTA could be reduced by $47 billion, or by nearly half. The simple treatment using the change in the fiscal constant may thus tend to overstate the fiscal gain from the BTA.

23. The Ryan-Brady proposal is available at: http://abetterway.speaker.gov/_assets/pdf/ABetterWay-Tax-PolicyPaper.pdf.

model solution when this trade shock is applied. As discussed above, the simulation is implemented by changing the coefficients β and γ in the import and export equations and the constant in the fiscal deficit equation from their base values.[24] The fourth column in the table reports the resulting changes in the variables as a percent of their base levels.

In the first simulation (A), the BTA increases export volume by 10.4 percent and reduces import volume by 4.4 percent. With base level exports at 12 percent of GDP and imports at 14.7 percent of GDP, the consequence is an increase in export demand and reduction in import supply amounting to a combined 1.9 percent of GDP. The upward pressure on demand relative to supply boosts the price level and causes an increase in the interest rate through the Taylor rule (with both the GDP and price level variables rising; equation 8). Thus, with the parameter λ set at about 27 basis points per billion dollars of additional GDP demand (table 2), the direct shock to the interest rate from the third term in equation 8 (change in GDP) is 95 basis points (= 0.268 × 0.019 × 18,569).

The rise in the interest rate has a large negative impact on investment, which falls by 9.9 percent. There is a modest positive impact on consumption in response to higher GDP. The overall effect on GDP is an increase of 0.7 percent, well below the direct trade contribution as a consequence of the large reduction in investment.

A key result of the BTA simulation (A) is the finding that the real exchange rate rises by 7.5 percent. This increase is a consequence of the relatively large rise in the interest rate, and the resulting impact as capital markets bid up the dollar (equation 7). Importantly, however, the rise in the exchange rate is far below the predicted 25 percent increase from a 20 percent BTA as envisioned by Auerbach (2017). The results of the first simulation of the FERTGEM model thus confirm the much more informal exercise in Cline (2017b, 20) finding that the exchange rate increase from a 20 percent BTA might be only about 4 percent initially and a cumulative 10 percent over a decade.

In the first simulation, there is a major change in one of the elements of the I–S equation, namely a decline in investment by 9.9 percent. As a consequence, an exchange rate appreciation large enough to offset the BTA completely does not need to occur to keep the I–S aggregates equal to the M–X aggregates. That is, the excess of investment over saving falls significantly, making it possible for the excess of imports over exports to do so as well.

The BTA does reduce the trade deficit, as real exports rise and real imports decline. With the stronger exchange rate, nominal imports fall even more, such that the nominal trade deficit narrows from $500 billion to $57 billion. The fiscal deficit remains almost unchanged, rising from $588 billion to $591 billion. The reason is that the direct fiscal gain of $100 billion from the BTA is slightly more than offset by additional interest costs on

24. Implementing the policy simulation also requires a change in the constant in the price equation, α_p. As discussed above, importables are about 20 percent of GDP. The border tax adjustment of 20 percent, with a passthrough of one-half, boosts the price of importables by 10 percent, and thus raises the overall price level by 2 percent of the base level of 100. The effect is to raise the constant in equation 9 from 89.95 to 91.95.

public debt at the higher interest rate. This estimate suggests that those supporting the BTA primarily because it would raise revenue should consider likely offsetting budgetary costs of rising interest rates.

Tax Cut. The fifth column in table 3 reports policy simulation B in which tax revenue is cut by 2 percent of GDP, reducing the economy-wide tax rate τ from 24.4 percent to 22.4 percent. This amount of revenue loss is implied in leading estimates of the consequences of the Trump administration's proposed corporate and personal tax cuts (as discussed in Cline 2017b, 3). In this case there is a large increase in the fiscal deficit, which rises from the base level of $588 billion to $1.03 trillion, or 5.6 percent of GDP. The increase in the fiscal deficit puts upward pressure on the interest rate, which rises from 3 percent to 3.52 percent. The higher interest rate puts upward pressure on the dollar, which rises by 4 percent. The stronger dollar causes exports to fall by 4 percent and imports to rise by 2 percent. So the classic "twin-deficit" dynamic, in which a rising fiscal deficit drives a wider trade deficit, is present. Investment falls because of the higher interest rate. However, consumption rises in response to higher disposable income. Overall GDP remains virtually unchanged.

Federal debt held by the public is already on track to rise from 77 percent of GDP in 2016 to 88.9 percent by 2027, even with the fiscal deficit at an average of only 3.8 percent of GDP over this period (CBO 2017, 2). Raising the deficit by almost 2 percent of GDP would cause the debt ratio to rise to the vicinity of 110 to 115 percent of GDP instead of the baseline 89 percent by 2026.[25] Such a high path for public debt would be risky and would constrain the policy space for countering future recessions with fiscal stimulus. The estimates in table 3 do not incorporate possible dynamic growth effects from greater incentives at lower tax rates, but such effects are likely to provide only partial offsets to the fiscal erosion.

BTA and Tax Cut. Simulation C in table 3 shows the impact of combining the BTA with the 2 percent of GDP tax cut. There is an even larger rise in the fiscal deficit, despite the new revenue from the BTA. The interest rate rises 150 basis points, much more than in either simulation A or simulation B. The higher interest costs on public debt exceed the revenue from the BTA. The dollar is driven up by 12 percent. The higher interest rate causes a 16 percent drop in investment, considerably larger than before.

Investment Surge? Supporters of the Ryan-Brady corporate tax reform might object that the border adjustment tax experiment in simulation A (table 3) mistakenly finds a reduction of investment as the reason the I–S equation is consistent with a reduction in the M–X equation (and therefore that the dollar does not rise enough to hold the trade balance unchanged). The argument would be that the BTA is part of a package that will stimulate investment, not reduce it. The basic question is whether the cut in investment imposed by higher interest rates will exceed or be less than the rise in investment from the new tax incentive.

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25. An extra 2 percent of GDP for 10 years would raise the debt by 20 percent from the baseline directly and impose some 3 percent of GDP in additional interest costs, based on the relationship of about 0.15 for indirect interest effects shown in one large-deficit variant analyzed by the Congressional Budget Office (preventing automatic spending reductions currently in the law; CBO 2017, 32).

The historical record does not provide strong support for a surge in investment following a cut in US corporate taxes. The tax rate applicable to all but small firms was 46 percent in 1982–86. The rate was cut to 34 percent in 1988 and remained there until 1993, when it was increased to 35 percent (Taylor 2002). US national accounts show that gross private fixed nonresidential investment was an average of 13.6 percent of GDP in 1985–86 and an average of 12.1 percent in 1988–92 (BEA 2017a). The 11 percentage point cut in the corporate tax rate was followed by what amounted to an 11 percent *reduction* in investment (i.e., 12.1/13.6) rather than an increase.

It is nonetheless useful to consider how an investment surge changes the general equilibrium outcome. Simulation D returns to the BTA parameters of simulation A but in addition arbitrarily imposes a 10 percent increase in gross private nonresidential investment onto the constant in the investment equation 6. In 2016, this investment stood at $2.31 trillion, so in the simulation the investment constant α_I rises from 797 to 797 + 231 = 1,028. The result of the simulation of border tax *cum* investment shock is shown in the second column of table 4 (D).[26]

As it turns out, the reduction in investment as a consequence of a higher interest rate more than offsets the positive investment shock posited as the effect of the corporate tax reform. Investment falls by 5.2 percent, a more moderate decline than the 9.9 percent decline in simulation A (table 3). Exports rise by about 8 percent from the BTA incentive, less than their 10 percent rise in the BTA-only exercise of simulation A. Real imports fall by 2.5 percent, less than their decline of 4.4 percent in simulation A. The real exchange rate rises more: by 10 percent, rather than about 7.5 percent in simulation A. The interest rate and the fiscal deficit rise modestly more than in the simple BTA in simulation A.

The principal implication of simulation D is that allowance for even a large surge in investment (in contrast to the experience in the late 1980s) moderates but does not fundamentally change the conclusion that the BTA reduces the external deficit by curbing investment substantially to make room for higher exports and lower imports. It is the rise in the interest rate that curbs investment, but this rise is not large enough to boost the exchange rate enough to cause a totally offsetting effect through curbing the increase in exports and limiting the decrease in imports.

In simulation E, the positive investment shock is once again added, this time without the BTA but including the tax cuts. Comparison of the percentage changes of macroeconomic variables in simulation E (table 4) to those in simulation B (table 3) shows the following impacts of adding the investment shock to the tax cuts: Consumption rises slightly more, investment falls by much less (a decline of 0.9 percent instead of 5.8 percent), exports fall somewhat more, imports rise somewhat more, the trade balance falls by about an additional $100 billion (in real terms), the real exchange rate rises by about 7 percent instead of about 4 percent, and the interest rate increases somewhat more (by 0.8 percentage points instead of 0.5 percentage points). The fiscal deficit rises

26. Note that tables 4–6 do not repeat the values of government spending (G) and foreign GDP (Y^F), which remain unchanged in all simulations at the amounts shown in table 3.

moderately more than in the tax-cuts-only case, reflecting higher interest payments. Broadly, the investment surge adds more pressure to the national accounts components of the fiscal deficit, so the package magnifies the twin-deficit result.

In simulation F, all three policy components are combined: the BTA, the tax cuts, and the investment shock. This time the demand pressures are sufficient that the interest rate increase is relatively large, with the rate rising from the model base of 3.01 percent to 4.83 percent. This high interest rate dominates the investment impact, which shows a larger decline in investment than in the BTA-only case: Investment falls 11.5 percent, compared to a decline of 9.9 percent in simulation A. The BTA export subsidy only boosts exports 4.5 percent rather than 10.4 percent in simulation A, because the adverse effect of the large 14.6 percent appreciation of the dollar offsets most of the stimulus from the BTA export subsidy. This rise in the real exchange rate is the largest among all six cases considered in tables 3 and 4. With the extra demand pressure, real imports fall only 0.6 percent (rather than 4 percent in simulation A).

SENSITIVITY TESTS AND ALTERNATIVE SPECIFICATIONS

As shown in table 2, there are 15 parameters in the FERTGEM model, excluding equation constant terms. A sensitivity analysis investigating the consequences of applying low, central, and high values for each of the parameters would generate 3^{15}= 14,348,907 possible combinations. Rather than exploring a significant portion, let alone all, of these combinations, a more productive approach to sensitivity analysis is to focus in on the most important uncertain parameters and to consider alternative specifications.

A key finding of this study is that the BTA does not cause a fully compensating increase in the exchange rate that in turn keeps imports and exports unchanged despite the new tax on imports and subsidy to exports. The rise in the interest rate causes a reduction in investment that provides room in the I–S = M–X accounting identity for the trade surplus to rise, rather than being fully offset by an exchange rate increase. The salience of the investment effect makes it a fruitful area for special attention to sensitivity analysis. Moreover, among the parameters in table 2, those with particular impact on investment tend to be less well established than those affecting, for example, the response of trade to the exchange rate and GDP.

One reasonable question is whether treatment of change in the interest rate following the Taylor rule should be dampened down when translating to the 10-year interest rate affecting investment and the exchange rate. Thus, for five major periods of monetary tightening or loosening in the past four decades, the median change in the US 10-year treasury rate was 0.7 times the median change in the federal funds rate.[27] The principal reason for treating the two interest rates interchangeably is that in this comparative static analysis, a change is treated as permanent and would tend to be the same for the short-term and the long-term rate. Nonetheless, a useful sensitivity analysis is to cut in half the two parameters λ and π in interest rate equation 8, on grounds that the Taylor rule refers to the federal funds rate, whereas the interest rate in the model is the 10-year rate.[28]

27. The calculation is for the following periods: March 1989–December 1993, December 1993–June 1995, December 1998–May 2000, June 2004–July 2006, and July 2006–July 2012. Calculated from Federal Reserve (2017b).

28. The third parameter in equation 8 is already specified with respect to the long-term rate.

A second sensitivity test explores whether there might be more adjustment in the consumption component of the national accounts identity. In particular, if domestic goods are not perfect substitutes for imported goods, then when imports decline in response to a new import tax, the consequence may partly be manifested in a reduction in consumption rather than a complete shift of the consumption from imported goods to domestic substitutes. In the main estimates, the BTA imposes a 20 percent tax on imports, and foreign suppliers allow half of the price impact to be passed through, so there is a 10 percent increase in import prices. With a price elasticity of unity, the volume of imports declines by 10 percent, or by $273 billion. For a test that allows only half of this decline to be replaced by domestic production, the constant term in the consumption equation 4 can be reduced by half of the cut in imports, or by $136.5 billion.

A third sensitivity test returns to the investment impact. There is considerable uncertainty about the response of investment to the interest rate, namely the magnitude of parameter θ in investment equation 6. The main estimate of this parameter, developed in appendix A, gives a large response of investment to the interest rate. Thus, the decline of investment to a 100 basis points increase in the long-term interest rate is placed at $343 billion, or 1.8 percent of GDP. The sensitivity test considered here cuts this parameter in half, to $\theta = 171.5$.[29]

Table 5 reports the results of these three sensitivity tests on the impact of the BTA, indicated as simulations G, H, and I, respectively. A striking feature of simulation G is that GDP now rises by an implausibly large amount, about 2.2 percent. The full set of simulations is designed to reflect comparative static results for the economy already at full employment and potential output. Simulation J discussed below thus considers how constraining output to remain unchanged tends to affect the estimate.

For its part, in simulation H, where domestic output does not as easily replace the foregone imports, the adjustment to the BTA involves a decline of consumption by 0.9 percent (instead of the rise by 0.6 percent in the main BTA test, simulation A). As a consequence, there is less recourse to a reduction in investment (which falls by 8.2 percent instead of 9.9 percent), and less upward pressure on the real exchange rate (which rises 6 percent rather than 7.5 percent in simulation A).

The main pattern in the first three sensitivity tests is that the BTA does not cause a large increase in the exchange rate. However, simulation J explores whether this finding is distorted by the large increase of output that occurs when there is less adjustment through the reduction of investment. This test is conducted by imposing a tightening in monetary policy that is sufficient to reduce the change in output back to zero, reflecting the framework in which the base output is already at full potential. As a first approximation of the increase in the interest rate needed to achieve this outcome, the direct and indirect effects of a higher interest rate on the components of GDP are as follows. An increase in the interest rate by 100 basis points reduces consumption by η (equation 4) and reduces investment by θ (equation 6). Increasing the interest rate by 100 basis points raises the real exchange rate by ρ (equation 7), which in turn reduces exports by $\rho\gamma$ (equation 3) and increases imports by $\rho\beta$ (equation 2). The resulting changes in contribution to GDP for C, I, X, and M become: $-\eta-\theta-\rho\gamma-\rho\beta$.

29. This change also necessitates a change in the investment constant to keep the model result equal to the actual base value of investment. Thus, α_I shifts from 797 to 282.5.

Applying the values for these parameters shown in table 2, the estimate is that the quasi-direct effect of raising the interest rate 100 basis points is to reduce output by $485 billion, or 2.6 percent of GDP.[30]

Simulation J replicates the assumptions of simulation I but applies an increase in the interest rate constant that is sufficient to constrain output to remain unchanged (rather than rising 1.31 percent as in simulation I). As in simulation I, the impact of a higher interest rate on investment is curbed by cutting the coefficient θ in half. Simulation J does find that when there is less scope for curbing investment, there is a considerably larger increase needed in the real exchange rate to keep the I–S balance consistent with the change in M–X caused by the BTA. This time the necessary dollar appreciation amounts to 11.4 percent. Nonetheless, in qualitative terms the finding remains that dollar appreciation from the BTA is lower than the 25 percent benchmark that some economists would expect, even if one leans against overstating the extent to which lower investment will be a consequence of the BTA and thereby make room for a smaller trade deficit. With respect to the interest rate, in simulation J the interest rate does rise by 142 basis points. Partly for this reason, but also because of the absence of an accelerator effect with output constrained to be unchanged, the consequence is that investment once again falls significantly (by 8.0 percent, much closer to the 9.9 percent in simulation A than in simulation I).

Finally, two additional simulations (table 6) show opposite extremes of the impact of the BTA. In the first, simulation K, it is assumed that the passthrough of the higher import price from the 20 percent BTA is complete rather than one-half. The rationale would be that whereas foreign suppliers respond only partially to exchange rate changes and partially "price to market," they would instead treat the new BTA as permanent (rather than changeable, as is the case for the exchange rate) and would no longer absorb special losses in order to price to the market. This simulation requires doubling the impact of the exchange rate on imports (coefficient β) and changing the base estimate of the import constant α_M as well.

As shown in table 6, with full passthrough the BTA has a larger impact on the interest rate, which rises by 111 basis points (rather than 94 basis points in the main BTA case, simulation A). Real imports fall about 8 percent, or about twice as much as in the main BTA simulation. The exchange rate rises 8.9 percent, instead of 7.5 percent in simulation A. The strong exchange rate translates imports to a nominal value that is 11.7 percent lower than in the base (versus 7.7 percent lower in simulation A), yielding a sizable nominal trade surplus instead of a deficit. Exports rise about 9 percent, as the stronger exchange rate offsets about half of the stimulus from the 20 percent export subsidy. The decline in investment in simulation K is 11.5 percent, larger than the 9.9 percent decline in simulation A, reflecting the larger increase in the interest rate.

A major implication of simulation K is that with complete passthrough, the BTA could indeed impose a serious loss on importers. The exchange rate would rise by less than half of the 25 percent increase needed to offset the BTA. The real volume of imports would fall about 8 percent, reflecting the 20 percent higher price with a partial offset from the exchange rate movement.

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30. Note however that this estimate applies a value of θ that is only half the size shown in table 2.

In the opposite extreme, simulation L, it is assumed once again that the import price passthrough is only one-half (as in all the other BTA simulations except K). In simulation L, however, *70 percent of import value is deducted from the taxable base, and 70 percent of exports are ineligible for deduction, on grounds that only the corporate profit content of trade should be subject to the BTA.* As discussed in appendix B, in the manufacturing sector corporate profits are about 30 percent of gross output. Simulation L may be seen as representing an analytically, if not necessarily legalistically, GATT-compatible BTA. It gives like-treatment to imports, exports, and domestic goods.[31]

In simulation L, an arguably GATT-compatible implementation of the BTA would effectively set a 6 percent tariff on imports rather than a 20 percent tariff. The simulation also maintains the standard import passthrough of one half. The effect would be only a small reduction in import volume (by 1.4 percent) and a real appreciation of the dollar by only 2.4 percent. Investment falls by about 3 percent, much less than in simulation A. The fiscal deficit rises slightly (from $588 billion in the base to $592 billion). The interest rate rises 30 basis points, and the resulting increase in interest on public debt exceeds the small net revenue from the BTA.

Table 7 provides a comparison of the results of the 12 simulations.

Because economists who argue that the exchange rate appreciation will fully offset the BTA use as their core premise the concept that the national accounts identity I–S = M–X must be maintained (e.g. Auerbach 2017), it is important to examine exactly how this identity is maintained in the simulations here. Table 8 reports the decomposition of changes in the elements in this identity.

The first column in table 8 reports the level of saving in each simulation. From equations 1, 1a, and 1b, total saving by identity equals output minus government spending (NIPA concept) minus consumption.[32] The remaining columns show the change from the model base in each of the simulations for each of four national accounts measures: investment, saving, imports (real, i.e. at base prices), and exports. The corresponding changes in *I–S* and in *M–X* are also shown.

The first key pattern in table 8 is that all simulations adhere to the required external balance requirement that I–S = M–X. Thus, the fourth column in the table is always equal to the final column in the table. A second major pattern is that it is by no means the case that the external balance remains unchanged. Across the 10 simulations in which there is a BTA present (all cases except B and E), the median change in the real trade deficit (*M–X*) is –$261 billion. The BTA tends to reduce the trade deficit, because the appreciation of the exchange rate is insufficient to offset fully the direct effect of a curb on imports from the tariff and a boost in exports from the subsidy. A third pattern is that a decline in investment is the driving force in the reduction of *I–S.* Thus, the median change in investment across the 10 BTA simulations is –$245 billion. Saving does tend to rise but more

31. In simulation L, the BTA tariff and subsidy are: $t = s = 0.3 \times 0.2 = 0.06$. The BTA-adjusted import coefficient β becomes 13.67/1.06 = 12.9. The BTA-adjusted export coefficient becomes 22.32/1.06 = 21.06. The BTA shift in the fiscal deficit constant becomes –30 instead of –100. The price coefficient Γ becomes 0.1/1.06 = 0.0943.

32. Factor payments are used on consumption, taxes, and private saving, so $Y = C + Tx + S_p$ where T_x is taxes. Government saving is: $S_G = Tx - G$. So $Y = C + [S_G + G] + S_p$. Rearranging, $Y - C - G = S_G + S_p \equiv S$.

moderately (by a median of $65 billion across the 10 BTA simulations). A fourth pattern is that a rise in exports is the dominant force in the reduction of *M–X*. The median change in exports for the 10 BTA simulations is +$187 billion, whereas the median change in real imports is –$79 billion. The dominance of export change reflects the placement of passthrough of the BTA at only one-half on the import side.

CONCLUSION

This study develops a simple, transparent general equilibrium model that provides a basis for analyzing the consequences of major policy changes affecting tax and trade policy. Simulations of the model imposing a 20 percent border tax adjustment, as in the Ryan-Brady proposal for corporate tax reform, find that the induced exchange rate appreciation typically would be in a range of 6 to 15 percent. In the principal BTA variant (simulation A), the real exchange rate rises by 7.5 percent. If there were an upsurge of 10 percent in private investment, as a positive "animal spirits" shock from the BTA, the dollar appreciation would be about 10 percent, reaching 15 percent if sizable tax cuts were added (2 percent of GDP). If a lower parameter is applied for the impact of the policy interest rate on long-term interest rates, or if consumption were to fall more because of imperfect substitutability with imports, dollar appreciation would be at the low end of the range, 6 percent.

This full range of dollar appreciation stands well below the 25 percent assumed by some economists as the consequence of the BTA (see Cline 2017b for discussion). One reason is that most of the simulations assume foreign suppliers would cut their prices to offset one-half of the new import tariff in an effort to maintain market share ("passthrough" of one-half). But even in a test allowing complete passthrough of the BTA (simulation K), the exchange rate would rise only about 9 percent. As a result, induced appreciation would not be large enough to keep exports from rising or imports from falling. The rise in the dollar would be insufficient to hold harmless consumers of imported goods facing the new tariff. The incomplete exchange rate offset thus undermines the argument that the BTA would not be protectionist because it would not change overall incentives to exports and imports.[33]

An important finding is that in the absence of a complete exchange rate offset, the I – S = M – X identity in the national accounts is maintained primarily through a substantial reduction in investment, rather than by maintaining an unchanged trade balance. As can be seen in table 7, the BTA simulations systematically reduce investment, whereas consumption tends to rise and is typically not the counterpart of the trade deficit reduction. The core logic of the concentration of adjustment in investment is appealing. Most modern analyses of exchange rate determination assign the key role to the interest rate, not to causation from changes in the trade balance. But if an increase in the interest rate is necessary to boost the dollar, then a side effect that should be expected

33. An important point to keep in mind is that the BTA would not be protectionist regardless of the exchange rate effect if it were properly applied only to the corporate profit component of imports and exports, but instead the Ryan-Brady proposal applies it to the full value of imports (tax) or exports (subsidy), such that domestic-like-treatment is no longer accorded to foreign competitors. In other words, the measure goes well beyond shifting from an origin basis to a destination basis in applying the corporate tax. Simulation L examines a GATT-compatible BTA that deducts the presumed foreign labor and input cost from the taxable import base.

is a decline in investment. A higher interest rate means that a higher marginal return must be earned on capital, implying in turn that the capital stock needs to be lower than otherwise, and the reduction in needed desired future capital stock means less investment (appendix A).

The two simulations examining the impact of a tax cut reducing revenue by 2 percent of GDP yield the familiar twin-deficit result: There is an increase in the fiscal deficit and an increase in the trade deficit as higher interest rates bid up the dollar. The size of the tax cut is gauged by the leading estimates of the implied revenue losses from the Trump tax plans released at the end of April 2017. The results serve as a reminder that expansionary fiscal policy could aggravate trade conflict, in view of the Trump administration's seeming view that trade deficits are a manifestation of unfair trade agreements.

Even though private investment fell rather than rose the last time the US corporate tax rate was reduced (1988), simulations imposing an exogenous positive shock to private investment permit an assessment of whether these results would be reversed after taking account of the lesser room for an improvement in the trade balance (in view of the I–S = M–X accounting identity). The simulations find that the basic results are not reversed by such a shock. There is still a sizable reduction in the trade deficit (especially the nominal deficit) and a decline in investment. The impact of a higher interest rate curbs investment by more than the increase from the positive exogenous shock (which is set at a highly optimistic level).

In a final simulation (L), implementation of the BTA is constrained to provide "like treatment" to imports by applying the tax only to the corporate profit component of imports rather than the entire import value. Such an approach would be a nonprotectionist way to shift corporate taxation from the origin principle to the destination principle. The simulation assumes that for foreign goods, the typical profit content accruing to foreign suppliers is 30 percent of import value. Compared to the basic BTA with no deductibility of imports at all, the simulation shows considerably less reduction in imports, slightly greater increase in exports, and an exchange rate appreciation of only 2.4 percent instead of 7.5 percent. However, it finds that the fiscal impact is negative rather than positive, as sought by supporters of the BTA. The rise in interest payments on public debt exceeds the new tax revenue when 70 percent of the import value base is deductible from the 20 percent corporate profits tax and 70 percent of exports must be included in the tax base.

The analysis of this study is focused on the BTA and to a lesser extent a general tax cut. However, the FERTGEM model developed here should also provide a basis for broader ongoing exploration of proposals for changes in fiscal, trade, and exchange rate policies.

Table 1 General equilibrium matrix equation

	Z														
	Y	C	I	X	M	E	Y^D	r	D^F	G	τ	Y^F	P		
Equation number	A														**K**
1	1	−1	−1	−1	1									=	0
2	$-\mu$				1	$-\beta$								=	α_M
3				1		γ						$-\varepsilon$		=	α_X
4		1					$-\delta$	$-\eta$						=	α_C
5	$\tau-1$						1							=	0
6	$-\psi$		1					θ						=	α_I
7						1		$-\rho$						=	α_E
8	$-\lambda$							1	$-\varphi$				$-\pi$	=	α_r
9	$-\omega$					Γ							1	=	α_P
10	τ							-0.01Δ	1					=	α_{DF}
11										1				=	G_o
12											1			=	τ_0
13												1		=	Y^F_0

Source: Author's calculations.

Table 2 Parameter values

Parameter	Concept	Value	Units
α_M	Import (M) equation constant	−1,920	$ billions
μ	Marginal impact of GDP on imports	0.177	Pure number
β	Marginal impact of exchange rate on M	13.67	$ billions/index
α_X	Export (X) equation constant	2,232	$ billions
γ	Marginal impact of exchange rate on X	22.32	$ billions/index
ε	Marginal impact of foreign income on X	0.0394	Pure number
α_C	Consumption equation constant	162	$ billions
δ	Marginal propensity to consume	0.9	Pure number
η	Marginal impact of interest rate on consumption	−12.7	$ billions
α_I	Investment (I) equation constant	797	$ billions
θ	Marginal impact of interest rate on I	343	$ billions/percent
ψ	Marginal impact of GDP on investment	0.176	Pure number
α_E	Exchange rate (E) equation constant	76	Index
ρ	Marginal impact of interest rate on E	8	Index/percent
α_r	Interest rate (r) equation constant	−97.7	Percentage points
φ	Marginal impact of fiscal deficit on r	0.00161	Percent/$ billion
λ	Marginal impact of GDP on r	0.00268	Percent/$ billion
π	Marginal impact of price level on r	0.5	Pure number
α_P	Price level constant	89.95	Index
ω	Marginal impact of GDP on price level	0.00108	Index/$ billion
Γ	Marginal impact of exchange rate on prices	0.1	Pure number
α_{DF}	Budget deficit constant	1,412	$ billions
Δ	Government debt held by public	14,298	$ billions
G_0	Base case government spending	3,277	$ billions
τ_0	Base case tax rate	0.244	Pure number
Y^F_0	Foreign GDP	56,709	$ billions

Table 3 Macroeconomic aggregates: Actual and model simulations (billions of 2016 dollars and index)

Variable	Actual	Model base	A	Percent change	B	Percent change	C	Percent change
GDP	18,569	18,567	18,695	0.7	18,570	0.0	18,701	0.7
Consumption	12,758	12,757	12,832	0.6	13,086	2.6	13,165	3.2
Investment	3,036	3,034	2,734	–9.9	2,857	–5.8	2,543	–16.2
Exports	2,232	2,233	2,466	10.4	2,141	–4.1	2,382	6.7
Imports, real	2,734	2,734	2,614	–4.4	2,791	2.1	2,667	–2.5
Trade balance, real	–502	–501	–149	–70.3	–651	29.9	–285	–43.2
Imports, nominal	2,734	2,734	2,523	–7.7	2,735	0.1	2,523	–7.7
Trade balance, nominal	–502	–500	–57	–88.6	–594	18.8	–141	–71.8
Real exchange rate	100	100.0	107.6	7.5	104.2	4.1	112.0	12.0
Disposable income	14,038	14,037	14,133	0.7	14,410	2.7	14,512	3.4
Interest rate (percent)	3.0	3.0	3.9	31.2	3.5	17.2	4.5	49.9
Price level	100	100.0	101.2	1.2	99.6	–0.4	100.8	0.8
Fiscal deficit	587	588	591	0.5	1,033	75.6	1,044	77.5
Government spending (NIPA)	3,277	3,277	3,277	0.0	3,277.0	0.0	3,277.0	0.0
Tax rate	0.244	0.244	0.244	0.0	0.224	–8.2	0.224	–8.2
Foreign GDP	56,709	56,709	56,709	0.0	56,709	0.0	56,709	0.0

NIPA = national income and product accounts; A = border tax adjustment (BTA); B = tax cut of 2 percent of GDP; C = BTA plus tax cut of 2 percent of GDP

Sources: BEA (2017a); Federal Reserve (2017b); and author's calculations.

Table 4 Simulation results with investment shock

Variable	Model base	D	Percent change	E	Percent change	F	Percent change
GDP	18,567	18,820	1.4	18,693	0.7	18,826	1.4
Consumption	12,757	12,913	1.2	13,169	3.2	13,249	3.9
Investment	3,034	2,877	–5.2	3,006	–0.9	2,685	–11.5
Exports	2,233	2,418	8.3	2,087	–6.5	2,334	4.5
Imports, real	2,734	2,666	–2.5	2,846	4.1	2,718	–0.6
Trade balance, real	–501	–248	–50.6	–759	51.5	–384	–23.2
Imports, nominal	2,734	2,543	–7.0	2,758	0.9	2,545	–6.9
Trade balance, nominal	–500	–125	–75.0	–671	34.1	–211	–57.9
Real exchange rate	100.0	110.1	10.1	106.6	6.5	114.6	14.6
Disposable income	14,037	14,228	1.4	14,506	3.3	14,609	4.1
Interest rate (percent)	3.0	4.3	41.9	3.8	27.2	4.8	60.7
Price level	100.0	101.1	1.1	99.5	–0.5	100.7	0.7
Fiscal deficit	588	607	3.1	1,049	78.2	1,063	80.6
Tax rate	0.244	0.244	0.0	0.224	–8.2	0.224	–8.2

BTA = border tax adjustment; D = 10 percent investment shock plus BTA; E = 10 percent investment shock plus tax cut; F = combined BTA, tax cut, and 10 percent investment shock

Source: Author's calculations.

Table 5 Sensitivity tests for the BTA

Variable	Model base	G	Percent change	H	Percent change	I	Percent change	J	Percent change
GDP	18,567	18,968	2.2	18,621	0.3	18,810	1.3	18,564	0.0
Consumption	12,757	13,020	2.1	12,647	–0.9	12,906	1.2	12,737	–0.2
Investment	3,034	2,833	–6.6	2,786	–8.2	2,866	–5.5	2,791	–8.0
Exports	2,233	2,488	11.4	2,494	11.7	2,422	8.4	2,394	7.2
Imports, real	2,734	2,650	–3.1	2,584	–5.5	2,662	–2.6	2,635	–3.6
Trade balance, real	–501	–162	–67.7	–90	–82.1	–240	–52.1	–241	–51.9
Imports, nominal	2,734	2,570	–6.0	2,510	–8.2	2,542	–7.0	2,500	–8.5
Trade balance, nominal	–500	–82	–83.5	–16	–96.7	–120	–76.1	–106	–78.8
Real exchange rate	100.0	106.4	6.3	106.0	6.0	109.9	9.9	111.4	11.4
Disposable income	14,037	14,340	2.2	14,077	0.3	14,220	1.3	14,034	0.0
Interest rate (percent)	3.0	3.8	26.3	3.8	24.9	4.2	41.0	4.4	47.2
Price level	100.0	101.6	1.6	101.2	1.2	101.1	1.1	100.7	0.7
Fiscal deficit	588	503.6	–14.4	582.4	–1.0	605.6	2.9	692.1	17.6
Tax rate	0.244	0.244	–0	0.244	0	0.244	0	0.244	0

BTA = border tax adjustment; G = BTA plus cut λ, π in half (impact on long-term interest rate); H = BTA plus reduce consumption constant; I = BTA plus cut θ in half (impact of interest rate on investment); J = same as I but with higher interest rate constant

Source: Author's calculations.

Table 6 Alternative extremes of BTA impact

Variable	Model base	K	Percent change	L	Percent change
GDP	18,567	18,763	1.1	18,606	0.2
Consumption	12,757	12,876	0.9	12,780	0.2
Investment	3,034	2,686	–11.5	2,937	–3.2
Exports	2,233	2,440	9.2	2,308	3.4
Imports, real	2,734	2,517	–8.0	2,695	–1.4
Trade balance, real	–501	–77	–84.7	–387	–22.7
Imports, nominal	2,734	2,413	–11.7	2,663	–2.6
Trade balance, nominal	–500	27	–105.3	–355	–29.1
Real exchange rate	100.0	109.0	8.9	102.5	2.4
Disposable income	14,037	14,185	1.1	14,066	0.2
Interest rate (percent)	3.0	4.1	37.0	3.3	10.1
Price level	100.0	101.1	1.1	100.4	0.4
Fiscal deficit	588	600	1.9	592	0.6
Tax rate	0.244	0.244	0	0.244	0

BTA = border tax adjustment; K = price passthrough on imports for BTA is complete rather than one-half; L = 70 percent of import value deductible as nonprofit content for assessing BTA; only 30 percent of exports deductible as BTA allowed for profit content only.

Source: Author's calculations.

Table 7 Changes in macroeconomic variables by scenario (percentages and billion of dollars)

	Simulation/Scenario	Y (percentage)	C (percentage)	I (percentage)	X (percentage)	M* (percentage)	E (percentage)	r (percentage points)	TB* (billions of dollars)	TBn (billions of dollars)	DF (billions of dollars)
A	Border tax adjustment (BTA)	0.69	0.59	−9.87	10.41	−4.38	7.51	0.94	352	443	3
B	Tax cut	0.02	2.58	−5.84	−4.14	2.09	4.14	0.52	−150	−94	445
C	BTA plus tax cut	0.72	3.20	−16.19	6.67	−2.47	12.00	1.51	216	359	456
D	BTA, investment shock	1.36	1.22	−5.16	8.27	−2.50	10.07	1.26	253	375	18
E	Tax cut, investment shock	0.68	3.23	−0.91	−6.55	4.09	6.55	0.82	−258	−171	460
F	BTA, tax cut, investment shock	1.39	3.86	−11.51	4.51	−0.58	14.59	1.83	116	289	474
G	BTA, 1/2 long-term interest rate change	2.16	2.06	−6.62	11.39	−3.10	6.33	0.80	339	418	−85
H	BTA, partial import substitution	0.29	−0.86	−8.15	11.68	−5.49	5.99	0.75	411	484	−6
I	BTA, 1/2 investment impact	1.31	1.17	−5.53	8.45	−2.65	9.86	1.24	261	380	17
J	= Simulation I plus monetary tightening	−0.02	−0.16	−8.01	7.21	−3.62	11.35	1.43	260	394	104
K	BTA, full passthrough	1.05	0.93	−11.45	9.25	−7.96	8.90	1.12	424	527	11
L	BTA, profit content only	0.21	0.18	−3.20	3.35	−1.42	2.43	0.31	114	146	4

Y = GDP; C = consumption; I = investment; X = exports; M* = real imports; E = real exchange rate; r = interest rate; TB* = real trade balance; TBn = nominal trade balance; DF = fiscal deficit

Source: Author's calculations.

Table 8 Changes in the components of the I–S = M–X identity
(billions of 2016 dollars)

		Change from base					
Scenario	**S=Y–C–G**	**I**	**S**	**I–S**	**M**	**X**	**M–X**
Base	2,533						
A	2,586	–300	53	–352	–120	232	–352
B	2,206	–177	–327	150	57	–92	150
C	2,258	–491	–275	–216	–67	149	–216
D	2,630	–156	97	–253	–68	185	–253
E	2,247	–28	–286	258	112	–146	258
F	2,300	–349	–233	–116	–16	101	–116
G	2,672	–201	138	–339	–85	254	–339
H	2,697	–247	164	–411	–150	261	–411
I	2,626	–168	93	–261	–72	189	–261
J	2,550	–243	17	–260	–99	161	–260
K	2,610	–347	77	–424	–218	207	–424
L	2,550	–97	16	–114	–39	75	–114

S = saving; Y = GDP; C = consumption; G = government spending (national income and product accounts); I = investment; M = imports (real); X = exports

Note: For simulation results for scenarios A–L, see table 7.

Source: Author's calculations.

APPENDIX A

IMPACT OF THE INTEREST RATE ON INVESTMENT

Consider the baseline path of capital stock, labor, and aggregate US output over the next 10 years. A plausible benchmark for real output growth is 2 percent annually. The labor force is projected to grow at 0.4 percent annually.[34] In view of the near constancy of the capital/output ratio at about 3:1 over recent decades, suppose the baseline capital stock is simply three times baseline output.[35]

Consider an aggregate production function benchmarked to 2016, with output at $18.6 trillion, capital stock three times as large, and labor input at 151.4 million workers (IMF 2017). Place the share of capital, which is also the elasticity of output with respect to capital in the Cobb-Douglas production function, at 35 percent (α = 0.35). Then:

$$Y = AK^{\alpha}L^{1-\alpha}; 18.6 = A[54.8^{0.35} \times\ 151.4^{0.65}]; A = 0.174 \quad \text{(A.1)}$$

The constant *A* is derived from the ratio of output to the bracketed expression involving the product of capital and labor. With labor growing at 0.4 percent and capital growing along with output at 2 percent (real), it turns out that this constant needs to rise at 1 percent per year, reflecting total factor productivity growth. In the baseline, by 2026 output rises to $22.7 trillion, and capital rises to $68 trillion (in constant 2016 dollars).

The marginal product of capital should be equal to the cost of capital, the interest rate. In this production function, the marginal product of capital equals:

$$\frac{\delta Y}{\delta K} = \alpha AK^{\alpha-1}L^{1-\alpha} \quad \text{(A.2)}$$

With the parameter values of equation A.1, this marginal product turns out to be 0.117. This rate of return of nearly 12 percent is a gross return. In the national accounts, depreciation (the difference between gross domestic product and net domestic product) averaged 14.45 percent of GDP in 2013–16, and gross investment averaged 19.45 percent of GDP.[36] With capital at 3 times GDP, the implied rate of depreciation on capital stock was 4.82 percent, and net investment averaged 5.0 percent of GDP. The net rate of return on capital, by implication, would be 6.9 percent (11.7 percent – 4.82 percent).

The impact of raising the interest rate by 100 basis points can then be calculated by examining how much the capital stock would need to be cut back from its baseline in order to increase the marginal product of capital by 100 basis points by the end of the adjustment period, set at 10 years. Given baseline labor and the baseline path of the production function constant embedding total factor productivity, the target amount of capital can be calculated from the posited path of marginal product of capital as follows. In equation A.2, rename the left

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34. CBO (2017) sets average growth at 1.9 percent and labor growth at 0.4 percent, a relatively low rate reflecting the aging of the US population.

35. BEA (2017b).

36. Based on 2013–15 data, average gross fixed government investment is 3.46 percent of GDP (BEA 2017b, table 5.10).

side as *MPK*; rename the product of the right-hand side elements not involving capital as $\prod$ (=$\alpha AL^{1-\alpha}$). Then solving for the desired capital stock yields:

$$K^* = \left[\frac{MPK}{\Pi}\right]^{\frac{1}{\alpha-1}} \qquad \text{(A.3)}$$

When desired capital stock is obtained from equation A.3 for the path of marginal product that rises to reach 100 basis points above the baseline by year 10 (that is, 12.7 percent gross return instead of 11.7 percent), the result is that by the end of the period, desired capital reaches only $59.9 trillion instead of the baseline $68 trillion. After taking account of depreciation, set at 5 percent of capital stock, the consequence is that gross investment is lower than in the baseline by 4.17 percent of GDP.[37]

Two final steps are required to obtain the coefficient for the impact of the interest rate on investment. The first is to recognize that most studies find the economy is better characterized by an elasticity of substitution that is on the order of one-half, rather than unity as in the Cobb-Douglas production function. As a consequence, the expected cutback in desired capital stock is only half as large. Correspondingly, at the midpoint of the period gross investment would be 2.25 percent of GDP lower than in the baseline. The second adjustment is to take account of the fact that 18 percent of gross investment is undertaken by the government, so the impact of the interest rate on investment would be only about four-fifths (0.82 times) as large as the amount inferred from the aggregate production function. On this basis, and using the 2016 base, the impact of the interest rate on gross private investment would be: 0.82 × 2.25% × 18,659 = $343 billion.

37. Evaluated at the mid-point average of 2021–22.

APPENDIX B

GAUGING THE EXPORT SUBSIDY FROM THE BTA

The size of the export subsidy in the border tax adjustment depends on whether the firm is primarily an exporter or primarily produces for the domestic market. Suppose the standard corporate profit tax rate is 20 percent, as in the Ryan-Brady proposal. Suppose further that all exports can be deducted from the tax base, also a feature of the proposal. Consider a firm that exports all of its output. It would be able to deduct all of its exports from its taxable base. But it would also be able to deduct its labor and input costs from its taxable base, so it would have more deductions than it could use. Suppose its profits were 30 percent of output, such that the tax would be 6 percent of total output in the absence of the BTA. These foregone taxes would constitute the full extent of the pool of funds available for the BTA subsidy. So the 100 percent export firm would be limited to providing a subsidy of only 6 percent to its exports, in this example. In the opposite extreme, a firm with almost no exports but also corporate taxes amounting to 6 percent of its output in the absence of the BTA would be able to reduce its taxable base by $1 for each dollar of additional exports. At the margin, the amount available to provide an export subsidy to the nonexporting firm would be 20 cents (the foregone corporate profit tax).

Table B.1 illustrates the spectrum of effective export subsidy rates across firms with alternative export intensities. For all cases, it is assumed that labor and input costs amount to 70 percent of total output value, and before-tax profit amounts to 30 percent. Assuming a corporate profit tax rate of 20 percent (as in Ryan-Brady), all firms would face the same corporate profit tax of 6 percent. The table presents the case in which the total volume of production is 100 and the unit price of output is 1, representing percentage profiles.

Consider firm "B," which exports 50 percent of its output. Compared to sales of 100, without the BTA, its tax would be 6. The BTA permits deduction of all exports, so its taxable base is 30 profits minus 50 exports equals –20, or zero effective tax base. As a consequence, by saving a tax of 6, it has a potential export subsidy pool of 6. Spread across its exports of 50, this pool can provide a unit subsidy of 6/50 = 12 percent. For firm E with exports of 10, the taxable profits under the BTA amount to 30 – 10 = 20, so the tax is 4 (20 percent of 20). The tax savings of 2 provide an export subsidy pool that, spread across 10 units exported, give a unit subsidy of 20 percent.

As the table shows, this process of calculating the potential export subsidy generates a subsidy equal to the full 20 percent corporate tax rate, so long as the export volume is equal to or less than the share of before-tax profits in total output (in the table, 30 units). Above this threshold, the extent of the unit export subsidy potential declines until it falls to 6 percent for the firm exporting all of its output.

Formalizing the example generates the following result:

$$IF\ \phi_x > \phi_\pi,\ then\ s = \frac{\tau_\pi \phi_\pi}{\phi_x};\ otherwise\ s = \tau_\pi, \tag{B.1}$$

where ϕ refers to "share," the subscripts refer to exports (x) and profits (π), and the corporate profit tax rate is τ_π.

For purposes of calibrating the FERTGEM model, it is useful to consider the manufacturing sector as the primary relevant set of activity affected by the BTA (although services are also exported). In the US input-output tables for 2015, exports amounted to 17.2 percent of gross output for the manufacturing sector as a whole (BEA 2017d). For the sector disaggregated into 19 subsectors, the highest export shares were 42.6 percent in "other transportation equipment" (including aircraft); 32.1 percent in "computer and electronic products;" 27.5 percent in "machinery;" and 27.2 percent in "electrical equipment, appliances, and components." For nonmanufacturing sectors, export shares were typically much lower (10 percent of gross output for agriculture, forestry, and mining except oil and gas; close to zero for construction and utilities; and about 3 percent for finance and insurance).

For the manufacturing sector as a whole, total corporate profits in 2015 amounted to $1.65 trillion (FRED 2017b). Gross product of the manufacturing sector was $5.65 trillion (BEA 2017d), so the share of profits in gross product was 29.3 percent. For most of manufacturing, then, the export share was smaller than the profit share in total sales ($\phi_x = 0.17 < \phi_\pi = 0.29$). On this basis, the appropriate calibration for the aggregate model is $s = \tau_\pi = 0.2$.

Table B.1 Potential export subsidy from BTA with 20 percent corporate profit tax

	A	B	C	D	E
Sales	100	100	100	100	100
Labor and inputs	70	70	70	70	70
Exports	100	50	30	25	10
Before tax profit	30	30	30	30	30
Base reduction from exports	–100	–50	–30	–25	–10
Taxable profits	0	0	0	5	20
Tax without BTA	6	6	6	6	6
Tax with BTA	0	0	0	1	4
Export subsidy pool	6	6	6	5	2
Units exported	100	50	30	25	10
Unit subsidy potential (percent)	6	12	20	20	20

BTA = border tax adjustment

Source: Author's calculations.

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