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THE IMPACT OF BREXIT ON FOREIGN INVESTMENT AND PRODUCTION

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ABSTRACT

In this paper, we estimate the impact of increasing costs on foreign producers following a withdrawal of the United Kingdom from the European Union (popularly known as Brexit). Our predictions are based on simulations of a multicountry neoclassical growth model that includes multinational firms investing in research and development (R&D), brands, and other intangible capital that is used nonrivalrously by their subsidiaries at home and abroad. We analyze several post-Brexit scenarios. First, we assume that the United Kingdom unilaterally imposes tighter restrictions on foreign direct investment (FDI) from other E.U. nations. With less E.U. technology deployed in the United Kingdom, U.K. firms increase investment in their own R&D and other intangibles, which is costly, and welfare for U.K. citizens is lower. If the European Union remains open, its citizens enjoy a modest gain from the increased U.K. investment since it can be costlessly deployed in subsidiaries throughout Europe. If instead we assume that the European Union imposes the same restrictions on U.K. FDI, then E.U. firms invest more in their own R&D, benefiting the United Kingdom. With costs higher on both U.K. and E.U. FDI, we predict a significant fall in foreign investment and production by U.K. firms. The United Kingdom increases international lending, which finances the production of others both domestically and abroad, and inward FDI rises. U.K. consumption falls and leisure rises, implying a negligible impact on welfare. In the European Union, declines in investment and production are modest, but the welfare of E.U. citizens is significantly lower. Finally, if, during the transition, the United Kingdom reduces current restrictions on other major foreign investors, such as the United States and Japan, U.K. inward FDI and welfare both rise significantly.

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1. Introduction

In June of 2016, voters in the United Kingdom decided to leave the European Union, a decision popularly known as *Brexit*. The dissolution means that multinational firms of the United Kingdom and European Union no longer enjoy free movement of capital across each other's borders as their subsidiaries will be subject to more stringent regulations and higher production costs.[1] In this paper, we estimate the impact of these capital restrictions on foreign investment, production, and welfare—in the United Kingdom, European Union, and other nations that hosted E.U. investment and invested in the European Union prior to the referendum.

To conduct our analysis, we extend the multicountry dynamic general equilibrium model in McGrattan and Prescott (2010) and Holmes, McGrattan, and Prescott (2015). The main feature of their models is technology capital, which is accumulated know-how from investments in R&D, brands, and organizations that can be used nonrivalrously by multinational firms in their domestic and foreign operations. This capital implies an essential role for FDI since multinationals have more locations in which to use it when countries become more open. Here, the main extension that we introduce is the explicit modeling of all bilateral costs on foreign direct investment, allowing us to study the partial dissolution of an economic union.

For our main simulation, we assume that U.K. investments in the European Union face the same restrictions as Norway's following the Brexit and that E.U. investments in the United Kingdom are treated reciprocally. To provide intuition, we analyze these policy changes in steps: first assuming that the United Kingdom tightens restrictions on E.U. FDI unilaterally and then assuming that both economies restrict the movement of capital across each other's borders. If the United Kingdom acts alone and tightens restrictions on E.U. FDI, E.U. firms have fewer incentives to invest in technology capital. Lower investment by E.U. firms has a negative impact on the United Kingdom. With less technology capital coming from abroad, U.K. firms must increase investment

[1] The OECD Investment Division computes an index on FDI restrictiveness of member countries, measuring regulatory restrictions such as foreign equity limits, screening and approval, restrictions on key personnel, and operational regulations. See Kalinova et al. (2010).

in their own R&D and other intangibles, which is costly. U.K. consumption falls and hours of work rise, implying a welfare loss for U.K. citizens. If E.U. nations remain open to U.K. outward FDI, their citizens enjoy a modest gain from the increased U.K. investment since it is deployed in subsidiaries throughout Europe.

If E.U. nations respond in kind by tightening restrictions on FDI from the United Kingdom, then the welfare of U.K. citizens is not necessarily lower in the post-Brexit period. In response to higher costs on their FDI, U.K. multinationals lower their investments in technology capital and begin to disinvest in their E.U. subsidiaries. Since the European Union is much larger in population and productive capacity than the United Kingdom, the disincentives to invest are far greater for U.K. firms. With FDI restrictions equally tight in both economies, we predict investment in technology capital to fall in the United Kingdom and to rise in the remaining E.U. nations. Thus, while the United Kingdom faces higher costs on their outward FDI, it benefits from the E.U.'s increased investment in intangible capital, which is deployed in U.K. subsidiaries. How this affects welfare depends not only on the relative sizes of the United Kingdom and European Union but also on pre-Brexit FDI stocks of foreign investors such as the United States and Japan.

To make quantitative predictions, we parameterize the model using cross-country data in the period prior to the Brexit referendum. The parameters are chosen to ensure that populations, corporate tax rates, real GDPs, and bilateral FDI flows are the same in the model and data. In the first experiment, we increase costs of E.U. FDI into the United Kingdom and find a average increase in U.K. investment in technology capital of 16 percent over the first decade following the policy change. By 2050, the predicted rise is closer to 45 percent. U.K. consumption is lower by 2.6 percent throughout the transition, and hours of work rise, eventually reaching 2.5 percent above pre-Brexit levels. As a result, U.K. welfare is lower by 3.6 percent. Meanwhile, E.U. consumption is unchanged, but E.U. hours of work fall slightly because the E.U. firms lower investment and production in response to increased U.K. investment. This implies a modest welfare gain of 0.2 percent for E.U. citizens.

In the second experiment, we increase costs of E.U. FDI into the United Kingdom and the costs of U.K. FDI into the European Union. In this case, the United Kingdom dramatically reduces its investment in technology capital: 65 percent over the first decade and eventually 88 percent relative to pre-Brexit levels. With significantly lower technology capital of U.K. firms, domestic and foreign production falls. The loss of income from production is made up by an increase in income from international lending. In other words, we predict that after Brexit, the United Kingdom finances production by non-U.K. multinationals. As a result, U.K. consumption falls by only 2 percent even though the predicted fall in U.K. business output is greater than 10 percent in the long run. With the fall in production, leisure rises sufficiently to imply a small but positive welfare gain of 0.3 percent for U.K. citizens.

We predict that the E.U. countries are significantly worse off if they respond in kind to the U.K.'s policy. The model predicts a large stock of U.K. technology capital in the pre-Brexit period because innovation is concentrated in countries with high total factor productivity (TFP) and freedom to move capital across borders. This arrangement was beneficial for E.U. countries that could take advantage of better technologies without making the investments themselves. With significant disinvestment by U.K. firms after Brexit, E.U. countries must increase their own investments in technology capital, and do so by roughly 26 percent in the first decade and eventually by 43 percent. Other expenditures fall and business output is down modestly, about 0.4 percent in the long run. Consumption falls by more, roughly 1.4 percent, and leisure falls somewhat. As a result, we find welfare losses on the order of 1.6 percent for those remaining in the European Union.

We run additional experiments in which there are higher costs of FDI flows between the United Kingdom and the European Union, but lower costs on FDI inflows to the United Kingdom from other nations. We start by assuming that during the Brexit, the United Kingdom simultaneously lowers restrictions on U.S. foreign direct investment. In this case, production in the United Kingdom falls by less and the welfare of U.K. citizens rises significantly more. A greater presence of U.S. multinationals raises the level of technology capital used in local production. We repeat the exercise, assuming the United Kingdom loosens restrictions on more and more economies. The final simulation has all foreign inflows treated symmetrically, in line with E.U. direct investment. In this case, the welfare of U.K. citizens is higher by almost 5 percent per year, and business output is lower than pre-Brexit levels by about 3 percent.

Most of the related work that estimates the impact of Brexit on FDI flows has been empirical, based either on gravity regressions or on the synthetic counterfactuals method. Dhingra et al. (2016) estimate gravity regressions with bilateral FDI inflows in 34 OECD countries as the dependent variable and use source and host country characteristics, including E.U. membership, as independent variables. They find that E.U. membership has a positive effect—averaging 28 percent across regression specifications—on FDI inflows. Reversing this, they predict that leaving the union would result in a decline of 22 percent (or $-0.28/1.28$). Campos and Coricelli (2015) use the synthetic counterfactuals method, comparing actual U.K. FDI inflows to that of a synthetic United Kingdom whose data is a weighted sum of data from control countries—in this case, the United States, Canada, and New Zealand—that did not enter the European Union. They estimate inflows would be 25 to 30 percent lower if the United Kingdom had not entered the union, which is close to the estimate of Dhingra et al. (2016).[2]

In contrast to the current literature examining foreign investment after Brexit, we use a general equilibrium model that allows us to predict how the Brexit can have an impact the sourcing of inward FDI. If the United Kingdom acts alone and increases restrictions on E.U. FDI, we predict a collapse in inward FDI from E.U. nations and a boom in inward FDI from elsewhere. Taken together, we predict a decline in U.K. inward FDI of 60 percent in the first decade relative to pre-Brexit levels and 35 percent in the long run. If the European Union puts similar restrictions on U.K. FDI, we find a *higher* overall level of inward FDI to the United Kingdom after the transition, on the order of 25 percent relative to pre-Brexit levels. In effect, Brexit imposes costs that make it

[2] See Campos et al. (2014) for details of the method and results for all E.U. members. See Pain and Young (2004) and Barrell and Pain (1997) for other work estimating the impact of E.U. membership on FDI flows and macroeconomic aggregates.

optimal for the United Kingdom to shift away from producing goods and services itself and toward financing the production of other nations' multinationals, both at home and abroad.

Other related work considers the impact of higher trade costs following the Brexit. Here, we focus on FDI and global capital flows and, to keep things tractable, work with a one-good model, estimating changes in *net* rather than *gross* exports. We can, however, compare estimates of predicted changes in U.K. production due to increased trade costs with predicted changes due to increased costs of FDI. Steinberg (2017) analyzes the impact of higher trade costs following Brexit in a dynamic model and estimates that U.K. output will be lower in the long run. He predicts declines in output in the range of 0.4 to 1.1 percent lower than the pre-Brexit levels. In our simulations, we find that output *rises* by 0.7 percent if the United Kingdom acts alone to impose higher FDI costs on E.U. firms and falls more than 10 percent if the remaining E.U. nations respond in kind.

In Section 2, we describe the model, and in Section 3, we discuss how we parameterize the model using pre-Brexit data from national and international accounts. In Section 4, we report results for the Brexit simulations. Section 5 concludes.

2. Model

The environment we use builds on McGrattan and Prescott (2010) and Holmes, McGrattan, and Prescott (2015). There are I economic unions, which are groups of countries, states, or provinces that impose few to no restrictions on cross-border direct investments of multinational firms. Each economic union is characterized by its productive capacity, its TFP, and its degree of openness to direct investments from outside the union. More specifically, economic union i has a total number of locations, N_i, where domestic or foreign firms can operate, a level of TFP, A_i, and a degree of openness to investments from firms in j, $\sigma_i^j \in [0, 1]$, where $\sigma_i^i = 1$. These characteristics are taken as given by multinational firms when making their production decisions. In this section, we describe the technologies available to these firms and the preferences of households that are the shareholders.

2.1. Firm Problem

Firms choose labor and capital in all locations. Some of the capital is tangible (e.g., structures and equipment), and some is intangible (e.g., R&D, brands, organizations). Some intangible capital is location-specific (e.g., local customer or client lists), and some is nonrivalrous and can be used in all locations (e.g., R&D). We denote the location-specific inputs of labor, tangible capital, and intangible capital used by firms from j operating in economic union i by L_i^j, $K_{T,i}^j$ and $K_{I,i}^j$, respectively. We denote the nonrivalrous intangible capital of j used in i by M_i^j and refer to it as *technology capital* to distinguish it from the location-specific stocks.

As in Holmes et al. (2015), we assume that firms choose how intensively they deploy their technology capital in certain foreign economies that allow firms market access only in exchange for the transfer of technology capital. Holmes et al. (2015) refer to this as a *quid pro quo* arrangement.[3] We denote the fraction of technology capital deployed in economic union i by firms in j by q_i^j—which we refer to as the *intensity level*. In this case, the total effective stock of technology capital is $q_i^j M_i^j$, with $q_i^j \in [0,1]$ and $q_i^i = 1$.[4] We include the quid pro quo trade-off here because the United Kingdom and other European Union nations invest in countries that insist on joint ventures for high-tech foreign firms with the hope of increasing their chance of fulfilling the goal of having more indigenous innovation.

In each period t, total output produced by multinationals from j in economic union i is given by

$$Y_{it}^j = A_{it}\sigma_{it}^j \left(q_{it}^j M_{it}^j N_{it}\right)^{\phi} \left(\left(K_{T,it}^j\right)^{\alpha_T} \left(K_{I,it}^j\right)^{\alpha_I} \left(L_{it}^j\right)^{1-\alpha_T-\alpha_I}\right)^{1-\phi}. \tag{2.1}$$

Factor inputs are chosen to the present value of after-tax worldwide dividends, $(1-\tau_{dt})\sum_t p_t D_t^j$,

[3] As we show later, this modeling choice partly endogenizes the degrees of openness to foreign investment, parameterized otherwise by σ_i^j.

[4] In the absence of a quid pro quo arrangement, multinationals would use all of their technology capital in all possible locations, and we would not need to index M^j with an i.

where τ_{dt} is the tax rate on shareholder dividends, p_t is the Arrow-Debreu price, and D_t^j is the total dividend payment. Total dividend payments are the sum of payments across economic unions hosting the FDI, namely,

$$D_t^j = \sum_i \Big\{ (1-\tau_{p,it}) \left(Y_{it}^j - W_{it} L_{it}^j - \delta_T K_{T,it}^j - X_{I,it}^j - \chi_i^j X_{M,t}^j \right) \\ - K_{T,i,t+1}^j + K_{T,it}^j \Big\} + \tau_s \left(\bar{X}_{M,t}^j / \mu_t^j \right) X_{M,t}^j \tag{2.2}$$

with $\chi_j^j = 1$ and $\chi_i^j = 0$ if $i \neq j$. The dividend from economic union i is computed as the after-tax accounting profit less retained earnings plus any subsidies to investment in R&D and other intangibles. The tax rate on profits in i is given by $\tau_{p,i}$ and is assessed on taxable income equal to output Y_i^j less payments to labor L_i^j at rate W_i, depreciation of tangible capital $K_{T,i}^j$ at rate δ_T, new investment in intangible capital $X_{I,i}^j$ that is location-specific, and investment at home in new technology capital X_M^j. When computing taxable profits, investments in tangible capital are treated as capital expenditures, implying that the firm subtracts only the depreciation allowance, whereas investments in the two intangible capitals are treated as expenses and are therefore fully subtracted. This differential tax treatment implies that retained earnings recorded by the accountants are net investment in *tangible* capital, which is given by $K_{T,i,t+1}^j - K_{T,it}^j$ between period t and $t+1$. The last term in (2.2) is a subsidy for R&D and other intangibles, which is a function of aggregate investment in technology capital in j, $\bar{X}_{M,t}^j$, as a share of all technology capital employed in j, μ_t^j (defined below). We use the following functional form:

$$\tau_s(x) = \nu_0 \exp(-\nu_1 x),$$

and interpret this as a subsidy that governments make to ensure that aggregate R&D is not too low.

The capital accumulation equations for the location-specific stocks are given by

$$K_{T,i,t+1}^j = (1-\delta_T) K_{T,it}^j + X_{T,it}^j - \varphi\left(X_{T,it}^j / K_{T,it}^j \right) K_{T,it}^j \tag{2.3}$$

$$K_{I,i,t+1}^j = (1-\delta_I) K_{I,it}^j + X_{I,it}^j - \varphi\left(X_{I,it}^j / K_{I,it}^j \right) K_{I,it}^j, \tag{2.4}$$

where $X^j_{T,i}$ and $X^j_{I,i}$ are new investments, δ_T and δ_I are depreciation rates for the tangible and intangible stocks, respectively, and φ is a function governing the cost of adjusting investment. In our analysis later, we use the following functional form:

$$\varphi(X/K) = \frac{\varphi_0}{2}(X/K - \delta - \gamma_Y)^{\varphi_1},$$

where δ is the depreciation rate of the relevant investment series and γ_Y is trend growth in the global output. In the absence of any quid pro quo policy, the accumulation equation for technology capital is assumed to have the same form as the accumulation equations in (2.3)-(2.4). If there are quid pro quo transfers, however, then some of the technology capital is transferred to local firms in the economy hosting the FDI. In this case, the next period technology capital is given by

$$M^j_{i,t+1} = (1-\delta_M)\left(1 - h^j_{it}\left(q^j_{it}\right)\right) M^j_{it} + X^j_{M,t} - \varphi\left(X^j_{M,t}/\mu^j_t\right)\mu^j_t, \tag{2.5}$$

where $h^j_{it}(q^j_{it}) \in [0,1]$ is the share transferred, say through forced joint ventures, when foreign firms choose intensity level q^j_{it}.[5] The function $h^j_{it}(\cdot)$ is assumed to be weakly increasing in the intensity choice q^j_{it}; the more technology capital brought in, the greater the required transfer.

In economic unions that engage in quid pro quo, there are two types of firms operating domestically: those that innovate and those that appropriate. The problem of the former is given above. The problem of the latter is different in several respects. First, the technology capital that appropriators accumulate is from the quid pro quo arrangement, not from their own investment. Thus, the technology capital appropriated from foreigners, which we denote by $\tilde{M}_i$, accumulates as follows:

$$\tilde{M}_{i,t+1} = (1-\delta_M)\tilde{M}_{it} + \sum\nolimits_j (1-\delta_M) h^j_{it}\left(q^j_{it}\right) M^j_{it}. \tag{2.6}$$

Holmes et al. (2015) find evidence from Chinese patent data that property rights being exchanged in quid pro quo arrangements apply in the domestic market, not outside. Thus, we assume that appropriators can only use the $\tilde{M}_i$ domestically. Their domestic output is given by

$$\tilde{Y}_{it} = A_{it}\left(\tilde{M}_{it}N_{it}\right)^{\phi}\left(\left(\tilde{K}_{T,it}\right)^{\alpha_T}\left(\tilde{K}_{I,it}\right)^{\alpha_I}\left(\tilde{L}_{it}\right)^{1-\alpha_T-\alpha_I}\right)^{1-\phi}. \tag{2.7}$$

[5] If there are no quid pro quo arrangements, we do not need to index M with the destination i, as companies would deploy all of their capital in all possible locations. In economies that use quid pro quo, some technology is transferred and we need to keep track of the remaining stocks, which differ by FDI host.

Given that production for appropriators is limited to domestic locations, parameters governing the level of intensity and the degree of openness are set equal to 1. Like multinationals, appropriators choose location-specific inputs to maximize the present after-tax discounted stream of dividends, which we denote by $\tilde{D}_{it}$. These dividends are paid to domestic households.

Now that we have introduced both types of firms, we can be more specific about the total technology capital available to multinationals incorporated in economy j. This total is given by

$$\mu_t^j = M_{jt}^j + \tilde{M}_{jt} + \sum_{\ell \neq j} \left(\sigma_{jt}^{\ell}\right)^{\frac{1}{\phi}} q_{jt}^{\ell} M_{jt}^{\ell}.$$

The first term on the right-hand side is the technology capital of multinationals incorporated in j. The second term is the technology capital of appropriators in j. The third term is the available technology capital of foreign multinationals operating in j, which is a function of the degrees of openness and the intensity levels.

We turn next to a description of the household problem.

2.2. Household Problem

Households choose sequences of consumption C_{it}, labor L_{it}, and assets B_{it+1} to solve the following problem:

$$\max \sum_t \beta^t \left[\log\left(C_{it}/N_{it}\right) + \psi \log\left(1 - L_{it}/N_{it}\right)\right] N_{it} \tag{2.8}$$

subject to

$$\sum_t p_t \left[C_{it} + B_{i,t+1} - B_{it}\right] \leq \sum_t p_t [(1-\tau_{l,it}) W_{it} L_{it} + (1-\tau_{dt}) \left(D_t^i + \tilde{D}_{it}\right) + r_{bt} B_{it} + \kappa_{it}], \tag{2.9}$$

where τ_{li} and τ_d are tax rates on labor and dividends, r_b is the after-tax return on international borrowing and lending, N_{it} is the population in economic union i, and κ_{it} is exogenously determined income, which includes both government transfers and nonbusiness net income.[6] Note that an

[6] Nonbusiness net income is included so that we can match accounts of the model to accounts in the data. In our application, we want to distinguish value added and investment from business and nonbusiness sectors. We also include nonbusiness labor as part of the total labor input, and this too is exogenously set. Public consumption is included with C_i.

implicit assumption being made is that N_i is both the count of production locations and the size of the population. We are assuming that a union's productive capacity scales with the population.

2.3. Market Clearing

The worldwide resource constraint is

$$\sum_i \left\{ C_{it} + \sum_j \left(X^j_{T,it} + X^j_{I,it} \right) + X^i_{M,t} + \tilde{X}_{T,it} + \tilde{X}_{I,it} + \bar{X}_{nb,it} \right\}$$
$$= \sum_{i,j} Y^j_{it} + \sum_i \left(\tilde{Y}_{it} + \bar{Y}_{nb,it} \right), \qquad (2.10)$$

which is the market-clearing condition for the goods market that includes nonbusiness output $\bar{Y}_{nb,it}$ and nonbusiness investment $\bar{X}_{nb,it}$. Recall that these are components of nonbusiness net income for households, which is included in κ_{it} in (2.9).

Market clearing in asset markets occurs if $\sum_i B_{it} = 0$, and market clearing in labor markets occurs if

$$L_{it} = \sum_j L^j_{it} + \tilde{L}_{it} + \bar{L}_{nb,it}, \quad i = 1, \ldots, I,$$

where L^j_{it} is the labor input for multinationals from j operating in i, $\tilde{L}_{it}$ is the labor input of appropriators in i, and $\bar{L}_{nb,it}$ is the time devoted to nonbusiness work.

2.4. Accounting measures

When simulating the model, we compare our theoretical predictions to empirical analogues in the national and international accounts. The most commonly used accounting measures are gross domestic product (GDP), gross national product (GNP), and components of the current account, namely, net exports and net factor incomes. In the model, we compute GDP and net factor incomes (NFI) as follows:

$$\text{GDP}_{it} = C_{it} + \sum\nolimits_j X^j_{T,it} + \tilde{X}_{T,it} + \bar{X}_{nb,it} + NX_{it} \qquad (2.11)$$

$$\text{NFI}_{it} = \sum\nolimits_{l \neq i} \left(K^i_{T,l,t+1} - K^i_{T,lt} + D^i_{lt} \right) - \sum\nolimits_{l \neq i} \left(K^l_{T,i,t+1} - K^l_{T,it} + D^l_{it} \right) + r_{bt} B_{it}, \quad (2.12)$$

where GNP is the sum of GDP and NFI, NX_{it} is net exports of goods and services by economy i, and NFI_{it} is equal to profits from direct investment abroad (first sum) less profits from direct investment by foreigners producing in i (second sum) plus foreign net interest. Although some categories of intangible investments have recently been included in measures of GDP for some countries, most is still excluded. In light of this, we use the old concept of GDP and assume full expensing of intangible investments.[7]

3. Model Parameters

In this section, we parameterize the model using data from national and international accounts prior to the June 2016 referendum in the United Kingdom. The analysis includes all nations that are major investors in the United Kingdom and European Union.[8] Parameters are chosen to replicate key statistics, and the model is then used to simulate alternative Brexit scenarios.

Table 1 displays parameters that are assumed to be the same for all economies. We use common parameters for household preferences (β, ψ), trend growth in TFP $(1+\gamma_A)^t$, trend growth in population $(1+\gamma_N)^t$, income shares $(\phi, \alpha_T, \alpha_I)$, nonbusiness activities ($\bar{L}_{nb}$, $\bar{X}_{nb}$/GDP, $\bar{Y}_{nb}$/GDP), depreciation rates (δ_M, δ_T, δ_I), tax rates on individual incomes (τ_l, τ_d), R&D subsidies (ν_0, ν_1), and adjustment costs (φ_0, φ_1). Specifically, we use estimates from Holmes et al.'s (2015) study of global capital flows, which are reported in Table 1.

We assume, as in Holmes et al. (2015), that quid pro quo policies are only used by some countries and only vis-à-vis some inward FDI. In the application here, we assume it is only used in China and India, which impose joint ventures on high-tech companies from developed nations doing significant R&D. The functional form for quid pro quo policy for hosts i that impose it is

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7 We do sensitivity analysis to ensure that this assumption does not affect our results.

8 More specifically, we include the United Kingdom, all other European Union countries, the United States, Canada, Norway, Switzerland, Australia, New Zealand, South Africa, Japan, Korea, China, Hong Kong, and India. China and Hong Kong are treated as an economic union, and all FDI flows between them are netted.

given by

$$h_i^j(q) = \min\{\bar{h} q \exp(-\eta(1-q)), 1\}, \tag{3.1}$$

where i indexes either China or India and j indexes either the United Kingdom, other E.U. countries, the United States, or Japan. For all other i, j, $h_i^j(q) = 0$. Note that the function in (3.1) is weakly increasing in q, and the functional form is motivated by the fact that we need some curvature (that is, $\eta > 0$) in order for an interior equilibrium to exist. In our simulations, we set $\bar{h} = 700$ and $\eta = 10$, which are taken from Holmes et al. (2015). These settings imply a sharp increase in costs when q exceeds 0.3.

Table 2 reports parameters that differ across economies. The first set shown in Table 2A includes levels of TFP, populations, and corporate income tax rates. TFP and population for the United Kingdom are normalized to 100, and estimates for all other economies are set relative to theirs. The second set shown in Table 2B includes all bilateral degrees of openness σ_i^j, $i, j = 1, \ldots, I$. The rows in Table 2B represent the recipients of FDI, and the columns represent the originators of FDI. In the pre-Brexit period, we impose that $\sigma_j^i = 1$ for bilateral flows between the United Kingdom and the European Union since the investment can flow freely within the union. The remaining bilateral degrees of openness and the levels of TFPs are set so as to exactly replicate all bilateral FDI flows (relative to GDP) and real GDPs per capita (relative to a common long-run growth trend).[9] (See the appendix for data sources.)

4. Post-Brexit

In this section, we use the parameterized model to run three sets of numerical experiments. First, we lower the degree of openness for E.U. FDI in the United Kingdom, namely, the parameters σ_{it}^j with i indexing the host, which in this case is the United Kingdom, and j indexing the source, which in this case is the European Union (or, equivalently element (2,1) of the matrix in Table 2B).

[9] To parameterize the degrees of openness, we use actual FDI flows rather than indices of FDI restrictiveness such as that computed by the OECD (2010). The indices have no theoretical counterpart and cannot accurately measure the overall restrictiveness of the regulatory regime.

The time series we feed in is shown in Figure 1 and is assumed to be known by all nations starting in 2016. The actual changes occur two years after the referendum, and the openness parameter ultimately falls to 0.95. The latter estimate represents the pre-Brexit degree of openness in the European Union to FDI from Norway.

In the second experiment, we lower the degree of openness for U.K. FDI in the European Union and simultaneously for E.U. FDI in the United Kingdom. In this case, two of the σ_{it}^{j} parameters are lowered, and we use the same time series as shown in Figure 1. Finally, we assume as before that there is a lowering of the openness parameters between the United Kingdom and the European Union, and, in addition, we assume that the United Kingdom unilaterally loosens restrictions on FDI from other nations. We start with only the United States. Then we additionally add Japan, then China, then all other countries. For each simulation, we report key statistics related to expenditures, the labor market, the current account, and welfare.

4.1. Costs of E.U. FDI Increased

In Table 3A, we report results in the case in which the United Kingdom tightens restrictions on inward FDI from E.U. nations and does so unilaterally. For expenditures and labor market variables, we compute the percentage changes relative to the pre-Brexit levels. For current account variables, which could be close to zero or negative, we first divide the values by GNP and then take absolute differences between the post- and pre-Brexit ratios. Two predictions are reported: the average over the first decade and the change once the economy has converged to a new balanced growth path. The latter is shown in parentheses.

First consider the changes in expenditures. Higher costs on E.U. subsidiaries in the United Kingdom have the largest impact on investment in technology capital since this type of capital can be used nonrivalrously in multiple locations. If costs are higher on E.U. FDI, E.U. firms are at a relative disadvantage in creating new R&D and brands and therefore respond by lowering their investment in X_M. If less technology capital is coming into the United Kingdom, the U.K. firms respond by increasing their own investments in technology capital. In this case, we predict an average decline in E.U. technology capital investments of 19 percent relative to pre-Brexit levels over the first decade and 45 percent in the long run. For U.K. firms, we see roughly the reverse: an average increase of 16 percent over the first decade and 45 percent in the long-run.

The increase in U.K. investment in R&D, brands, and other intangibles is beneficial to the European Union since much of this capital can be deployed costlessly in subsidiaries throughout Europe. In fact, the trade-off between higher costs of outward FDI and higher benefits from U.K. investment is roughly offsetting and E.U. consumption is unchanged. With the drop in their own investment, E.U. output and hours of work are slightly lower. For the United Kingdom, on the other hand, an increase in investment means lower consumption and higher output and hours of work. U.K. consumption falls 2.6 percent, and hours of work by the end of the transition are higher by 2.5 percent, leaving U.K. citizens worse off under a unilateral policy change.

The effects of the policy change are also reflected in net factor incomes. Higher restrictions on E.U. FDI imply a relative disadvantage to E.U. multinationals and, therefore, lower outward FDI. Net factor incomes from corporate profits (NFI_{prof}) relative to GNP eventually fall for E.U. firms by about 3 percent and rise for U.K. firms by about 16 percent, with the difference attributed to the European Union being much larger than the United Kingdom. Overall, E.U. net factor incomes change little because E.U. nations respond to higher FDI costs by increasing lending to non-E.U. producers that have a relative advantage. This lending shows up in higher net foreign interest payments that roughly offset the fall in net foreign profits. For the United Kingdom, the policy has the opposite effect, and therefore net foreign profits are higher and net foreign interest payments are lower after the change.

For other countries, the main effect of the policy change is the response of investment in technology capital since all countries are affected by costs on capital flow movements. Lower investment by E.U. firms affects all nations with inward FDI from the European Union. However, general equilibrium effects are important. For example, although the United Kingdom increases its investment, the U.K. economy is relatively small. Therefore, higher costs on E.U. firms can lead large countries, such as the United States, to increase their own investment in R&D, brands, and other capital. In this simulation, we predict that the United States increases its investment by roughly 6 percent. Small and relatively open countries such as Canada can take advantage of the U.S. response since they are hosts to large U.S. FDI stocks.

4.2. Costs of U.K. and E.U. FDI Increased

Next, we analyze a Brexit scenario with the European Union responding in kind to the U.K. policy of tighter regulations on inward FDI. For this simulation, the degree of openness parameters in elements (2,1) and (1,2) of the matrix in Table 2B are both lowered as shown in Figure 1. We find that the economic impact of these policy changes depends crucially on the relative sizes and TFPs of the investing nations and their pre-Brexit FDI stocks.[10]

In Table 3B, we report results of these policy changes. U.K. expenditures on all types of investments fall after 2016, with investments in new technology capital falling the most dramatically. On the new balanced growth path, investment in technology capital, X_M, of U.K. multinationals is down 88 percent. In the pre-Brexit period, the model predicts that a significant amount of investment in R&D and other intangibles is done in the United Kingdom because it has a much higher level of TFP than the other countries in the union. (See Table 2A.) Given the nonrivalrous nature of technology capital, U.K. multinational firms could costlessly use this capital in many locations within the union prior to the Brexit. When costs of producing in the European Union rise after Brexit, the United Kingdom reduces direct investment in the other E.U. locations and instead increases financing of production of non-U.K. multinationals. In effect, the U.K. foreign investment shifts from FDI to portfolio investment. Production at home and abroad falls, and, in the new balanced growth path, U.K. net factor income is no longer in the form of profits but rather net interest. Overall, the current account relative to GNP is higher not because of net

[10] Kierzenkowski et al. (2016) argue that "lower FDI inflows would seem unavoidable" if access to the E.U. single market is restricted. Here, the impact on FDI inflows is not unambiguously negative.

factor incomes but because net exports as a share of GNP rise. Domestic absorption in the United Kingdom falls significantly because of lower investment spending.

In the second two rows of Table 3B, we report predictions for the European Union. With less U.K. technology capital, the remaining E.U. countries must accumulate more of their own. The fact that they face higher costs in their U.K. subsidiaries has little impact on their investment decisions since the United Kingdom is a much smaller economy (and therefore has fewer productive locations). The results show a shift by the European Union from investing in location-specific capital to investing in technology capital, which continues throughout the transition. Evidence of this shift can also be seen in the current account changes. In contrast to the United Kingdom, the current account share of GNP falls, the net exports share of GNP falls, and E.U. countries do less financing of other production and more outward FDI. Overall, the impacts are significantly smaller as the European Union is much bigger in size—in both population and production locations. Business output falls by only 0.4 percent by the end of the transition. Consumption also falls by less, roughly 1.4 percent, but labor rises modestly, even with domestic wages falling somewhat.

Figure 2 shows the timing of FDI flows between the United Kingdom and the European Union as a share of the host economy's GNP.[11] The U.K.'s direct investment in the European Union as a share of E.U. GNP is negative during most of the transition and roughly zero by 2050. A negative FDI share means that retained earnings from the E.U. subsidiaries are falling, in this case to zero, as U.K. firms shut them down. Meanwhile, E.U. firms retain less in the initial decades, but as they accumulate technology capital, they eventually bring investment levels in their U.K. subsidiaries back to pre-Brexit levels. If we include all inward flows, both series in Figure 2 would be higher by roughly 1.5 percentage points, implying a greater role for inward FDI in the United Kingdom after Brexit. In contrast, gravity regression estimates predict a smaller role for FDI.[12]

As costs on foreign producers rise in the United Kingdom and European Union, total business

[11] As we noted earlier, we use the old concept of GNP that excludes intangible investment. If we add back all intangible investments, the differences in the ratios reported are less than 0.15 percentage points.

[12] See Dhingra et al. (2016) and Bruno et al. (2016) for more details on gravity regression results.

outputs in these two economies fall. In Figure 3, we display the time series for business outputs relative to trend for these economies along with an aggregate of all other nations. There is an adjustment period before costs on FDI actually rise. By 2050, U.K. output is below by 10 percent, E.U. output is below by 1 percent, and all other output is up by 0.4 percent. Production shifts from the United Kingdom and the European Union to other economies, most notably to Australia, New Zealand, South Africa, and Japan early on, and then later to Norway, Switzerland, the United States, and Canada. When aggregated, the business output of non-U.K. and non-E.U. firms is initially below the pre-Brexit level but eventually rises above.

For non-U.K economies, the main similarity in the results is the response of technology capital investments (X_M). All but one non-U.K. country has higher investment in the long run because, after Brexit, they have a comparative advantage to innovate. As a result, non-U.K. countries do more outward FDI and have higher net factor incomes from profits abroad. Exactly how much more depends on their pre-Brexit FDI stocks, which in turn is a function of their relative sizes, TFPs, and degrees of openness. For example, Switzerland has a large stock of technology capital because it is relatively closed to inward FDI, whereas other countries are relatively more open to its outward FDI. In the post-Brexit period, with U.K. firms disinvesting, Swiss firms take advantage of their position as a major foreign investor and increase their technology capital stock even further.

Table 4 shows the welfare gains or losses for the two simulations described above—with the United Kingdom less open to FDI—and others described below. Welfare is calculated as the consumption equivalent needed to be indifferent between the new policies (that is, lower σ's) and no change. A positive value indicates a gain with Brexit. With the U.K. unilaterally changing policy, we predict a significant welfare loss to U.K. citizens, on the order of 3.6 percent. E.U. citizens have a modest gain because of a modest increase in leisure. If both the United Kingdom and the European Union tighten regulations on each other's FDI, we see the reverse: a gain for U.K. citizens and a loss for E.U. citizens. Although consumption in the United Kingdom falls, there is a large increase in hours of leisure and thus a small gain. E.U. citizens are worse off because they consume less and work more. Similarly for most other nations, the welfare impact depends crucially on whether the United Kingdom acts alone or not because the relative advantages for countries doing outward FDI are different under the two Brexit scenarios. Furthermore, the interconnectedness of investment and production is clear from the fact that the welfare losses and gains in many of the non-E.U. countries are large, in the range of -0.86 to 0.69.

4.3. Costs of Inward FDI from non-E.U. Countries Decreased

Next, we estimate the impact of looser restrictions on FDI into the United Kingdom from other nations, with the timing the same as the Brexit timing shown in Figure 1. In the post-Brexit scenario, these other nations are treated symmetrically with the nations in the European Union.

We start by loosening restrictions on FDI from the United States to the United Kingdom. Reading across the first row of Table 2B, we see that the pre-Brexit degree of openness for these flows is 0.91 (which is element (1,5) in the matrix). We assume that during the transition, this parameter rises to 0.95, using the same timing as in Figure 1. The results of this experiment are shown in the third columns of Tables 4 and 5 (which are directly comparable to the second columns in the tables).

Table 4 shows the impact on welfare. Restricting inward FDI flows from E.U. nations while simultaneously loosening flows from the United States implies a significantly higher welfare gain for U.K. citizens. Table 5 reports key statistics that help to explain why. Notice that this policy change leaves U.K. consumption roughly unchanged, and leisure is still significantly higher. These results follow from the fact that the United States has accumulated a large stock of technology capital, which now has freer access in the United Kingdom. With more activity in U.S. subsidiaries, U.K. business output, investment, labor, and wages all fall by less. The current account relative to GNP changes little, but net exports and net factor incomes are affected. More U.S. production means higher net exports and higher net foreign interest in the United Kingdom.

Comparing the second and third columns of Table 4, we see that welfare is not necessarily higher for all after FDI restrictions on the United States are loosened. How nations fare depends on whether they are relatively open or closed to U.S. FDI. Those that are relatively open to U.S. FDI gain because the United States does more investment in technology capital when costs are lowered on its outward FDI. However, general equilibrium effects imply wage changes as production patterns shift, and this can lead to a negative impact on welfare. In all of the countries that have lower welfare relative to the baseline (in the second column), wages are lower during the transition.

The last three columns of Tables 4 and 5 relate to experiments with the United Kingdom sequentially loosening restrictions on Japan, China, and then all other nations listed in Table 4. In each case, as restrictions are loosened, we find higher consumption, higher leisure, and higher welfare for the United Kingdom. Welfare patterns for other nations depend on their own bilateral relationships with the economies doing more outward FDI. The final experiment shows a welfare gain of close to 5 percent for the United Kingdom and a welfare loss of 1.7 percent for the European Union. In all cases, the United Kingdom relies less on income from production and more on income from net interest than in the pre-Brexit period. In all cases, the remaining E.U. countries are worse off because they restricted free access to U.K. technology.

5. Conclusion

In this paper, we estimated the impact of tightening regulations on foreign producers following the U.K. referendum to leave the European Union. We showed that the impact on investment, production, and welfare depends importantly on whether the United Kingdom acts unilaterally to block E.U. FDI or jointly with E.U. nations to erect cross-border barriers on each other's FDI. Economies that remain open enjoy the benefit of new ideas and knowledge of others, without undertaking costly investments themselves. If the United Kingdom unilaterally tightens regulations, U.K. firms must invest on their own, and U.K. citizens are worse off because they enjoy less consumption and less leisure. Although their outward FDI faces higher costs, the European Union benefits from increased investment by U.K. firms in R&D and other intangible capital.

If the European Union also tightens regulations on U.K. FDI, then the relative sizes and TFPs of the two economies, along with other investing nations, will determine global investment and production patterns in the post-Brexit period. Given the United Kingdom is relatively small, if the U.K. and E.U. firms face the same regulations, we predict that the optimal response of U.K. firms is to lower investments in R&D and other intangibles and to disinvest in their E.U. subsidiaries. In this scenario, the United Kingdom would increase international lending, financing the production of others, both domestically and abroad, which would imply greater inward FDI and greater benefits to U.K. citizens. Reducing current restrictions on other major investors, such as the United States and Japan, would lead to even further increases in U.K. inward FDI and potentially significant gains in welfare.

A. Data Sources

In this appendix, we report on our data sources. All of our data and computer codes are available at our website, www.econ.umn.edu/≃erm.

The main series used for our analysis are aggregate populations, gross domestic products, FDI flows, and average corporate tax rates. The source of the population and GDP data is the World Bank's World Development Indicators (WDI) database. The specific series that we use are total population (SP.POP.TOTL), GDP in current U.S. dollars (NY.GDP.MKTP.CD), and GDP at purchasing power parity in constant 2011 international dollars (NY.GDP.MKTP.PP.KD). For each of these variables, when constructing a composite series for a group of countries, such as the European Union or China and Hong Kong, we simply add populations and GDPs across countries to arrive at the total for the economic union.

The main source for bilateral foreign direct investment flows is the Organisation for Economic Co-operation and Development (OECD) FDI statistics. These flows are reported to the OECD by the member countries for each of their partner countries. The data for inward FDI flows to China from its partners come from the *China Statistical Yearbook*. These data are available from 1990 to 2013. Outward FDI data by host country are available from the *China Commerce Yearbook* for years 2003 - 2013. When constructing FDI statistics for the European Union members and for China and Hong Kong, we subtract any FDI flows between member countries.

The source of data on corporate tax rates are estimates from the accounting firm KPMG International (1993-2016). In order to construct tax rates for our composite countries, a simple average is taken across prevailing tax rates in the countries being aggregated.

For computation of the initial steady state, an average of each of the data series was taken across three years: 2010 through 2012. We chose a start date of 2010 to avoid the trough of the Great Recession and an end year of 2012 because that was the last year in which all of the data series were available.

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Table 1

Model Parameters Common Across Economies

Parameter	Expression	Value
Preferences		
Discount factor	β	.98
Leisure weight	ψ	1.32
Growth rates (%)		
Population	γ_N	1.0
Technology	γ_A	1.2
Income shares (%)		
Technology capital	ϕ	7.0
Tangible capital	$(1-\phi)\alpha_T$	21.4
Plant-specific intangible capital	$(1-\phi)\alpha_I$	6.5
Labor	$(1-\phi)(1-\alpha_T-\alpha_I)$	65.1
Nonbusiness sector (%)		
Fraction of time at work	$\bar{L}_{nb}$	6
Investment share	$\bar{X}_{nb}$/GDP	15
Value-added share	$\bar{Y}_{nb}$/GDP	31
Depreciation rates (%)		
Technology capital	δ_M	8.0
Tangible capital	δ_T	6.0
Plant-specific intangible capital	δ_I	0
Tax rates (%)		
Labor wedge	τ_l	34
Dividends	τ_d	28
R&D subsidy parameters		
Slope	ν_0	0.5
Curvature	ν_1	150
Adjustment cost parameters		
Slope	φ_0	1
Curvature	φ_1	2

Note.—Parameters are taken from Holmes, McGrattan, and Prescott's (2015) analysis of the U.S. current account. See Holmes, McGrattan, and Prescott (2014) for a sensitivity analysis with respect to these parameter choices.

Table 2A

Exogenous Inputs: TFPs, Populations, Profit tax rates

Economy	TFP	Population	Tax Rate
United Kingdom (UK)	100	100	26
European Union (EU)	83	698	23
Norway (NO)	175	8	28
Switzerland (CH)	163	13	21
United States (US)	117	493	40
Canada (CA)	117	54	28
Australia (AU)	115	35	30
New Zealand (NZ)	117	7	29
South Africa (ZA)	53	82	35
Japan (JP)	100	202	40
Korea (KR)	96	79	23
China (CN)	37	2136	21
India (IN)	21	1972	33

Table 2B

Exogenous Inputs: Bilateral Degrees of Openness

In\Out	UK	EU	NO	CH	US	CA	AU	NZ	ZA	JP	KR	CN	IN
UK	1	1	.85	.58	.91	.88	.60	.74	.65	.81	.75	.89	.91
EU	1	1	.95	.97	.90	.93	.61	.73	.66	.79	.82	.87	.79
NO	.68	.75	1	.68	.48	.73	.61	.49	.50	.54	.49	.64	.61
CH	.37	.42	.40	1	.74	.40	.39	.42	.42	.73	.41	.47	.50
US	.88	.92	.91	.94	1	.91	.97	.85	.78	.86	.84	.78	.86
CA	.77	.54	.52	.50	.79	1	.51	.55	.55	.72	.54	.61	.65
AU	.81	.74	.55	.78	.79	.83	1	.81	.58	.82	.67	.81	.71
NZ	.62	.45	.53	.54	.44	.61	.85	1	.45	.58	.48	.50	.54
ZA	.78	.49	.48	.68	.62	.48	.47	.50	1	.65	.52	.55	.60
JP	.72	.47	.60	.78	.46	.61	.68	.48	.47	1	.70	.70	.62
KR	.68	.71	.68	.68	.68	.68	.69	.51	.52	.75	1	.70	.75
CN	.78	.89	.66	.75	.82	.74	.79	.82	.68	.93	.84	1	.73
IN	1	1	.64	.88	.93	.59	.90	.62	.63	.98	.84	.76	1

Table 3A. Change in Expenditures, Labor Market Variables, and the Current Account, Relative to Pre-Brexit Levels[a]

(UK Tightens Restrictions on EU FDI Unilaterally)

	Expenditures[b]					Labor Market		Current Account			
	Y	C	X_T	X_I	X_M	L	W	CA	NX	NFI_{prof}	NFI_{int}
United Kingdom	0.2	-2.6	-2.0	-5.0	15.7	2.1	-1.9	-2.2	-0.6	-0.4	-1.3
	(0.7)	(-2.6)	(0.7)	(0.7)	(44.8)	(2.5)	(-1.8)	(-4.0)	(-5.9)	(15.8)	(-13.9)
European Union	-0.2	0.0	-0.5	-1.0	-18.8	-0.1	0.0	1.4	0.6	0.4	0.5
	(-0.8)	(0.0)	(-0.8)	(-0.8)	(-44.6)	(-0.6)	(-0.2)	(1.1)	(1.1)	(-3.1)	(3.2)
Norway	0.2	-0.2	0.6	1.4	5.5	0.3	-0.1	-0.7	-0.2	-0.2	-0.2
	(0.2)	(-0.2)	(0.2)	(0.2)	(13.6)	(0.3)	(-0.1)	(-0.5)	(-0.8)	(2.1)	(-1.8)
Switzerland	-0.1	0.2	0.2	0.8	1.1	-0.2	0.1	-0.8	-0.6	0.0	-0.2
	(0.5)	(0.2)	(0.5)	(0.5)	(2.5)	(0.3)	(0.2)	(-0.4)	(-0.3)	(0.9)	(-1.1)
United States	0.0	0.1	0.4	1.0	3.3	0.0	0.1	-0.5	-0.3	-0.1	-0.1
	(0.2)	(0.0)	(0.2)	(0.2)	(5.8)	(0.2)	(0.1)	(-0.2)	(-0.2)	(0.6)	(-0.5)
Canada	-0.2	0.3	0.1	0.5	0.0	-0.3	0.2	-0.4	-0.4	0.0	-0.1
	(0.2)	(0.2)	(0.2)	(0.2)	(-2.4)	(0.0)	(0.2)	(0.0)	(0.2)	(-0.4)	(0.2)
Australia	-0.3	0.4	-0.3	-0.3	-3.2	-0.5	0.2	-0.4	-0.4	0.1	0.0
	(0.4)	(0.3)	(0.4)	(0.4)	(-9.6)	(0.1)	(0.4)	(-0.3)	(0.4)	(-0.6)	(-0.1)
New Zealand	0.0	0.0	0.3	0.9	0.5	0.0	0.0	-0.1	-0.1	0.0	0.0
	(0.0)	(0.0)	(-0.1)	(0.0)	(0.8)	(0.0)	(0.0)	(0.1)	(-0.1)	(0.1)	(0.1)
South Africa	-0.3	0.3	-0.2	-0.3	-5.7	-0.4	0.2	0.0	-0.2	0.1	0.1
	(0.0)	(0.3)	(0.0)	(0.0)	(-18.9)	(-0.2)	(0.2)	(0.2)	(0.5)	(-1.3)	(1.0)
Japan	0.0	0.1	0.3	0.8	0.2	0.0	0.0	-0.2	-0.1	0.0	0.0
	(0.0)	(0.0)	(0.0)	(-0.1)	(-0.6)	(-0.1)	(0.0)	(0.1)	(0.0)	(-0.1)	(0.2)
Korea	0.0	0.0	0.3	0.8	0.6	0.0	0.0	-0.2	-0.1	0.0	0.0
	(0.0)	(0.0)	(0.0)	(0.0)	(0.7)	(0.0)	(0.0)	(0.1)	(-0.1)	(0.1)	(0.0)
China	-0.1	0.1	-0.1	-0.2	2.3	-0.1	0.0	-0.2	-0.1	0.0	0.0
	(0.0)	(0.0)	(0.0)	(0.1)	(2.7)	(0.0)	(0.0)	(-0.1)	(0.0)	(0.1)	(-0.1)
India	-0.1	0.1	-0.2	-0.6	2.7	-0.1	0.0	-0.1	-0.1	0.0	0.0
	(0.1)	(0.0)	(0.1)	(0.1)	(3.0)	(0.1)	(0.1)	(-0.1)	(0.0)	(0.0)	(-0.2)

[a] Values for expenditures and labor market variables are percentage changes, and values for the current account are absolute changes after dividing the series by GNP. Averages over the first decade (years 2016-2025) are displayed first, and changes relative to the eventual balanced growth path are displayed below in parentheses.

[b] Results are reported only for business output and investments.

TABLE 3B. CHANGE IN EXPENDITURES, LABOR MARKET VARIABLES, AND THE CURRENT ACCOUNT, RELATIVE TO PRE-BREXIT LEVELS[a]

(UK and EU Tighten Restrictions on Each Other's FDI)

	Expenditures[b]					Labor Market		Current Account			
	Y	C	X_T	X_I	X_M	L	W	CA	NX	NFI_{prof}	NFI_{int}
United Kingdom	-1.9	-2.0	-8.1	-18.6	-64.5	0.1	-2.0	16.9	11.5	-0.5	5.9
	(-10.4)	(-2.1)	(-10.4)	(-10.4)	(-87.8)	(-6.4)	(-4.3)	(8.8)	(7.9)	(-24.0)	(24.9)
European Union	-1.0	-1.3	-3.4	-8.0	25.8	0.2	-1.2	-1.2	-0.1	-0.6	-0.5
	(-0.4)	(-1.4)	(-0.4)	(-0.4)	(43.1)	(0.7)	(-1.1)	(-1.6)	(-1.0)	(3.3)	(-3.9)
Norway	-0.1	0.9	1.4	4.1	8.9	-0.7	0.6	-2.6	-1.9	0.0	-0.7
	(1.1)	(0.8)	(1.1)	(1.1)	(3.0)	(0.2)	(0.9)	(-0.3)	(0.0)	(0.2)	(-0.5)
Switzerland	0.1	1.0	2.6	7.0	15.8	-0.6	0.8	-7.0	-5.4	0.8	-2.4
	(3.2)	(0.9)	(3.2)	(3.2)	(20.2)	(1.7)	(1.5)	(-2.7)	(-2.4)	(7.4)	(-7.7)
United States	0.0	0.6	1.3	3.6	8.3	-0.5	0.5	-1.9	-1.4	-0.1	-0.5
	(1.0)	(0.5)	(1.0)	(1.0)	(8.1)	(0.3)	(0.6)	(-0.5)	(-0.1)	(0.7)	(-1.0)
Canada	0.1	0.4	1.6	4.2	11.4	-0.2	0.4	-2.5	-1.6	-0.2	-0.8
	(0.9)	(0.3)	(0.9)	(0.9)	(13.6)	(0.4)	(0.5)	(-0.7)	(-0.6)	(1.9)	(-2.0)
Australia	0.5	-0.5	1.2	2.6	3.3	0.8	-0.2	0.5	0.5	0.0	0.0
	(-1.0)	(-0.6)	(-1.0)	(-1.0)	(1.3)	(-0.3)	(-0.7)	(0.8)	(-0.4)	(0.2)	(1.0)
New Zealand	0.3	0.1	1.3	3.5	3.7	0.2	0.1	-0.5	-0.3	0.0	-0.2
	(-0.1)	(0.0)	(-0.1)	(-0.1)	(4.2)	(-0.1)	(-0.1)	(0.2)	(-0.2)	(0.4)	(0.0)
South Africa	0.3	-0.5	0.4	0.5	22.7	0.6	-0.3	-1.2	-0.3	-0.4	-0.5
	(0.3)	(-0.6)	(0.3)	(0.3)	(38.6)	(0.6)	(-0.3)	(-1.0)	(-0.9)	(2.7)	(-2.8)
Japan	0.3	0.2	1.5	3.8	2.4	0.1	0.2	-0.6	-0.4	0.0	-0.2
	(0.0)	(0.1)	(0.0)	(0.0)	(1.2)	(-0.1)	(0.0)	(0.2)	(-0.2)	(0.1)	(0.2)
Korea	0.2	0.2	1.4	3.7	1.8	0.0	0.2	-0.5	-0.4	0.0	-0.2
	(-0.1)	(0.1)	(-0.1)	(-0.1)	(-0.4)	(-0.1)	(0.0)	(0.3)	(-0.1)	(-0.1)	(0.5)
China	0.0	0.1	0.1	-0.5	10.5	-0.1	0.1	-0.3	-0.2	0.0	-0.1
	(0.3)	(0.0)	(0.3)	(0.3)	(14.2)	(0.2)	(0.1)	(0.0)	(0.0)	(0.0)	(0.0)
India	-0.1	-0.3	-0.5	-1.8	8.0	0.1	-0.2	0.2	0.3	0.0	0.0
	(-0.5)	(-0.4)	(-0.5)	(-0.5)	(10.7)	(-0.1)	(-0.4)	(0.2)	(-0.2)	(0.2)	(0.2)

[a] Values for expenditures and labor market variables are percentage changes, and values for the current account are absolute changes after dividing the series by GNP. Averages over the first decade (years 2016-2025) are displayed first, and changes relative to the eventual balanced growth path are displayed below in parentheses.

[b] Results are reported only for business output and investments.

Table 4
Welfare Gains for Alternative Policy Simulations[a]

Economy	Less open to FDI: UK Only	Less open to FDI: UK & EU	Sequentially, UK is more open to:[b] US	Japan	China	All others
United Kingdom	-3.61	0.25	2.30	3.40	3.78	4.84
European Union	0.23	-1.59	-1.72	-1.78	-1.79	-1.74
Norway	-0.36	0.69	0.55	0.55	0.55	0.89
Switzerland	0.06	0.23	0.30	0.31	0.30	-0.03
United States	-0.04	0.39	0.55	0.50	0.47	0.45
Canada	0.23	0.12	0.17	0.17	0.16	0.41
Australia	0.38	-0.61	-0.58	-0.47	-0.39	-0.15
New Zealand	-0.02	-0.10	-0.21	-0.21	-0.22	0.43
South Africa	0.38	-0.86	-0.85	-0.84	-0.84	-0.44
Japan	0.02	0.01	-0.03	0.48	0.45	0.40
Korea	-0.01	0.05	0.03	0.04	0.04	0.44
China	0.01	-0.05	0.01	0.03	0.08	-0.12
India	0.03	-0.37	-0.28	-0.24	-0.28	-0.52

[a] The gains are percentage increases in the paths of consumption necessary for households to be indifferent between the new policy and no change. A positive (negative) value indicates a gain (loss) with Brexit.

[b] All policy experiments assume that the United Kingdom and the European Union are less open to each other's FDI as in column 2.

Table 5
New Balanced Growth Path in UK for Alternative Policy Simulations[a]

Statistic	Less open to FDI: UK Only	Less open to FDI: UK & EU	Sequentially, UK is more open to:[b] US	Japan	China	All others
Consumption	-2.63	-2.13	0.07	1.28	1.70	2.86
Business output	0.73	-10.39	-7.23	-5.39	-4.78	-2.70
Business investment	20.50	-45.12	-42.60	-41.02	-40.46	-38.70
Labor input	2.54	-6.40	-5.52	-4.97	-4.81	-4.07
Wage rate	-1.77	-4.26	-1.81	-0.44	0.03	1.42
Current account	-3.99	8.80	8.81	7.53	7.20	5.06
Net exports	-5.90	7.92	10.30	10.70	10.80	9.29
Net foreign profits	15.84	-24.02	-29.21	-29.10	-29.06	-24.12
Net foreign interest	-13.91	24.90	27.72	25.93	25.46	19.89

[a] See footnotes in Tables 3 and 4.

Figure 1. Degree of Openness, UK to EU and EU to UK

(1=Fully open, 0=Fully closed)

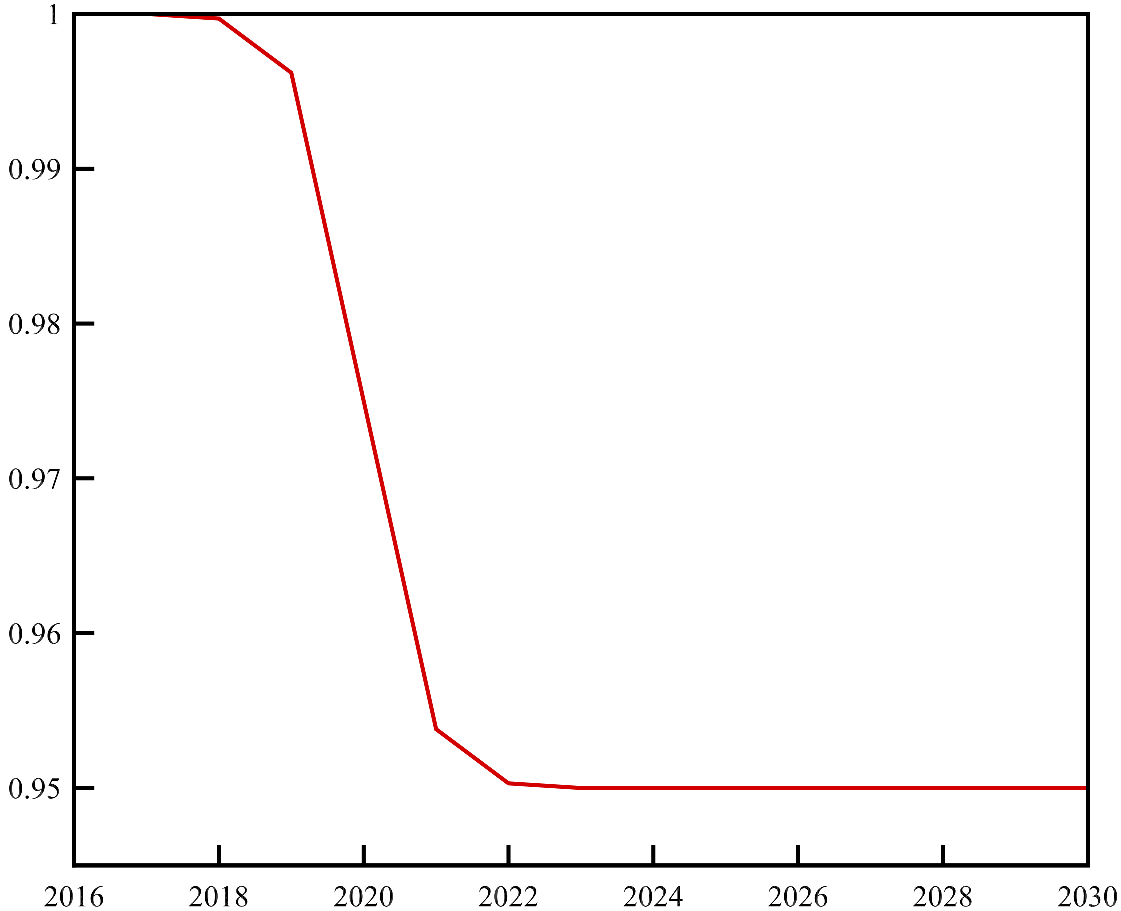

Figure 2. FDI Flows Between UK and EU

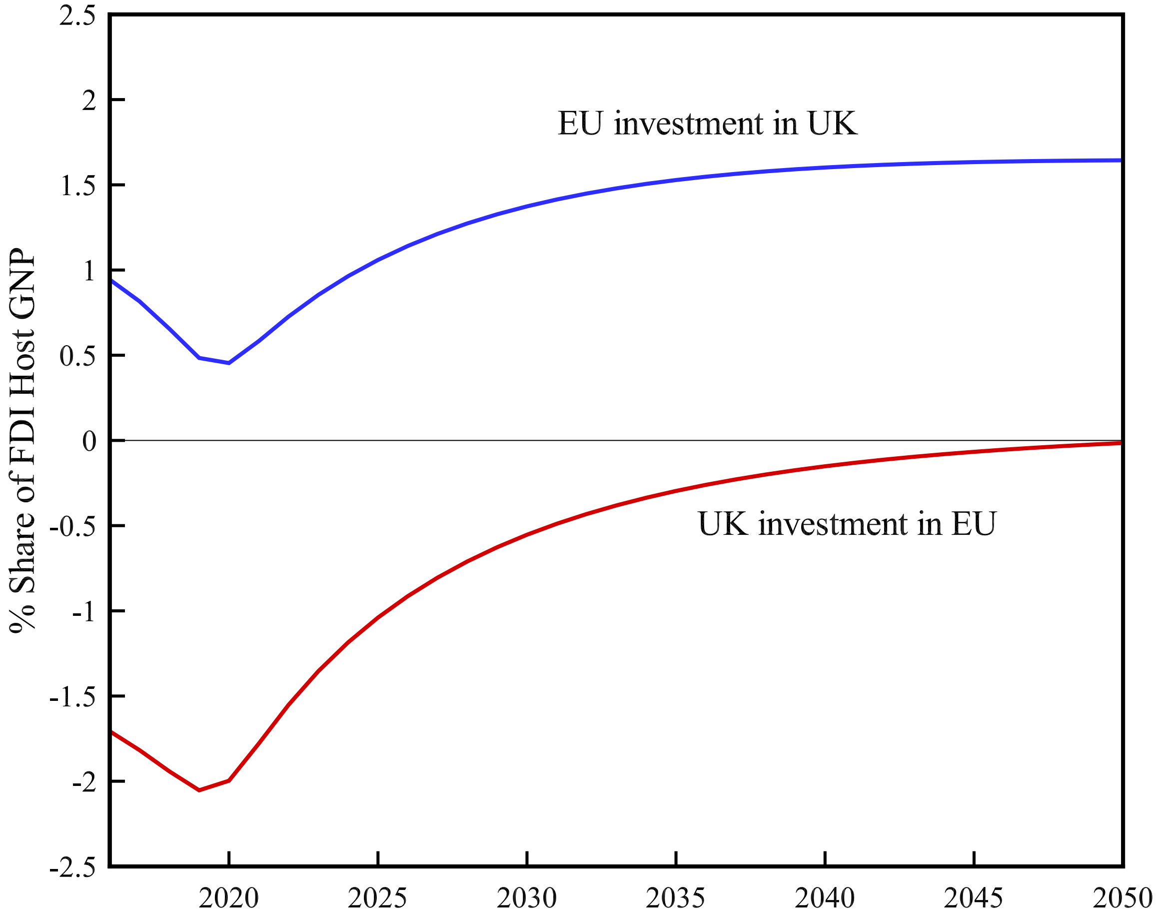

Figure 3. Business Outputs of UK, EU, and all Other Economies