

Foreign Direct Investment Flows and Economic Growth: An Autoregressive Distributed Lag Analysis (ARDL) for Chile, 1960-2020

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Abstract

This paper utilizes the recent ARDL modelling technique to test whether foreign capital complements or substitutes for private capital and economic output (labor productivity) in the Chilean economy for the 1960-2020 period. That is, it evaluates whether the so-called “complementarity hypothesis” is refuted in the Chilean case. The discussion is motivated by presenting a modified production function which treats the foreign capital stock as an additional input and provides an economic rationale for its inclusion. The paper also addresses the issue of whether inward foreign direct investment diverts resources away from the financing of private investment spending via the repatriation of profits and dividends back to parent companies, often residing in developed countries. Several important findings were revealed. First, the Bounds test indicated that the included $I(0)$ and $I(1)$ variables in both the production (labor) productivity functions are cointegrated. Thus, there is a long-term and stable relationship between the variables over the period under review. The error-correction terms for both functions indicated that deviations away from the long-term output (labor) productivity relationship are corrected in subsequent periods. Second, the results suggest that both private and foreign capital have a positive (long-term) effect on both economic output and labor productivity, controlling for both quantitative and qualitative variables included in the empirical model, such as the terms of trade and dummy variables. Third, the model diagnostics for both the output and labor productivity equations indicated that the estimates do not exhibit serial correlation and heteroscedasticity, and that they are structurally stable over the period under review. Fourth, the estimates for the output and labor productivity equations which include the “net” foreign capital stock (viz., adjusted for the repatriation of profits), suggest that foreign capital continues to have a positive, albeit smaller, effect on economic output and labor productivity. The latter finding suggests that, although the impact of foreign capital in terms of financing may be diminished, it still may be providing other

benefits or externalities in the form of the transfer of better technologies and managerial expertise. Fifth, Block-Granger “causality” tests find strong support for precedence from foreign and private domestic capital to output (labor productivity), but also for “reverse causality or precedence” from output (labor) productivity to foreign capital and from foreign capital to private domestic capital. This finding provides further support for the complementarity hypothesis.

Keywords: Autoregressive Distributed Lag (ARDL) model, Block-Granger causality test, Bounds test, Johansen cointegration methodology, Complementarity hypothesis, Error correction term (ECT), Foreign Direct Investment (FDI), Gross and net foreign capital stock, Hannan-Quinn criterion (HQ), Labor productivity, Ramsey Reset test, Unit root tests

JEL: O10; O40; and O57

1. Introduction

Economic theory maintains that FDI inflows to emerging nations increase their stock of capital which, in turn, raises the host country’s labor productivity and incomes, a process that eventually translates into higher levels of output, employment creation, and potential tax revenues (Note 1). In addition to the direct effects of FDI, Cicea & Marinescu (2020), De Mello (1997) Huang (2004), Ram and Zhang (2002), Kehal (2005), and Kumar (2007), observe that indirect positive spillover effects on overall efficiency may arise from the enhanced competition generated by foreign firms, the transfer of needed technology and managerial knowhow to local firms, and trade-induced learning-by-doing effects as local firms attempt to overcome competition in the global market.

The extant literature on the hypothesis of FDI-Led Growth (FLG) by no means speaks with one voice but, in general, finds in cross-country studies that the “nexus between FDI and the host country’s growth seems generally positive” when host countries adopt a more liberalized trading regime (see Agosin, 1999; Chari et al., 2021; Cicea & Marinescu, 2020; De Mello, 1997; Edwards, 1999; Goldfajn et al., 2021; Huang, 2004; Kehal, 2004; Kumar, 2007; Ram & Zhang, 2002; Zhang, 2001). Recent country studies also suggest that export-oriented FDI, such as that undertaken by TNCs in Chile, Mexico and China, may promote exports (and economic growth) by establishing assembling plants and helping host firms access international markets for exports (see De Mello 1997; Osei & Kim, 2020; Ramirez, 2026; Zhang, 2001). Other country studies, notably by Chakraborty and Basu (2002) for India and De Mello (1997) for Brazil, have found no support for the FLG hypothesis; in fact, their empirical work suggests that the line of causality runs from GDP growth to FDI—a finding consistent with the market-seeking FDI hypothesis of Dunning (1988) and Mortimore (2003), viz., that FDI is attracted to growing internal markets for services such as telecommunications, gas and electricity, retail commerce, and financial services.

FDI flows may also have a negative effect on the growth prospects of a country if they give rise to substantial reverse flows in the form of remittances of profits and dividends and/or if the TNCs obtain substantial tax or other concessions from the host country. Ramirez (2026), for example, documents that “in the Chilean case, the repatriation of net profits on FDI rose

from \$2.1 billion in 2002 to \$10.3 billion in 2005 and a staggering \$19.1 billion in 2007. Thereafter, it fell to \$5.1 billion and \$5.7 billion in 2016 and 2017, respectively, before rising to \$6.8 billion in 2018 and leveling off at over \$8.5 billion during the 2019-2021 interval” (p.64). In relative terms, Ramirez goes on to add that “Chile’s repatriation of net profits on FDI” averaged close to 60 percent of the country’s gross inflows of FDI over the 2002-2020 period (p. 65). These negative effects would be further compounded if the expected positive spillover effects from the transfer of technology are minimized or eliminated altogether because the technology transferred is inappropriate for the host country’s factor proportions (e.g., too capital intensive); or, when this is not the case, as a result of overly restrictive intellectual property rights and/or prohibitive royalty payments and leasing fees charged by the TNCs for the use of these “intangibles” (see Agosin, 1999; Chang, 2008; Green, 2005, 2013; Cypher and Dietz, 2020; Ram & Zhang, 2002; Rodrik, 2018; and Kehal, 2004).

2. Conceptual Model

Following the lead of Agosin (1999), De Mello (1997) and Ram and Zhang (2002), it is possible to analyze the potential impact of inward FDI on private investment and growth in Chile by appealing to the modified neoclassical production function given in equation (1) below.

$$Y = AF [L, K_p, K_f, \alpha_i] \quad (1)$$

$$F_1, F_2 > 0; F_{11}, F_{22} < 0; F_{12} > 0.$$

$$F_3 > 0; \quad F_{23} \geq 0; F_{13} \geq 0.$$

where: Y is the level of real output; L denotes labor; K_p is the stock real private capital; K_f refers to the stock of real FDI capital; A captures the efficiency of production; and α_i represents other relevant variables that researchers have incorporated into the modified production function to explain the level of GDP such as real exports of goods and services, the terms of trade, and real government consumption expenditures (see Agosin, 1999; De Mello, Jr., 1997; Ram 1986; and Ramirez, 2026).

When the stock of FDI is entered as a separate input in the production function, a *ceteris paribus* increase in inward FDI gives rise to three conceptually distinct effects. First, if the stock of FDI capital is productive and complements the private capital stock by augmenting domestic savings and investment, a *ceteris paribus* increase in the stock of FDI capital will increase output directly in the same way that an increase in any other factor of production raises output ($F_3 > 0$). Secondly, if it generates (unmeasured) positive spillover effects via the transfer of advanced technology and managerial skills to local firms, then it will indirectly increase private investment and output by further raising the marginal productivity of domestic capital ($F_{23} > 0$) relative to the real interest rate. Third, it will increase output via its positive impact on the marginal productivity of labor, i.e., by increasing the amounts of both private (domestic) and foreign capital per worker (F_{12} and $F_{13} > 0$).

Of course, as discussed above, an increase in inward FDI that leads to substantial reverse flows of profits and dividends, the transfer of inappropriate technology, and/or eliminates

domestic enterprises through intense competition (as a result of TNCs' monopoly over state-of-the-art technology and managerial knowhow) could lead to a situation where foreign and private capital are direct substitutes ($F_{23} < 0$). Under these conditions there would still be a positive direct effect, but a negative indirect effect that could more than offset it, i.e., when the following condition arises: $[(F_3) + (F_{13}) + (F_{23}) - (F_{12})] < 0$. Finally, in cases where foreign and private capital are independent ($F_{23} = 0$), perhaps in the case of a foreign copper mining enclave with little forward and backward linkages to the rest of the economy, a *ceteris paribus* increase in foreign direct investment will generate a direct positive effect on output.

Chile has a sufficiently long (and official) annual time series data (extending back to the decade of the sixties) for both private investment and FDI flows so that, using a perpetual inventory method, capital stock data can be generated for both types of capital. In addition, there is annual data on profit remittances going back to the decade of the fifties, so we can compute a "net" capital stock variable for FDI, viz., a capital variable that considers the outflow of profits from the gross inflows of FDI. This permits us to empirically assess the hypothesis put forth by critics on the left which contends that FDI inflows do not contribute to capital formation and divert resources away from the financing of private investment spending, thereby slowing down economic growth. We are also fortunate to have official data on the economically active population (EAP) for the period under review—as opposed to the common but problematic practice of using the total population variable as a proxy (e.g., see Ram and Zhang, 2002). (Note 2).

3. Empirical Model

For estimation purposes, this study estimates an autoregressive distributed lag (ARDL) model (see Pesaran and Shin, 1998) for the modified production function given above. This is a relatively recent econometric technique that is used to estimate the short and long-term relationship between variables even when some of the regressors are integrated into different orders, if none of them are integrated of order two (which is rarely the case with macro data). It is also capable, via the bounds test, of determining whether the variables in question are cointegrated or have a long-term relationship over time (see Pesaran, Shin, and Smith, 2001; Narayan, 2004; 2005). If the test determines that the variables in question are cointegrated, the model can be transformed into an error correction model that separates the short-term dynamics of the model from its long-run equilibrium (see Engle and Granger, 1987). The endogeneity issue is addressed in the model by including optimal lags for both the dependent variable (controlling for the momentum of the series) and the included regressors, thus ensuring that there are no contemporaneous feedback loops (see Nkoro and Uko, 2016). Finally, Monte-Carlo simulations undertaken by Pesaran and Shin (2000) show that the small-sample properties of ARDL models, viz., efficiency and robustness, are superior to those of the Johansen methodology (see Haug, 2002; and Nkoro and Uko, 2016). However, a drawback of this methodology is that it cannot determine, as the Johansen methodology can, the *number* of unique cointegrating relationships in the cointegrating space. In addition, it does not allow the investigator to impose restrictions on the cointegrating vector and/or the short-run adjustment coefficients associated with the variables in question (see Asteriou, 2021; Kirchgassner et al., 2013; Johansen, 1988; and Patterson, 2000).

In this study, we first estimate a modified production for Chile during the 1960-2020 period using the ARDL technique and then proceed to estimate a labor productivity function after determining whether the underlying Cobb-Douglas production function exhibits constant returns to scale. The data are in annual terms which translates into sixty-one potential observations over the 1960-2020 period. To conserve space, the basic ARDL model for the labor productivity function is given below.

$$\Delta y_t = \alpha + \beta_1 \Delta y_{t-1} + \beta_2 \Delta k_{pt-i} + \beta_3 \Delta k_{fgt-i} [\Delta k_{fnt-i}] + \delta_1 k_{pt-i} + \delta_2 k_{fgt-i} [k_{fnt-i}] + \delta_3 EC_{t-1} + \beta_4 TOT + \beta_5 D_1 + \beta_6 D_2 + \varepsilon \quad (2)$$

where lower case letters denote natural logarithms of the relevant variables in per worker (EAP) terms, and Δ is the difference operator; y denotes the natural log of output per worker (1978 pesos); Δy_t is the labor productivity growth rate and it is defined as, $(\Delta \ln Y - \Delta \ln L)$; k_p denotes the natural log of the stock of private capital per worker (1978 pesos); k_{fg} and k_{fn} denote, respectively, the natural logs of gross and net stocks of FDI capital per worker (1978 pesos); Δk_{pt} is the growth rate in the private capital stock per worker and is defined as $(\Delta \ln K_p - \Delta \ln L)$, and likewise for the other variables in factor-intensive form; EC_{t-1} is the error correction term; TOT refers to the terms of trade and, in an export-oriented and open economy such as Chile, is a highly important variable; D_1 is a dummy variable that equals 1 for the economic and political crises years and D_2 captures the export-led expansion of 1991-93 and 2011-2013. The dummy variables and the TOT variable enter as static (fixed) regressors into the distributed lag model. Finally, ε is a normally distributed error term.

The economic rationale for the inclusion of the variables in equation (2) and the interpretation of their respective coefficients is given below. Following the lead of Albala-Bertrand & Mamatzakis., 2001, Aschauer (1989), Blomstrom and Wolff (1994) and Mamatzakis, 1999, the dependent variable in this study was estimated as a labor productivity growth variable (Note 3). β_1 to β_3 represent short-run coefficients and they represent the respective percentage change in the growth rate of the variables in question (Note 4). β_2 is expected to be positive because the more private capital workers have to work with, the more productive they are, *ceteris paribus*. β_3 , on the other hand, can be positive or negative depending on whether the accretions of gross (net) foreign capital stock per worker (the flow of FDI per worker) complements or substitutes for private capital formation. The long-run coefficients for the private capital stock per worker and foreign capital stock per worker are represented, respectively, by δ_1 and δ_2 . δ_1 is expected to be positive, while δ_2 can be positive or negative for the reasons alluded above. δ_3 , the coefficient for the error-correction term, is expected to be negative and significant, meaning that shock-induced deviations from the long-term labor productivity (output) relationship are corrected in subsequent periods (years); β_4 is expected to be positive and significant, while β_5 and β_6 are expected, respectively, to have a negative and positive significant effect on the growth rate in labor productivity, *ceteris paribus*. Before presenting the results, it should be noted that the optimal lag-selection for the ARDL model was determined via the Hannan-Quinn criterion (HQ) because it penalizes model complexity less severely than the Bayesian Information criterion (BIC), but more severely than the Akaike Information criterion (AIC); it is basically a “middle-ground” ARDL model selection method that avoids the over-fitting tendencies of AIC and the under-fitting tendencies of BIC

(see Asteriou, 2021; and Kirchgassner et al., 2013).

4. Empirical Results

Using the Augmented-Dickey Fuller (ADF) and Phillips-Perron unit root tests with a constant, the results indicate (see Appendix) that the $\ln Y$, $\ln K_p$ and $\ln K_f$ variables are stationary in their first differences, while the $\ln L$ and the TOT variables are stationary in levels; that is, we have a mix of $I(0)$ and $I(1)$ variables (Note 5). The presence of variables of different orders of integration necessitates the use of the ARDL bounds test for cointegration as it remains consistent regardless of the underlying order of integration, provided no variable is $I(2)$. Tables 1A and 1B below show, respectively, the results of the bounds test for the production and labor productivity functions, and they clearly indicate that the F-statistics for both functions are above the upper critical bound for a sample size of 60 observations, thus rejecting the null hypothesis of no cointegration and confirming the presence of a long-term relationship between the variables in question.

Table 1A. Bounds Test for Production Function: $\ln Y$, $\ln L$, $\ln K_p$ and $\ln K_f$

Null hypothesis: No levels relationship	
Deterministics: Unrest. constant (Case 3)	
Sample size: 57	
Test Statistic	Value
F-statistic	6.146292
t-statistic	-2.373999

	Sample Size	10%	5%	1%
		F-Statistic		
I(0)	55	2.843	3.408	4.828
I(1)	55	3.920	4.623	6.195
I(0)	60	2.838	3.415	4.748
I(1)	60	3.923	4.615	6.188
I(0)	Asymptotic	2.720	3.230	4.290
I(1)	Asymptotic	3.770	4.350	5.610
		t-Statistic		
I(0)	Asymptotic	-2.570	-2.860	-3.430
I(1)	Asymptotic	-3.460	-3.780	-4.370
* I(0) and I(1) are respectively the stationary and non-stationary bounds.				

Table 1B. Bounds Test for Labor Productivity Function:

Null hypothesis: No levels relationship	
Deterministics: Unrest. constant (Case 3)	
Sample size: 57	
Test Statistic	Value
F-statistic	10.35539
t-statistic	-0.820464

	Sample Size	10%	5%	1%
		F-Statistic		
I(0)	55	3.280	3.987	5.707
I(1)	55	4.273	5.090	6.977
I(0)	60	3.270	4.000	5.697
I(1)	60	4.260	5.057	6.987
I(0)	Asymptotic	3.170	3.790	5.150
I(1)	Asymptotic	4.140	4.850	6.360
		t-Statistic		
I(0)	Asymptotic	-2.570	-2.860	-3.430
I(1)	Asymptotic	-3.210	-3.530	-4.100

* I(0) and I(1) are respectively the stationary and non-stationary bounds.

In view of the fact cointegration exists between the variables in question for both functions, corresponding error-correction models can be generated for each of them. The results are displayed in Table 2A below. The first part of the table shows the short-run results, while the second part depicts the long-run coefficients. Turning first to the short-run results for the output equation, the estimates suggest that the contemporaneous percentage changes in the labor force and the private capital stock (private investment) are positive and economically significant, while the contemporaneous percentage change in the foreign capital stock is positive but statistically insignificant at the five percent level (see p-values). The error correction term is negative and economically (statistically) significant, suggesting that a deviation from long-run output growth during this year is corrected by 25.4 percent in the next year. Turning to the long-run estimates, they suggest that both the contemporaneous and lagged private capital stock and the foreign capital stock have a positive and significant effect on output growth, while in the case of the labor force, the contemporaneous effect is positive as expected, but not the lagged effect which is, unexpectedly negative, and statistically significant. Static regressors have their expected signs, with the TOT variable having a positive and significant effect on the percentage change in output, while the dummy variables have their expected signs, negative for D1 and positive for D2, and are both highly significant.

The model diagnostics, as reported by Durbin Watson, LM, Harvey, Ramsey Reset, and Jarque-Bera (normality) tests suggest that the output equation does not exhibit serial correlation, heteroscedasticity, or structural instability over the period in question (see p-values in parenthesis). Further visual proof is given in Figures 1A and 1B below which show, respectively, that both the cumulative sum (CUSUM) of residuals and (CUSM) of squared residuals are within the 5 percent critical bounds without crossing upper or lower bounds, implying that the model is structurally stable over the period in question.

Table 2B report the short-run estimates for the labor productivity function, and they indicate that the growth rate in private capital worker has a positive and statistically significant effect on labor productivity growth, while not in the case of the growth rate in foreign capital per worker where the sign is positive but statistically insignificant. Like the output equation, the error-correction term is negative and highly significant, suggesting that deviations away from the long-run labor productivity relationship are corrected over time. The long-run estimates

reveal that lagged percentage changes in foreign capital per worker have a positive and significant effect on the growth rate in labor productivity, while in the case of the private capital per worker variable, the effect is positive and significant in both the contemporaneous and lagged versions. Again, like the output equation, the static regressors have their expected signs, with the TOT variable having a positive and significant effect on the percentage change in labor productivity, and, in the case of the dummy variables, the effects are, respectively, negative for D1 and positive for D2.

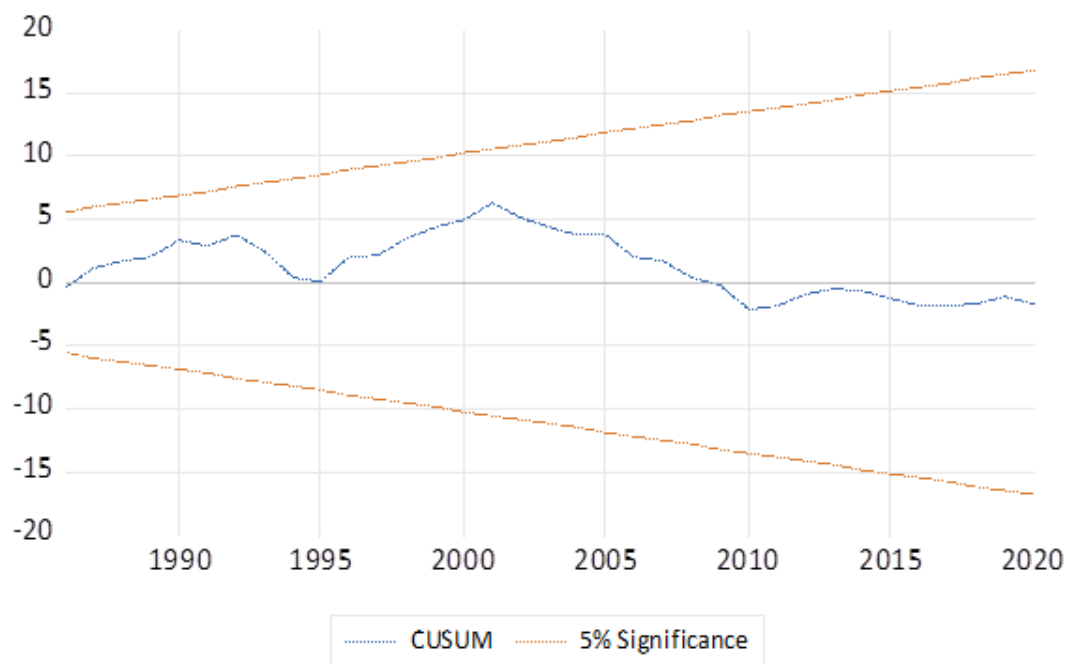


Figure 1A.

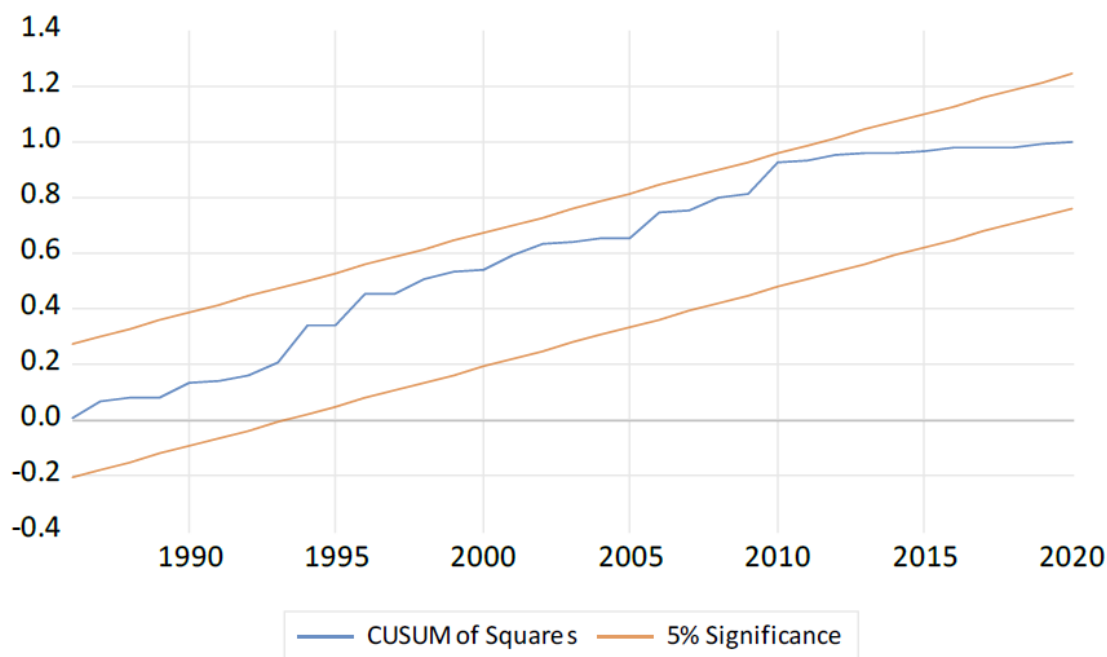


Figure 1B.

Table 2A. ADRL estimates for the Production Function. Dependent variable: $D(\ln Y)$
Short-run coefficients with p-values in parenthesis

$D(\ln Y(-1))$	0.030 (0.683)
$D(\ln L)$	0.505 (0.002) ***
$D(\ln K_p)$	0.620 (0.002) ***
$D(\ln K_{fg})$	0.035 (0.385)
$ECT(-1)$	-0.254 (0.001) ***
AdjR2	0.77
F-Statistic	13.44 (0.000) ***
Long-run coefficients with p-values in parenthesis. Dependent Variable: $\ln Y$	
$\ln Y(-1)$	0.787 (0.000) ***
$\ln L$	0.505 (0.002) ***
$\ln L(-1)$	-0.677 (0.000) ***
$\ln K_p$	0.619 (0.002) ***
$\ln K_p(-2)$	0.420 (0.000) ***
$\ln K_{fg}$	0.061 (0.000) ***
TOT	0.074 (0.045) **
D1	-0.020 (0.028) **
D2	0.023 (0.000) ***
AdjR2	0.98
F-Statistic	14.145 (0.000) ***
D.W. Statistic	1.8
LM Test	0.542 (0.466)
Harvey Test	1.322 (0.238)
Ramsey Reset Test	0.003 (0.997)
Jarque-Bera Test	4.385 (0.111)

Note: ***significant at 1%, **significant at 5%, *significant at 10%.

Table 2B. ADRL estimates for the Labor Productivity Function. Dependent variable: $D(y)$
Short-run coefficients with p-values in parenthesis

$D(y(-1))$	0.209 (0.000) ***
$D(k_p)$	0.372 (0.009) ***
$D(k_{fg}(-1))$	0.072 (0.201)
$ECT(-1)$	-0.10 (0.000) ***
AdjR2	0.729
F-Statistic	8.49 (0.000) ***
Long-run coefficients with p-values in parenthesis. Dependent Variable: y	
$y(-1)$	0.951 (0.000) ***
k_p	0.373 (0.000) ***
$k_p(-2)$	0.532 (0.078) *
k_{fg}	0.047 (0.000) ***
TOT	0.077 (0.026) **
D1	-0.025 (0.045) **
D2	0.031 (0.007) ***
AdjR2	0.989
F-Statistic	48.302 (0.000) ***
D.W. Statistic	1.95
LM-Test	0.542 (0.466)
Harvey Test	1.322 (0.238)
Ramsey Reset Test	0.003 (0.997)
Jarque-Bera Test	2.453 (0.293)

Note: ***significant at 1%, **significant at 5%, and *significant at 10%.

The model diagnostics for the labor productivity function are like those of the output equation, and they suggest that the labor productivity growth rate function does not exhibit serial correlation, heteroscedasticity, and/or structural instability over the period in question. Further visual proof is given in Figure 2A and 2B below which shows, respectively, that both the cumulative sum (CUSUM) of residuals and (CUSUM) of squared residuals are within the 5 percent critical bounds without crossing upper or lower bounds.

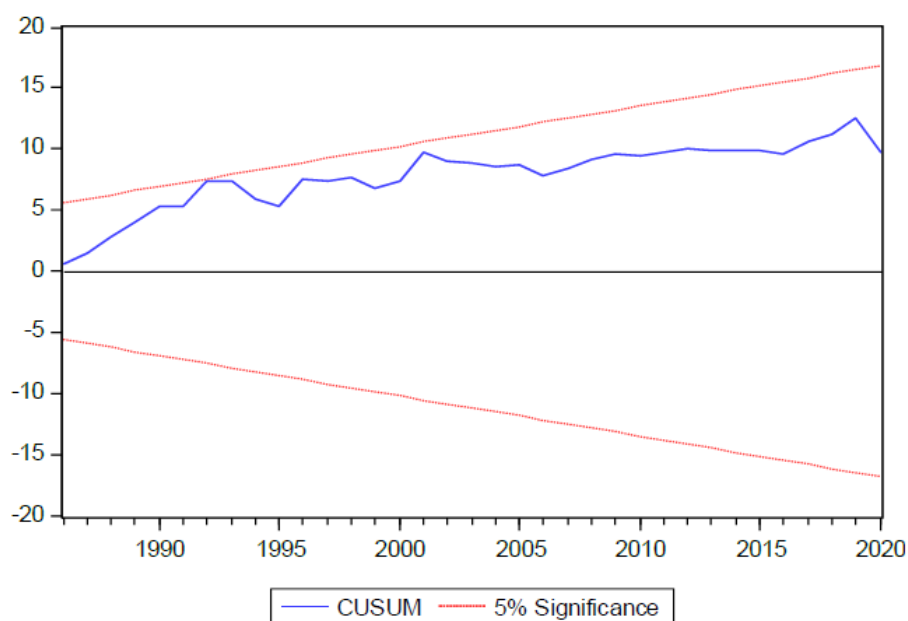


Figure 2A.

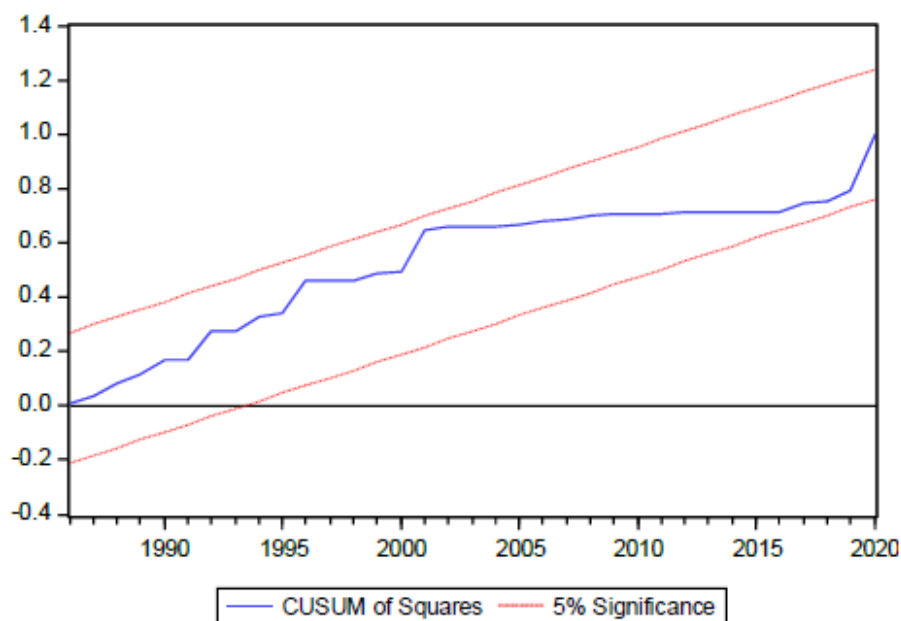


Figure 2B.

In general, the reported estimates for the production and labor productivity functions suggest that both foreign capital and private capital have a positive and long-run impact on the growth rate in output (labor productivity) in the Chilean case for the period under review. Thus, going back to equation 1, the evidence thus far supports the complementary hypothesis between foreign capital and private domestic capital, *ceteris paribus*.

In order to test the hypothesis, put forth by critics on the left that FDI inflows do not contribute to the financing of private capital formation and economic growth because they divert resources (repatriated profits and dividends) away from the financing of private investment spending, this study generated a net stock of FDI per worker that takes into account the outflow of profits from the gross inflows of FDI. The reported ARDL results for the output and labor productivity functions when including this “net” or adjusted foreign capital stock variable are given, respectively, in Tables 3A and 3B below.

Table 3A. ADRL estimates for Production Function. Dependent variable: D(lnY) Short-run coefficients with p-values in parenthesis

D(lnY (-1))	-0.033 (0.651)
D(lnL)	0.617 (0.019) **
D(lnK _p)	0.645 (0.001) ***
D(lnK _{fn})	0.020 (0.487)
ECT (-1)	-0.168 (0.001) ***
AdjR2	0.737
F-Statistic	11.49 (0.000) ***
Long-run coefficients with p-values in parenthesis. Dependent Variable: lnY	
lnY(-1)	0.838 (0.000) ***
lnL	0.580 (0.003) ***
lnL (-1)	-0.792 (0.000) ***
lnK _p	0.651 (0.001) ***
lnK _p (-2)	0.403 (0.001) ***
lnK _{fn}	0.033 (0.016) **
TOT	0.122 (0.010) ***
D1	-0.023 (0.07) *
D2	0.036 (0.000) ***
AdjR2	0.990
F-Statistic	210.61 (0.000) ***
D.W. Statistic	2.01
LM Test	1.146 (0.327)
Harvey Test	1.044 (0.419)
Ramsey Reset Test	0.258 (0.614)
Jarque-Bera Test	4.69 (0.095)*

Note: ***significant at 1%, **significant at 5%, and *significant at 10%.

Table 3B. ADRL estimates for the Labor Productivity Function. Dependent variable: $D(y)$
Short-run coefficients with p-values in parenthesis

$D(y(-1))$	0.244 (0.000) ***
$D(k_p)$	0.372 (0.009) ***
$D(k_{fn}(-1))$	0.072 (0.201)
ECT (-1)	-0.07 (0.051) **
AdjR2	0.692
F-Statistic	8.96 (0.000) ***
Long-run coefficients with p-values in parenthesis. Dependent Variable: y	
$y(-1)$	0.958 (0.000) ***
k_p	0.413 (0.000) ***
$k_p(-2)$	0.522 (0.091) *
k_{fn}	0.020 (0.025) **
TOT	0.097 (0.004) ***
D1	-0.030 (0.039) **
D2	0.031 (0.006) ***
AdjR2	0.986
F-Statistic	48.302 (0.000) ***
D.W. Statistic	1.79
LM Test	0.402 (0.672)
Harvey Test	1.462 (0.191)
Ramsey Reset Test	1.23 (0.273)
Jarque-Bera Test	3.75 (0.153)

Note: ***significant at 1%, **significant at 5%, and *significant at 10%.

The short-run estimates for the output equation in Table 3A show that the percentage change in the net foreign capital variable continues to have a positive but insignificant effect, while the percentage change in the labor force and the percentage change in private capital have a positive and highly significant effect on output growth. The error-correction term remains negative and highly significant, but its magnitude is reduced, suggesting that deviations during the current year from the long-term output relationship are corrected by 16.8 percent the following year, *ceteris paribus*. Static regressors have their anticipated signs and remain highly significant in terms of their impact on output growth. The long-term estimates suggest that the labor force and the lagged private capital stock continue to have a positive and significant effect on economic output, while the impact of the net foreign capital stock, although positive, is reduced in magnitude and statistical significance (see p-values). Again, the performance statistics suggest that the regression does not suffer from serial correlation, heteroscedasticity, and structural instability.

Turning to the labor productivity short-term results reported in Table 3B above, it can be readily seen that the percentage change in the net or adjusted foreign capital per worker variable continues to have a positive and insignificant effect on the growth rate in labor productivity, while the percentage change in the private capital stock per worker is positive and highly significant. The error-correction term remains negative and significant, suggesting that movements away from the long-term labor productivity relationship are corrected in subsequent periods, while the model diagnostics are comparable to the previous models. Like the long-term results for the output equation, those for the labor productivity relationship

suggest that the private capital stock per worker has a positive and significant effect on labor productivity, and that the foreign capital per worker also has a positive and significant effect, but its economic impact is reduced. Finally, the static regressors have their anticipated signs and significance, while the performance statistics are comparable to those reported in previous models. Again, the results for the adjusted foreign capital stock per worker variable suggest that its role in financing private investment spending may be reduced, but that it continues to have a positive effect on labor productivity overall, *ceteris paribus*. Again, the performance statistics for the labor productivity function suggest that the regression does not suffer from serial correlation, heteroscedasticity, and structural instability, and its CUSUM graphs are like those of the production function, viz., the residuals stay within the 5 percent critical bounds without crossing upper or lower bounds (available upon request). Thus, based on the results for Chile during the period in question, there is insufficient evidence to refute the complementary hypothesis.

Before concluding, this study also addressed the issue of precedence or causality by undertaking a Block-Granger causality test for the variables included in the modified production (labor) productivity function. Tables 4A and 4B show, respectively, the results for the production and labor productivity functions. Turning the reported results in Table 4A for the growth rate in output, $D(\ln Y)$, it is revealed that there is precedence or ‘causality’ from $D(\ln K_p)$ and $D(\ln K_f)$ to $D(\ln Y)$, as well as from $D(\ln Y)$ and $D(\ln L)$ to $D(\ln K_f)$ [see p-values]. There is also precedence from $D(\ln K_f)$ to $D(\ln K_p)$ [see p-value: 0.001], suggesting that foreign capital is complementary to private capital, but not the other way around (Note 6). Finally, as mentioned, there is precedence from $D(\ln L)$ to $D(\ln K_f)$ but not the reverse.

Table 4A. Block Granger Causality test for Production Function, 1960-2020

Dependent variable: $D(\ln Y)$			
Excluded	Chi-sq	df	Prob.
$D(\ln L)$	5.386499	4	0.2499
$D(\ln K_p)$	13.64932	4	0.0085
$D(\ln K_f)$	10.97993	4	0.0268
All	19.35048	12	0.0804
Dependent variable: $D(\ln L)$			
Excluded	Chi-sq	df	Prob.
$D(\ln Y)$	4.877019	4	0.3002
$D(\ln K_p)$	3.884896	4	0.4218
$D(\ln K_f)$	3.729968	4	0.4438
All	8.730486	12	0.7258
Dependent variable: $D(\ln K_p)$			
Excluded	Chi-sq	df	Prob.
$D(\ln Y)$	2.179077	4	0.7029
$D(\ln L)$	4.717486	4	0.3175
$D(\ln K_f)$	18.44377	4	0.0010
All	21.13961	12	0.0484
Dependent variable: $D(\ln K_f)$			
Excluded	Chi-sq	df	Prob.
$D(\ln Y)$	9.331560	4	0.0533
$D(\ln L)$	11.48325	4	0.0216
$D(\ln K_p)$	6.372694	4	0.1730
All	31.13280	12	0.0019

Turning to the estimates in Table 4B below for the growth rate in labor productivity, $D(y)$, it can be readily seen that they parallel those of the production function. There is straightforward evidence of precedence from $D(k_p)$ and $D(k_f)$ to $D(y)$, and “reverse causality” from $D(y)$ to $D(k_f)$ and, again, from $D(k_f)$ to $D(k_p)$, providing support for the complementarity hypothesis. Thus, although the ARDL technique ostensibly controls for the issue of endogeneity by selecting the “correct” number of lags (thus generating orthogonal residual errors which are independent of the regressors), the results from the reported Block-Granger causality estimates suggest the presence of “reverse causality or precedence” for some of the variables. Thus, this issue needs to be investigated further via the Johansen methodology and the application of direct exogeneity tests (zero restrictions) on the adjustment coefficients for each of the included (endogenous) variables (Note 7).

Table 4B. Block Granger Causality test for Labor Productivity, $D(y)$, equation, 1960-2020

VEC Granger Causality/Block Exogeneity Wald Tests			
Sample: 1960 2020			
Excluded	Chi-sq	df	Prob.
Dependent variable: $D(y)$			
$D(k_p)$	10.63288	4	0.0310
$D(k_f)$	17.51055	4	0.0015
All	24.56039	8	0.0018
Dependent variable: $D(k_p)$			
$D(y)$	2.300139	4	0.6807
$D(k_f)$	11.51764	4	0.0213
All	13.42246	8	0.0981
Dependent variable: $D(k_f)$			
$D(y)$	14.39017	4	0.0061
$D(k_p)$	5.811825	4	0.2136
All	25.47340	8	0.0013

5. Conclusion

This paper utilized an ARDL modelling technique to evaluate whether foreign capital complements or substitutes for private capital and economic output (labor productivity) in the Chilean economy for the 1960-2020 period. It motivated discussion by presenting a modified production function which treated the foreign capital stock as an additional input and provided an economic rationale for its inclusion. The paper also addressed the issue of whether inward foreign direct investment diverts resources away from the financing of private investment spending via the repatriation of profits and dividends back to parent companies, often residing in developed countries.

Several important findings were revealed. First, the Bounds test indicated that the included $I(0)$ and $I(1)$ variables in both the production (labor) productivity functions are cointegrated. Thus, there is a long-term and stable relationship between the variables over the period under review. The error-correction terms for both functions indicated that deviations away from the long-term output (labor) productivity relationship are corrected in subsequent periods. Second, the results suggest that both private and foreign capital have a positive (long-term)

effect on both economic output and labor productivity, controlling for both quantitative and qualitative variables included in the empirical model, such as the terms of trade and dummy variables. Third, the model diagnostics for both the output and labor productivity equations indicated that the estimates do not exhibit serial correlation and heteroscedasticity, and that they are structurally stable over the period under review. Fourth, the estimates for the output and labor productivity equations which include the “net” foreign capital stock (viz., adjusted for the repatriation of profits), suggest that foreign capital continues to have a positive, albeit smaller, effect on economic output and labor productivity. The latter finding suggests that, although the impact of foreign capital in terms of financing may be diminished, it still may be providing other benefits or externalities in the form of the transfer of better technologies and managerial expertise. Fifth, Block-Granger “causality” tests find strong support for precedence from foreign and private domestic capital to output (labor productivity), but also for “reverse causality or precedence” from output (labor) productivity to foreign capital and from foreign capital to private domestic capital. The latter finding provides additional support for the complementarity hypothesis.

From a policy standpoint, the results reported in this study for Chile suggest that policy makers should strive to attract inward foreign direct investment into key export- and import-competing sectors of their economies, provided that there is also a regulatory framework in place which prevents what is often a massive reverse flow of resources out of the country in the form of profits and dividends. It should be emphasized, however, that these are *partial* results, since we do not take into account the *financing* and promotional costs associated with state-sponsored efforts to attract foreign direct investment (e.g., the elimination of taxes on the repatriation of profits and/or the borrowing costs associated with building economic infrastructure to accommodate the demands of foreign capital), both of which introduce distortions and costs that may exceed the social rate of return to foreign direct investment. Also, as indicated above, future research on this topic needs to directly address the inherent problem of endogeneity via exogeneity (zero restriction) tests and include additional control variables such as government investment spending or government consumption expenditures (for further details, see Ramirez, 2026).

References

- Albala-Bertrand, J. M., & Mamatzakis, E. C. (2001). Is Public infrastructure productive? evidence from Chile. *Applied Economic Letters*, 8(3), 195-199.
<https://doi.org/10.1080/13504850150504595>
- Aschauer, D. A. (1989). Public investment and productivity growth in the Group of Seven. *Economic Perspectives*, 13, 17-25.
- Agosin, M. R. (1999). Trade and Growth in Chile. *Cepal Review*, 68, 79-100.
<https://doi.org/10.18356/18ba57ab-en>
- Asteriou, D., & Hall, S.G. (2021). *Applied Econometrics*. London: MacMillan International.
- Banco Central de Chile. *Indicadores Economicos y Sociales*, 1960-2001 [August 2003 14: Excel edition].

Blomstrom, M., & Wolff, E. (1994). Multinational corporations and productivity convergence in Mexico. In W. Baumol, R. Nelson & Wolff (Eds.), *Convergence of productivity: Cross-national Studies and historical evidence*. Oxford University Press.

<https://doi.org/10.1093/oso/9780195083903.003.0010>

Bouton, L., & Sumlinski, M. A. (2001). *Trends in private investment spending in developing nations: Statistics for 1970-2000*. Washington, D.C.: International Finance Corporation.

<https://doi.org/10.1596/0-8213-4785-3>

Chakraborty, C., & Basu, P. (2002). Foreign direct investment and growth in India: A cointegration approach. *Applied Economics*, 34, 1061-1074.

<https://doi.org/10.1080/00036840110074079>

Chang, H-J. (2008). *Bad Samaritans*. New York: Bloomsbury Press.

Chen, C., Chang, L., & Zhang, Y. M. (1995). The role of foreign direct investment in China post-1978 economic development. *World Development*, 4(23), 691-703.

[https://doi.org/10.1016/0305-750X\(94\)00143-M](https://doi.org/10.1016/0305-750X(94)00143-M)

Chari, A., Henry, P. B., & Reyes, H. (2021). The Baker Hypothesis: Stabilization, Structural Reforms, and Economic Growth. *Journal of Economic Perspectives*, 35(3), 83-108.

<https://doi.org/10.1257/jep.35.3.83>

Cicea, C., & Marinescu, C. (2020). Bibliometric analysis of foreign direct investment and economic growth relationship. *Journal of Business Economics and Management*, 2(22), 445-466. <https://doi.org/10.3846/jbem.2020.14018>

Cypher, J. M., & Dietz, J. L. (2020). *The Process of Economic Development*. Fifth Edition. New York: Routledge. <https://doi.org/10.4324/9780429289248>

De Mello, L. R. Jr. (1997). Foreign direct investment in developing countries and growth: A selective survey. *Journal of Development Studies*, 34, 1-34.

<https://doi.org/10.1080/00220389708422501>

Economic Commission for Latin America and the Caribbean (ECLAC). (2012-2023). *Preliminary Overview of the Economies of Latin America and the Caribbean*, Santiago, Chile: United Nations.

Dunning, J. H. (1988). *Explaining international production*. London: Harper and Collins.

ECLAC. (2015-2023). *Economic Surveys of Latin America and the Caribbean 2013-2022*, Santiago, Chile: United Nations

Goldfajn, I., Martinez, L., & Valdez, R. O. (2021). Washington Consensus in Latin America: From Raw Model to Straw Man. *Journal of Economic Perspectives*, 35(3), 109-132.

<https://doi.org/10.1257/jep.35.3.109>

Green, D. (2013). *Faces of Latin America*. 4th ed. New York: Monthly Review Press.

Green, D. (2005). *Silent Revolution: The Rise and Crisis of Market Economies in Latin*

America. New York: Monthly Review Press.

Huang, T. Jr. (2004). Spillovers from FDI in China. *Contemporary Economic Policy*, 22, 13-25. <https://doi.org/10.1093/cep/byh002>

Johansen, S., & Joselius, K. (1990). Maximum likelihood estimation and inference on cointegration with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52, 169-210. <https://doi.org/10.1111/j.1468-0084.1990.mp52002003.x>

Kehal, H. S. (2004). *Foreign Direct Investment in Developing Countries*. New York: Palgrave Macmillan Ltd. <https://doi.org/10.1057/9780230554412>

Kirchgassner, G., Wolters, J., & Hassler, U. (2013). *Introduction to Modern Time Series Analysis*. London: Springer. <https://doi.org/10.1007/978-3-642-33436-8>

Kumar, A. (2007). Does Foreign Direct Investment Help Emerging Economies? *Economics Letter*, 2, 1-8.

Narayan, P. K. (2004). Reformulating critical values for the bounds F-statistics approach to cointegration: An application to the tourism demand model for Fiji (Vol. 02/04, pp. 1–32). *Discussion Papers Monash University*.

Narayan, P. K. (2005). The saving and investment nexus for China: Evidence from cointegration tests. *Applied Economics*, 37(17), 1979-1990. <https://doi.org/10.1080/00036840500278103>

Nkoro, E., & Uko, A. K. (2016). Autoregressive distributed lag (ARDL) cointegration technique: application and interpretation. *Journal of Statistical and Econometric Methods*, 5(4), 63-91.

OECD. 2003. *Economic Surveys: Chile*. Paris: OECD

Osei, M. J., & Kim, C. J. (2020). Foreign direct investment and economic growth: Is more financial Development better? *Economic Modelling*, 93, 154-161. <https://doi.org/10.1016/j.econmod.2020.07.009>

Patterson, K. (2000). *An Introduction to Applied Econometrics: A Time-Series Approach*. London: Palgrave Macmillan.

Pesaran, M. H., & Shin, Y. (1998). Generalized impulse response analysis in linear multivariate models. *Economics Letters*, 58(1), 17-29. [https://doi.org/10.1016/S0165-1765\(97\)00214-0](https://doi.org/10.1016/S0165-1765(97)00214-0)

Pesaran, M. H., Shin, Y., & Smith, R. J. (2000). Structural analysis of vector error correction models with I (1) variables. *Journal of Econometrics*, 97(2), 293-343. [https://doi.org/10.1016/S0304-4076\(99\)00073-1](https://doi.org/10.1016/S0304-4076(99)00073-1)

Pesaran, M. H., Shin, Y., & Smith, R.J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289-326. <https://doi.org/10.1002/jae.616>

Rodrik, D. (2018). *Straight Talk on Trade*. Princeton: Princeton University Press.

<https://doi.org/10.1515/9781400888900>

Ramirez, M. D. (2026). Foreign Direct Investment and Net Reverse Transfers from Latin America and the Caribbean, *Atlantic Economic Journal*, 54(1), 59-74.

<https://doi.org/10.1007/s11293-026-09848-4>

Ramirez, M. D. (2006). Is Foreign Direct Investment Beneficial for Mexico? An Empirical Analysis, 1960-2001, *World Development*, 34(5), 802-817.

<https://doi.org/10.1016/j.worlddev.2006.01.001>

Ram, R. (1986). Government size and economic growth. *American Economic Review*, 76, 191-203.

Ram, R., & Zhang, K. H. (2002). Foreign Direct Investment and Economic Growth: Evidence from Cross-Country Data for the 1990s, *Economic Development and Cultural Change*, 51, 205-215. <https://doi.org/10.1086/345453>

UNCTAD. (2012-2024). *World Investment Reports* 2012, 2015, 2017, 2022, 2023, and 2024. New York: United Nations Conference on Trade and Development.

Notes

Note 1. The interested reader is referred to a seminal study by Bosworth and Collins (1999) which presents pooled data for developing nations during the 1979-95 period. The estimates suggest that FDI has a positive and statistically significant effect on private investment spending and savings, while portfolio investment has-- in both cases--a statistically insignificant effect. For further details see Table 4, p.162.

Note 2. Foreign investment and other economic data (including profit remittances) used in this study were obtained from official sources such as the Banco Central de Chile, *Indicadores Economicos y Sociales*, 1960-2001 [August 2003: Excel edition]; International Finance Corporation (IFC), Economic Commission for Latin America and the Caribbean (ECLAC), Organization for Economic Cooperation and Development (OECD), *Economic Surveys: Chile*. Paris: OECD., and United Nations Conference on Trade and Development (UNCTAD). See References for further details.

Note 3. The rationale for focusing on the rate of labor productivity growth, rather than output growth, resides in the notion that the accumulation of FDI over time generates a spillover efficiency to the workforce via the transfer of better machinery and equipment as well as managerial know-how. In fact, even if the TNCs do not share the technology with the local firms, they may still have a positive effect on overall labor productivity as local firms are forced to train their labor and management to catch up with their foreign competitors. For further detail see Blomstrom and Wolf (*op. cit.*) who find that labor productivity growth in Mexico is positively associated with the degree of foreign concentration in each industry (pp. 263-284).

Note 4. Following the neoclassical approach, the coefficients on labor, private capital, and foreign capital are constrained to sum to unity so that the growth rate elasticities of the dynamic production function equal their factor shares, provided, of course, that factor and product markets are perfectly competitive. However, since this may be an untenable assumption for a developing country such as Chile, I tested the restriction via the Wald test and failed to reject the null hypothesis of constant returns to scale (p-value: 0.934). For further details, see Chakraborty, C., and Basu, P. (2002).

Note 5. The unit root results for the ADF and Phillips-Perron tests are reported in Table A1 and A2 in the Appendix.

Note 6. As a robustness check, the *pairwise* Granger causality tests for the production function are reported below and they are generally consistent with those reported for the Block-Granger causality test.

Pairwise Granger Causality Tests			
Sample: 1960 2020			
Null Hypothesis:	Obs	F-Statistic	Prob.
InL does not Granger Cause InY	57	1.28658	0.2885
InY does not Granger Cause InL		0.77597	0.5463
InK _p does not Granger Cause InY	55	2.44741	0.0489
InY does not Granger Cause InK _p		0.54346	0.7046
InK _f does not Granger Cause InY	57	4.35692	0.0044
InY does not Granger Cause InK _f		3.02052	0.0266
InK _p does not Granger Cause InL	55	0.29964	0.8767
InL does not Granger Cause InK _p		2.10372	0.0956
InK _f does not Granger Cause InL	57	1.36513	0.2600
InL does not Granger Cause InK _f		2.94013	0.0297
InK _f does not Granger Cause InK _p	55	2.44207	0.0525
InK _p does not Granger Cause InK _f		1.75999	0.1532

7. The Block-Granger results are consistent with the *pairwise* Granger causality tests undertaken in this study. The results are given below:

Pairwise Granger Causality Tests			
Sample: 1960 2020			
Null Hypothesis:	Obs	F-Statistic	Prob.
D(k _p) does not Granger Cause D(y)	55	2.63429	0.0460
D(y) does not Granger Cause D(k _p)		0.84495	0.5040
D(k _f) does not Granger Cause D(y)	57	2.62301	0.0461
D(y) does not Granger Cause D(k _f)		8.49256	3.E-05
D(k _f) does not Granger Cause D(k _p)	55	2.86613	0.0335
D(k _p) does not Granger Cause D(k _f)		1.33799	0.2702

Appendix

Table A1. Augmented Dickey Fuller (ADF) Unit Root Tests with constant, 1960-2020

Variables	Level	First Difference	5% Critical Value
lnY	-0.54	-6.49*	-2.91
lnL	-3.25*	-5.66*	-2.91
lnK _p	-0.57	-4.10*	-2.91
lnK _f	-0.23	-3.29*	-2.91
TOT	-6.39*	-7.65*	-2.91

Note: MacKinnon (1996) critical values for rejection of hypothesis of a unit root. * Denotes significance at the 5 percent level.

Table A2. Phillips-Perron (PP) Unit Root Tests with constant, 1960-2020

Variables	Level	First Difference	5% Critical Value
lnY	-0.55	-6.48*	-2.91
lnL	-3.24*	-6.01*	-2.91
lnK _p	-1.34	-4.08*	-2.91
lnK _f	-0.53	-3.31*	-2.91
TOT	-6.37*	-29.65*	-2.91

Note: MacKinnon (1996) critical values for rejection of hypothesis of a unit root. * Denotes significance at the 5 percent level.